

Hazardous Activities and Industries List guidance

Identifying HAIL land



Ministry for the
Environment
Manatū Mō Te Taiao



Te Kāwanatanga o Aotearoa
New Zealand Government

Disclaimer

The information in this publication is, according to the Ministry for the Environment's best efforts, accurate at the time of publication. The Ministry will make every reasonable effort to keep it current and accurate. However, users of this publication are advised that:

- the information provided has no official status and so does not alter the laws of New Zealand, other official guidelines or requirements
- it does not constitute legal advice, and users should take specific advice from qualified professionals before taking any action as a result of information obtained from this publication
- the Ministry does not accept any responsibility or liability whatsoever whether in contract, tort, equity or otherwise for any action taken as a result of reading, or reliance placed on this publication because of having read any part, or all, of the information in this publication or for any error, or inadequacy, deficiency, flaw in or omission from the information provided in this publication
- all references to websites, organisations or people not within the Ministry are provided for convenience only and should not be taken as endorsement of those websites or information contained in those websites nor of organisations or people referred to
- the information provided should not be considered as comprehensive or complete. Every site should be evaluated on its own merits, rather than assuming this guidance has covered every possible combination of contaminants and factors.

Acknowledgements

This document was prepared with help from Erin Richards, Natalie Webster and Graeme Proffitt of Pattle Delamore Partners Ltd for the Ministry for the Environment, with input from representatives of regional councils, territorial and unitary authorities, oil industry and senior contaminated land practitioners.

We would also like to acknowledge the WasteMINZ Technical Working Group: Kevin Tearney, Martyn O'Cain, Davina McNickel, Graeme Proffitt, Marcus Herrmann, Graham Aveyard, Rachel Rait, Bradley Bellamy, Rochelle Jacobs and Ester Powell.

This document may be cited as: Ministry for the Environment. 2023. *Hazardous Activities and Industries List guidance: Identifying HAIL land*. Wellington: Ministry for the Environment.

Published in March 2023 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10362, Wellington 6143, New Zealand

ISBN: 978-1-991077-40-0
Publication number: ME 1751

© Crown copyright New Zealand 2023

This document is available on the Ministry for the Environment website: environment.govt.nz.

Contents

Abbreviations	4
Glossary	6
1 Purpose of this guidance	7
2 Background to the HAIL	8
2.1 HAIL categories and activities	8
3 HAIL activity profiles	10
3.1 Introduction to HAIL activity profiles	10
3.2 Use of HAIL activity profiles	11
Part A: Hazardous Activities and Industries List	12
Part B: HAIL activity profiles	15
A Chemical manufacture, application and bulk storage	16
B Electrical and electronic works, power generation and transmission	109
C Explosives and ordnance production, storage and use	134
D Metal extraction, refining and reprocessing, storage and use	148
E Mineral extraction, refining and reprocessing, storage and use	179
F Vehicle refuelling, service and repair	209
G Cemeteries and waste recycling, treatment and disposal	253
H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment	276
I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment	279
Part C: Supplementary information and additional considerations	281
Bibliography	283

Abbreviations

1080	Sodium monofluoroacetate
2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
2,4-D	2,4-Dichlorophenoxyacetic acid
2,4-DB	4-(2,4-dichlorophenoxy)butyric acid
ACM	Asbestos-containing material
AFFF	Aqueous film forming foam (for firefighting)
ANZECC	Australian and New Zealand Environment and Conservation Council
BRANZ	Building Research Association of New Zealand
BAP	Benzo(a)pyrene
BTEX	Benzene, toluene, ethylbenzene and total xylene
CCA	Chromated copper arsenate
DCE	1,2-dichloroethene or dichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
DNAPL	Dense non-aqueous phase liquid
DNT	2,6-dinitro toluene
HAIL	Hazardous Activities and Industries List
IBCs	Intermediate bulk containers
LNAPL	Light non-aqueous phase liquid
LOSP	Light organic solvent preservative
LPG	Liquifiable petroleum gas
MCPA	2-methyl-4-chlorophenoxyacetic acid
MCPB	4-(4-chloro-2-methylphenoxy)butanoic acid
MEK	Methyl ethyl ketone
NESCS	Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011
MSMA	Monosodium methanearsonate
MTBE	Methyl tertiary-butyl ether
OCPs	Organochlorine pesticides
OPEs	Organophosphate esters
OPPs	Organophosphates
PAHs	Polycyclic aromatic hydrocarbons
PBDEs	Polybrominated diphenyl ethers
PBBzs	Polybromobenzenes
PCBs	Polychlorinated biphenyls

PCE	Perchloroethylene
PCNB	Pentachloronitrobenzene
PCP	Pentachlorophenol
PFAS	Per- and poly-fluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
POP	Persistent organic pollutant
PSI	Preliminary site investigation
PTFE	Polytetrafluoroethylene
RDX	Cyclo-trimethylene trinitramine
TBT	Tributyltin
TCE	Trichloroethene
TEL	Tetraethyl lead
TML	Tetramethyl lead
TNT	Trinitrotoluene
VTAs	Vertebrate toxic agents

Glossary

Activity factors: aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

Conceptual site model (CSM): a representation of the source (contaminants), receptors (such as site users or the environment) and any exposure pathways.

Exposure area: a relatively geologically and chemically homogeneous area over which a receptor can expect a uniform level of exposure to identified contaminants when undertaking a particular activity. An exposure area may form part of a larger heterogeneous site. Also referred to as a 'decision unit' or 'averaging area'. See Contaminated Land Management Guidelines No. 5 (Ministry for the Environment, 2021), section 4.2.3.

HAIL activity: any one of the 53 individual activities and industries listed on the HAIL, denoted by a HAIL category letter followed by a number, for example, A2 – Chemical manufacture, formulation or bulk storage. HAIL categories H and I are also HAIL activities.

HAIL activity profile: information about each HAIL activity relating to a source of contamination that has the potential to pose a risk to human health and the environment.

HAIL category: the broad categories denoted by a letter A to I on the HAIL, which group broadly similar HAIL activities together, for example, category G – Cemeteries and waste recycling, treatment and disposal. HAIL categories H and I are also HAIL activities.

HAIL land: means land that is, or has been, used for an activity or industry listed on the HAIL.

Half-life: the time it takes for the concentration of a substance to be reduced by 50 per cent.

Hazardous substance: includes any substance defined in section 2 of the Hazardous Substances and New Organisms Act 1996 as a hazardous substance.

NESCS: the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011. The principal piece of legislation under which territorial local authorities regulate contaminated land. Land where a HAIL activity has been undertaken is subject to the NESCS when any of the five regulated activities are proposed.

Site: the property or properties where a HAIL activity has been undertaken. A site may include a single parcel of land or multiple parcels. A site is not the same as a **Piece of Land**, which as above, encompasses the footprint of a HAIL activity, irrespective of property boundaries.

Substance factors: characteristics or properties of contaminants or hazardous substances that affect the exposure risk posed by the substance, such as mobility, persistence or toxicity.

1 Purpose of this guidance

This document provides guidance for identifying and classifying Hazardous Activities and Industries List (HAIL) land.

It provides details on the scope of each of the 53 activities and industries listed on the HAIL. This information will assist in determining whether land meets the criteria to be classified as HAIL, that is, land that has been used, or is currently being used, for one or more HAIL activities.

It has two additional purposes, as follows.

1. HAIL categorisation

To clarify the scope and coverage of the HAIL categories and define specific terminology.

To improve consistency in decision making among users of the guidance when assessing a site against a land use listed on the HAIL.

2. HAIL characterisation

To provide initial information to characterise a site, in order to inform a conceptual site model for the purposes of supporting a high-level risk assessment.

This document includes HAIL activity profiles that describe each HAIL activity and the scope of its intended coverage and distinguish between similar categories. Each activity profile includes several important factors about each HAIL activity, including the contaminants of concern, mechanisms for contamination and risk factors.

This guidance focuses on enabling users to make informed decisions on the identification, classification and registration of HAIL land, and the assessment of resource consent applications for HAIL land. It also contains information useful for making a high-level judgement about the level of risk that HAIL land may pose to human health and the environment.

This guidance should be read in conjunction with [Contaminated Land Management Guidelines No. 4: Classification and information management protocols](#) (Ministry for the Environment, 2006) and [Contaminated Land Management Guidelines No. 5: Site investigation and analysis of soils](#) (Ministry for the Environment, 2021). This is to ensure best practice is applied to assigning the correct category, determining the relevant contaminants of concern and developing a robust and reliable conceptual site model.

2 Background to the HAIL

The Resource Management Act 1991 prescribed the functions of local government for the management of natural and physical resources under that Act, including functions relating to contaminated land.

The HAIL was introduced to assist councils to identify contaminated sites to meet their statutory obligations under the Resource Management Act.

It has been the reference for defining potentially contaminated land since the Act was given effect in 1991. It has been influential in the development of regional, unitary and district plan rules relating to the use and management of contaminated land. These rules ensure activities can take place in accordance with the relevant statutory requirements either as permitted activities (with no or limited controls) or as activities that require an environmental authorisation, such as a resource consent.

The HAIL is a revision of the list of industrial activities first published in the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC, 1992). It was later published as Contaminated Land Management Guidelines Schedule A (Ministry for the Environment, 2004b). An additional list, with typical hazardous substances for each HAIL category, was published as Contaminated Land Management Guidelines Schedule B (Ministry for the Environment, 2004c).

2.1 HAIL categories and activities

The HAIL is a list of 53 activities and industries that are considered likely to cause land contamination through the use, storage or disposal of hazardous substances.

The activities and industries have been grouped into nine categories (A–I).

Categories A to G group together broadly similar industry and activity types.

Categories H and I are also HAIL activities and cover land subject to the migration, or the intentional or accidental release, of hazardous substances. These categories apply where no defined site use, activity or specific substance is identified as a common cause of contamination.

The HAIL categories are:

- Category A – Chemical manufacture, application and bulk storage
- Category B – Electrical and electronic works, power generation and transmission
- Category C – Explosives and ordnance production, storage and use
- Category D – Metal extraction, refining and reprocessing, storage and use
- Category E – Mineral extraction, refining and reprocessing, storage and use
- Category F – Vehicle refuelling, service and repair
- Category G – Cemeteries and waste recycling, treatment and disposal
- Category H – Land that has been subject to the migration of hazardous substances
- Category I – Land that has been subject to the intentional or accidental release of a hazardous substance.

Many large-scale industries are likely to encompass more than one HAIL activity. Such activities should be recorded as specifically as possible. This may result in a site having more than one HAIL activity assigned to it.

3 HAIL activity profiles

3.1 Introduction to HAIL activity profiles

The HAIL activity profiles have been developed to improve consistency when using the HAIL to determine whether land is or has been subject to a HAIL land use. A detailed description of each HAIL activity has been provided to enable informed decisions about HAIL land.

The profiles include a summary of the factors and attributes specific to each of the 53 HAIL activities. Each profile provides information that will give the user an understanding of the activity in terms of its potential to cause contamination.

The HAIL activity profiles provide the following information for each HAIL activity:

- **a general description of the category:** to inform a HAIL categorisation
- **HAIL activity intention:** a brief description and summary of the scope of the activity, to give insight into why the activity or industry was included on the HAIL. This includes:
 - description of the activity or industry
 - activity applicability
 - contamination setting
- **exclusions:** some activities may be specifically excluded from being classified as a particular HAIL activity. This may be because the activity does not pose a significant risk to human health or the environment under normal conditions, or because it fits better within another HAIL activity
- **activity factors:** covers distinct components of each activity. These processes may be specific to each HAIL activity. Each profile covers the likely mechanisms for contamination and risk factors
- **substance factors:** address the main contaminants of concern that are typically associated with each HAIL activity. These tables cover:
 - chemical persistence
 - period of use
 - general comments, which provides information about each contaminant in that HAIL activity
- **period of use:** this column provides significant dates between which the HAIL activity is likely to have included the use, storage or disposal of persistent hazardous substances. This may include the timeframe during which specific hazardous substances were available and in use. The possibility exists in all HAIL activities that substances that are no longer permitted may still have been used. These dates are a general guide, rather than a definitive date range.

3.2 Use of HAIL activity profiles

How the HAIL activity profiles will assist with HAIL identification

The HAIL activity profiles provide detailed information for the verification and registration of HAIL land.

The activity profiles also provide information to assist with the determination on whether the land use history may trigger a resource consent for further investigations or controls.

Correctly identifying the most appropriate HAIL activity or activities based on past or present land use is critical to determining the likely contaminants and potential risks to human health and the environment.

The HAIL activity profiles will assist councils when following the process outlined in Contaminated Land Management Guidelines No. 4 (Ministry for the Environment, 2006).

How the HAIL activity profiles will help with risk assessment

The HAIL activity profiles include information about the potential mechanisms of contamination, common exposure pathways, and the likely contaminants of concern associated with the HAIL activity.

The activity profile information will support the initial design and scope of conceptual site models, site investigations and the assessment of site investigation reports.

Supplementary information is provided in part C and is intended to clarify definitions and concepts and to increase awareness of factors that affect contamination on a site-specific basis.

Part A: Hazardous Activities and Industries List

A Chemical manufacture, application and bulk storage

1. Agrichemicals, including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application
2. Chemical manufacture, formulation or bulk storage
3. Commercial analytical laboratory sites
4. Corrosives, including formulation or bulk storage
5. Dry-cleaning plants, including dry-cleaning premises or the bulk storage of dry-cleaning solvents
6. Fertiliser manufacture or bulk storage
7. Gasworks, including the manufacture of gas from coal or oil feedstocks
8. Livestock dip or spray race operations
9. Paint manufacture or formulation (excluding retail paint stores)
10. Persistent pesticide bulk storage or use, including sport turfs, market gardens, orchards, glass houses or spray sheds
11. Pest control, including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application
12. Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides
13. Petroleum or petrochemical industries, including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground
14. Pharmaceutical manufacture, including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges
15. Printing, including commercial printing using metal type, inks, dyes or solvents (excluding photocopy shops)
16. Skin or wool processing, including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products
17. Storage tanks or drums for fuel, chemicals or liquid waste
18. Wood treatment or preservation, including the commercial use of antisapstain chemicals during milling, or bulk storage of treated timber outside

B Electrical and electronic works, power generation and transmission

1. Batteries, including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)
2. Electrical transformers, including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
3. Electronics, including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices
4. Power stations, substations or switchyards

C Explosives and ordnance production, storage and use

1. Explosive or ordnance production, maintenance, dismantling, disposal, bulk storage or repackaging
2. Gun clubs or rifle ranges, including clay target clubs that use lead munitions outdoors
3. Training areas set aside exclusively or primarily for the detonation of explosive ammunition

D Metal extraction, refining and reprocessing, storage and use

1. Abrasive blasting, including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material
2. Foundry operations, including the commercial production of metal products by injecting or pouring molten metal into moulds
3. Metal treatment or coating, including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds
4. Metalliferous ore processing, including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals
5. Engineering workshops with metal fabrication

E Mineral extraction, refining and reprocessing, storage and use

1. Asbestos products manufacture or disposal, including sites with buildings containing asbestos products known to be in a deteriorated condition
2. Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)
3. Cement or lime manufacture using a kiln, including the storage of wastes from the manufacturing process
4. Commercial concrete manufacture or commercial cement storage
5. Coal or coke yards
6. Hydrocarbon exploration or production, including well sites or flare pits
7. Mining industries (excluding gravel extraction), including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

F Vehicle refuelling, service and repair

1. Airports, including fuel storage, workshops, washdown areas, or fire practice areas
2. Brake lining manufacturers, repairers or recyclers
3. Engine reconditioning workshops
4. Motor vehicle workshops
5. Port activities, including dry docks or marine vessel maintenance facilities
6. Railway yards, including goods-handling yards, workshops, refuelling facilities or maintenance areas
7. Service stations, including retail or commercial refuelling facilities
8. Transport depots or yards, including areas used for refuelling or the bulk storage of hazardous substances

G Cemeteries and waste recycling, treatment and disposal

1. Cemeteries
2. Drum or tank reconditioning or recycling
3. Landfill sites
4. Scrap yards including automotive dismantling, wrecking or scrap metal yards
5. Waste disposal to land (excluding where biosolids have been used as soil conditioners)
6. Waste recycling or waste or wastewater treatment

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

Part B: HAIL activity profiles

Notes regarding use of these activity profiles

The profiles summarise the main factors and attributes specific to each of the 53 HAIL activities. They are useful for identifying sites where a HAIL activity is or has been undertaken.

Specific examples of exclusions are given where there are similarities in land use.

Each profile includes activity and substance factors that outline the nature and extent of risks and exposures of a HAIL activity.

- **Activity factors:** the activity factors are an overview of the main considerations about the activity and include a description of the activity's processes, the mechanism of potential contamination and the risk factors. This covers aspects or characteristics of a HAIL activity that show the extent, severity or nature of the potential contamination. The potential for contamination from the use, storage and disposal of hazardous substances will depend on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.
- **Substance factors:** the substance factors are an overview of the main considerations about the relevant contaminants. They include a description of chemicals of concern, the chemical persistence, period of use and general comments. These factors cover the characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use, and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model (Ministry for the Environment, 2021).

A Chemical manufacture, application and bulk storage

A1 Agrichemicals, including commercial premises used by spray contractors for filling, storing or washing out tanks for agrichemical application

HAIL activity intention

Description	<p>Agrichemicals are defined in NZS 8409 as “plant protection products (herbicides, insecticides, fungicides), veterinary medicines, and agricultural use of detergents and sanitizers”. Many are hazardous substances with the potential to adversely affect the environment and human health.</p> <p>This activity relates to discrete areas where agrichemicals are mixed for spraying and where tanks are washed out or stored. Such areas have a higher likelihood of soil contamination because many types of chemicals are handled repeatedly in one location. Soils in these areas become saturated and the chemical degradation capacity is reduced, this means chemical residence times are likely to be longer, and contaminants may be present at greater depths in the soil profile. The nature of this activity creates a unique contamination signature as opposed to areas affected by the widespread application of agrichemicals</p>
Applicability	<p>This category is intended to apply to areas on sites where spray tanks and agrichemical containers have been repeatedly filled, stored or washed out, creating a discrete or localised area of elevated contaminant concentrations relevant to the remainder of the site (a hotspot). Such areas are often part of a site where commercial-scale activities have taken place, including farms, vineyards, forestry blocks, sports fields and turfs, golf courses, and spraying contractors’ yards.</p> <p>For purposes of identification in this category, a spray contractor may include anyone who prepares and uses agrichemicals on an agricultural or commercial scale.</p> <p>Tanks include tanks on plant and machinery for the application of agrichemicals, such as spraying tanks on tractors, utes or quad bikes, and may include helicopter spray tanks and backpack spraying tanks.</p>
Contamination setting	<p>Impacted areas on a site are likely to have been exposed to varying and potentially high concentrations of a variety of agrichemicals for many years. Due to the practice of filling, mixing and washing out tanks, and/or deliberate disposal of rinsate or wash water, a hotspot of contamination can be created in the immediate filling area. This is likely to be in the area where tanks are stored due to leakage or poor storage practices.</p>
Exclusions	<ul style="list-style-type: none"> • Broad-acre application of agrichemicals, such as forestry, sports turfs, viticulture, paddocks and field crops. • Locations where an accidental release of an agrichemical has occurred. • Storage or mixing of agrichemicals in a residential setting (where small volumes of product would be handled at one time and any spills that were to occur would be limited in extent). • Storage of agrichemicals in original containers in a retail setting.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Filling tanks with agrichemicals	Filling tanks includes handling open containers of agrichemicals in their concentrated form, and adding these to the tank, while agitating the contents to mix them properly. This practice creates opportunities for discharges to land from slops, spills and splashes, as well as airborne dust drift from powders.	<p>Spills or leaks (through damaged or old tanks and fittings and equipment) of agrichemicals onto land at tank-mixing locations.</p> <p>Drift of wettable powders and dry flowable products.</p> <p>Direct flow path to surface soils in immediate and/or limited area.</p> <p>Overland flow paths to surrounding and/or wider area and to sensitive receiving environments.</p> <p>Impermeable soils draining spills away to sensitive receiving environments.</p> <p>Migration into shallow soil profile and deeper to groundwater.</p>	<ul style="list-style-type: none"> • The types and volume of agrichemicals used, including their persistence and toxicity. • Condition of the tanks, lines and nozzles from which any leaks could occur. • Processes and safeguards to prevent discharges. • The period and frequency over which tank filling took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Storing agrichemicals in application tanks	Storage of agrichemicals involves having multiple tanks of agrichemicals stored in an area over a long period, to the extent of several years or on a permanent basis. Storage practices may also include storing tanks full of agrichemical mixtures because of mixing more than was needed, or not being able to complete spraying due to weather or other factors.	<p>Drips and leaks (through damaged and old tanks and fittings) of agrichemicals onto land at storage locations.</p> <p>Contamination of surface soils in limited area.</p> <p>Overland flow paths to surrounding and/or wider area and to sensitive receiving environments.</p> <p>Impermeable soils could drain spills away to sensitive receiving environments.</p> <p>Migration into shallow soil profile and deeper to groundwater.</p>	<ul style="list-style-type: none"> • The types and volume of agrichemicals used, including their persistence and toxicity. • Condition of the tanks, lines and nozzles from which any leaks could occur. • Processes and safeguards to prevent discharges. • The period and frequency over which storage in tanks occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Washing out tanks	Washing out tanks after application involves rinsing the tanks, lines and nozzles to remove any residue from the previous batch of agrichemicals and disposing of the wash water generated by washing tanks. Wash water can contain additives used to decontaminate spraying equipment, including	<p>Spills or leaks (through damaged or old tanks and fittings and equipment) of agrichemicals onto land at cleaning locations.</p> <p>Point source of contamination for surface soils in limited area.</p>	<ul style="list-style-type: none"> • The types and volume of agrichemicals used, including their persistence and toxicity. • Condition of the tanks, lines and nozzles from which any leaks could occur. • Practices and process for disposal of contents. Historical practices varied, and, in worst cases, the

Activity	Description	Mechanism of contamination	Risk factors
	substances such as ammonia, detergent or other products specific to the agricultural residues being neutralised or removed from the equipment.	<p>Overland flow paths to surrounding and/or wider area and to sensitive receiving environments.</p> <p>Impermeable soils could drain spills away to sensitive receiving environments.</p> <p>Migration into shallow soil profile and deeper to groundwater.</p>	<p>remaining spray and/or wash water may have been dumped from the tanks to ground or into a watercourse.</p> <ul style="list-style-type: none"> The period and frequency over which these operations occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
Metals and metalloids	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	<p>Arsenic: Late 1800s to late 1970s.</p> <p>Cadmium (as contaminant in fertiliser): 1880s to present.</p> <p>Copper: 1800s to present.</p> <p>Lead: Late 1800s to 1970s.</p> <p>Mercury: 1940s to 1960s (mainly as a seed treatment, otherwise rare).</p> <p>Zinc: 1800s to present.</p>	<p>Toxicity is specific to the element and the chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
<p>Acidic herbicides</p> <p>Acidic herbicides are a group of compounds that include derivatives of phenol (pentachlorophenol), benzoic acid (dicamba), acetic acid (2,4-D, MCPA, 2,4,5-T), propanoic acid (dichlorprop, fenoprop, mecoprop) and butanoic acid (2,4-DB, MCPB)</p>	<p>Persistence in soil increases with concentration as micro-organisms that degrade acid herbicides are affected. Spills of concentrated herbicide, or prolonged repeated discharges of dilute herbicide mixtures, can compromise the ability of soil organisms to break down acid herbicides and, in such cases, the contaminants can be persistent.</p>	<p>1950s to present.</p>	<p>Human health effects and environmental toxicity are specific to the herbicide and the chemical form that the herbicide is in.</p> <p>Acidic herbicides are used mainly for broadleaf weed control, and there are many hundreds of brand name compounds, each with a specific purpose.</p> <p>The active ingredient used in each herbicide determines how the product works, how it persists and its mobility in</p>

Key contaminants of concern	Chemical persistence	Period of use	General comments
			soils. Contamination with dioxins during manufacture was a common problem.
<p>Organophosphates (OPPs) and organonitrogens (including carbamates)</p> <p>Common trade names include: parathion, malathion, chlorpyrifos, diazinon, dichlorvos, phosmet, fenitrothion, tetrachlorvinphos, azamethiphos, azinphos-methyl and terbufos</p>	<p>Persistence in soil increases with concentration as micro-organisms that degrade OPPs are affected. Spills of concentrated herbicide, or prolonged repeated discharges of dilute OPP mixtures, can compromise the ability of soil organisms to break down the OPPs, and, in such cases, the contaminants may be persistent.</p>	<p>OPPs are widely used as pest control agents and represent about 50% of currently used insecticides.</p> <p>1940s to 1960s to present, some phased out before 2016.</p>	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>OPPs are generally acutely toxic to vertebrates (including humans) and invertebrates in terrestrial and aquatic habitats.</p>
<p>Organochlorines</p> <p>Organochlorine pesticides (OCPs) are generally categorised as chlorinated cyclodienes, chlorodiphenylethane, chlorinated benzenes and cyclohexanes</p>	<p>OCPs are characteristically described as persistent and bioaccumulating substances prone to long-range transportation.</p> <p>Organochlorines are also very persistent in the environment, often remaining in soil for years or even decades.</p>	<p>1940s to current.</p> <p>Dieldrin was banned in 1987.</p> <p>Lindane banned for most uses in 1989, and all uses in 2015.</p> <p>DDT was banned in 1989.</p> <p>Chlorothalonil approvals mostly revoked in 2017.</p> <p>Difocol was listed as a persistent organic pollutant (POP) in 2020 and approval is currently being reviewed by the Environmental Protection Authority.</p> <p>Endosulfan was deregistered in 2008.</p>	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain.</p> <p>OCPs are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats.</p> <p>Historical application of OCPs was as an insecticide and a defoliant and they were widely used for this purpose from the 1940s to the 1960s.</p>
<p>Synthetic pyrethroids</p>	<p>Persistence in soil increases with concentration as micro-organisms that degrade pyrethroids are affected.</p> <p>Spills of concentrate, or prolonged repeated discharges of dilute pyrethroid mixtures, can compromise the ability of soil organisms to break down the substances and, in such cases, the contaminants can be persistent.</p>	<p>1970s to present.</p>	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Pyrethroids generally have low to moderate toxicity to vertebrates (including humans).</p> <p>Pyrethroids are highly toxic to invertebrates and fish.</p> <p>Pyrethroids are broad spectrum insecticides, effective against a wide range of insect pests.</p>

Key contaminants of concern	Chemical persistence	Period of use	General comments
Neonicotinoids	Neonicotinoids are water soluble and can remain active in soil for years. Rain or irrigation water can carry them long distances to contaminate new soil, plant life and water supplies.	1990s to present.	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Neonicotinoids are highly toxic to both terrestrial and aquatic insects. Evidence of their toxicity to birds, mammals, reptiles and fish is increasing, but further research is required.</p> <p>Neonicotinoids are a class of synthetic, neurotoxic insecticides that are widely used, including on agricultural crops, lawns, gardens, golf courses, and in flea and tick pet treatments.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A2

Chemical manufacture, formulation or bulk storage

HAIL activity intention

Description	<p>Chemical manufacture involves creating chemicals from raw products, while formulation involves mixing precursor substances to synthesise new chemicals or mixtures. Bulk storage associated with this activity relates to the storage of raw products, precursors, intermediates and final products used during or following manufacture or formulation. In the context of this category, bulk storage of chemicals refers to sites where chemicals have been manufactured or synthesised. Bulk storage of chemicals includes, but is not limited to:</p> <ul style="list-style-type: none">• storage of chemicals in purpose-made tanks or vessels• areas that have been repeatedly used to store chemicals in drums or intermediate bulk containers (IBCs) associated with chemical manufacture or bulk storage.
Applicability	<p>This category is intended to apply to sites that manufacture, formulate or store chemicals. This could include a broad range of chemicals and facility types. This category is not specific to a particular type of industry or any group or individual chemicals. Before assigning a site to this category, check whether another HAIL activity more closely matches the site use or is a better fit.</p>
Contamination setting	<p>Premises will include areas associated with a broad range of manufacturing, mixing, blending processes, materials handling and storage equipment. Potentially affected areas would be where equipment and machinery, storage vessels, tanks and piping are located. Areas where filling, spills and on-site disposal occur, particularly resulting from poor handling, storage and/or maintenance practices, may also be impacted.</p>
Exclusions	<ul style="list-style-type: none">• Sites where a more specific HAIL is a better fit, such as a pharmaceutical manufacturing plant.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Chemical manufacturing	<p>The broad nature of this activity can cover a wide range of equipment and multiple processes and methodologies used in the manufacturing of chemicals and an even wider range of products and chemicals.</p> <p>The scale of the operation can also vary significantly. This activity can be a large industrial plant producing a wide range of chemicals or a small unit producing a bespoke chemical.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged or old tanks and fittings and equipment) of product or chemicals onto land • impermeable surfaces draining to sensitive receiving environments • migration into shallow soil profile and deeper to groundwater from corroded drainage pipes and channels • inappropriate disposal to land of chemicals or products that were not suitable for their intended use. 	<ul style="list-style-type: none"> • The types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment. • Processes and safeguards to prevent discharges. • Permeability of soils and surfaces. • The period over which manufacturing took place. • How chemicals were manufactured: continuous process or batch production. • Volume of chemicals used. • Immediate and surrounding topography and proximity to sensitive receiving environments.
Chemical formulation	<p>The broad nature of this activity can cover a wide range of equipment and multiple processes and methodologies used in the formulation of chemicals and an even wider range of products and chemicals.</p> <p>The scale of the operation can also vary significantly. This activity can be a large industrial plant mixing or blending a wide range of chemicals or a small unit using one or two chemicals to produce a bespoke formulation.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged or old tanks and fittings and equipment) of product or chemicals onto land • impermeable surfaces draining spills away to sensitive receiving environments • migration into shallow soil profile and deeper to groundwater from corroded drainage pipes and channels • inappropriate disposal to land of chemicals or products that were not suitable for their intended use. 	<ul style="list-style-type: none"> • The types of chemicals and products used in, or formulated by, the process, their physical form and properties, including their persistence and toxicity. • Condition of the tanks, lines and equipment, and any leaks that could occur in old or damaged equipment. • The period over which formulation took place. • How often chemicals were formulated: continuous process or batch production. • Volume of chemicals used • Immediate and surrounding topography and proximity to sensitive receiving environments.
Bulk storage of chemicals	<p>Storage of one or more raw products, precursors, intermediates and final products involves having tanks, bins, bags, stockpiles of the components used in the chemical manufacturing or formulation stored in an area either repeatedly or on a permanent basis.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged or old tanks and fittings and equipment) of agrichemicals onto land at cleaning locations • point source of contamination for surface soils in limited area 	<p>Storage of raw products, precursors, intermediates and final product risk factors include:</p> <ul style="list-style-type: none"> • standard of facilities and measures to mitigate or control leaks or spills

Activity	Description	Mechanism of contamination	Risk factors
		<ul style="list-style-type: none"> overland flow paths to surrounding and/or wider area and to sensitive receiving environments impermeable soils could drain spills away to sensitive receiving environments migration into shallow soil profile and deeper to groundwater. 	<ul style="list-style-type: none"> the volume and types of chemicals in the storage containers, their physical form and properties, including their persistence and toxicity condition of storage vessels, tanks, bags and containers permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
A broad range of chemicals may be present of these sites. Therefore, the contaminants of concern are usually specific to the operation.	Persistence and mobility are dependent on the specific contaminant of concern and environmental conditions and soil properties.	The period of use for contaminants of concern in this category is dictated by the date the contaminant was first developed, the date of any regulation restricting or banning any individual chemical or product, or by the period during which the manufacture, formulation and storage were undertaken at the specific site.	<ul style="list-style-type: none"> This activity is not specific to a particular type of industry or any specific group or individual chemicals. A broad range of chemicals and facility types could fit within this activity. The contaminants of concern and their period of use would need to be identified through the development of a conceptual site model as part a preliminary site investigation.

Back to [Chemical manufacture, application and bulk storage list](#).

A3

Commercial analytical laboratory sites

HAIL activity intention

Description	<p>Commercial analytical laboratories undertake testing on a wide range of media using many different testing techniques, specialised equipment, and a broad range of chemicals, many of which are hazardous.</p> <p>Laboratories frequently use and store chemical reagents including acids, bases, solvents and environmental samples many of which are, or contain, hazardous substances. The quantities of chemical reagents stored vary significantly between facilities, depending on the volume and range of testing undertaken.</p> <p>Given the diversity of these facilities (eg, types of chemical reagents stored, use and handling of the reagents), a review of the laboratory's processes and the hazardous substances used is necessary to fully understand the potential mechanisms of soil contamination.</p>
Applicability	<p>This category is intended to capture commercial analytical laboratory sites that store, use, generate or process hazardous substances. Commercial laboratories may be stand-alone facilities or part of a larger industry (eg, within a paint manufacturing plant).</p> <p>Where a laboratory is a part of a larger industrial site, it will likely be using chemicals specific to that industry and that part of the site should be recorded under the relevant HAIL activity.</p>
Contamination setting	<p>Laboratory testing is generally undertaken inside a specialised facility. The ground will be sealed and more than likely maintained to a high standard. Spills to ground would be minimised by this seal. Activities in this category will encompass sample preparation, analysis and storage, and the storage of chemical reagents used in the preparation and analysis of samples. However, historical facilities and practices may not have been to as high a standard and the risk of contamination of the ground may be greater. The on-site disposal of contaminated used containers, contaminated reagents and broken or outdated equipment is more frequently encountered with older laboratories.</p>
Exclusions	<ul style="list-style-type: none"> • Clandestine laboratories (eg, methamphetamine laboratories). • School chemistry laboratories unless evidence of poor chemical management or on-site waste disposal is available.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of chemicals at a laboratory facility typically includes small tanks and containers of various liquids and chemical reagents required for the laboratory processes.</p> <p>Laboratories also store samples that could contain hazardous substances in plastic bags, tubs and other containers.</p> <p>Storage areas are likely to be designated and controlled areas that will be located within the laboratory, for example, flammable substance store.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks of chemical reagents and samples to ground. This could occur if there were fractures on the flooring or the storage took place on unsealed areas. 	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks or spills. • The volume and types of chemicals in the storage containers, their physical form and properties, including their persistence and toxicity. • Condition of storage vessels, tanks, bags and containers. • Topography and proximity to sensitive receiving environments. • Permeability of surfaces and soils.
Sample preparation and analysis	<p>Laboratory work involves a lot of both manual and automatic handling of chemical reagents and samples usually within a controlled environment.</p> <p>Cleaning of equipment may be undertaken using solvents or mechanical cleaning methods (eg, industrial dishwashers).</p> <p>Laboratory processes also involve drying, crushing and extraction using various mechanical equipment. Air control systems in these areas, if uncontrolled, may discharge hazardous chemicals to air.</p> <p>The activities undertaken at a laboratory are diverse and will be unique to each facility and the testing being undertaken.</p> <p>Standard laboratory practice generally strictly controls the management of samples and chemicals, to minimise contamination of the facility or cross contamination of samples being analysed.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks of chemical reagents and samples to ground. This could occur if there were fractures on the flooring or the preparation and analysis took place on unsealed areas • deposition from discharges to air, especially dust, can contaminate surfaces and soils if discharge is to an unsealed area. 	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks, spills or discharges. • The volume and types of chemicals in the samples prepared, their physical form and properties, including their persistence and toxicity. • Topography and proximity to sensitive receiving environments. • Permeability of surfaces and soils.

Activity	Description	Mechanism of contamination	Risk factors
Disposal	<p>Laboratories have the potential to generate a lot of waste from processing. The following items may need to be disposed of:</p> <ul style="list-style-type: none"> • excess chemicals and liquids • excess samples, which could include a wide range of media • chemical containers. <p>Modern laboratories are required to control the disposal of their wastes to ensure appropriate disposal. However, historically the use of on-site pits to dispose of laboratory waste was common.</p> <p>Waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • historical on-site disposal of chemical and material spills, contaminated sample containers, contaminated broken or used chemical containers or analytical equipment or reaction vessels. 	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Acids (such as hydrochloric and sulfuric acids)	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to their water solubility.</p>	1800s to present.	<p>A range of acids are frequently used in analytical laboratories.</p> <p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Bases and alkalis (such as sodium or potassium hydroxide)	Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade. Will likely be mobile in the environment due to their water solubility.	1800s to present.	Bases and alkalis are frequently used in analytical laboratories. Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes. Bases and alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Solvents (hexane, acetone, toluene)	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Human health effects and environmental toxicity are specific to the solvent. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant. Many different solvents can be used in the laboratory. They are used to extract contaminants from other matrices and as a solution in which samples are analysed.
Solvents – chlorinated (dichloromethane, tetrachloromethane, tetrachloroethane)	Persistence will be dependent the solvent, on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used in laboratories. Their use has declined due to their toxicity. Chlorinated solvents are toxic, and some are considered carcinogenic. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant. They are used to extract contaminants and constituents from other matrices and as a solution in which samples are analysed.
Metals and metalloids	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	1800s to present.	Toxicity is specific to the element and the chemical form that the element is in. Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil .

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .

Back to [Chemical manufacture, application and bulk storage list](#).

A4

Corrosives, including formulation or bulk storage

HAIL activity intention

Description	<p>Corrosives comprise substances that are strongly acidic or alkaline, and can be solids, liquids or gases. Corrosives have many uses, including as chemical intermediates and reagents in chemical industries and as cleaning products. Activities in this category encompass a broad range of manufacturing, mixing, blending, materials handling and storage equipment. The manufacture of corrosives is limited, with most products being imported. However, some corrosives are manufactured in New Zealand. The formulation of corrosives will be specific to the compound manufactured, and the manufacturing will be undertaken in specialist facilities equipped with the infrastructure (such as closed vessels and hydrogenators) and materials (could include catalysts) required to make the corrosive.</p> <p>Typically, corrosives are acids or bases capable of damaging or destroying metal and concrete, causing chemical burns to skin on contact, damaging eyes from impacted dust, or damaging internal organs, if ingested. Corrosives can also be oxidising or dehydrating in nature. Corrosive substances have a pH of less than 3.0 and greater than 10.0.</p> <p>Acids are commonly used in the metal industry (eg, cleaning before plating), in the laboratory setting and in the production of fertiliser, as well as in the water-treatment industry.</p> <p>Alkalis are also used in many industries, including the manufacturing of soaps, salts, plastics and lubricants. They are also used in electroplating, dyeing and cleaning products, as well as for treating industrial and drinking water.</p>
Applicability	<p>This category is intended to cover those industries that manufacture and formulate corrosives or store them in bulk quantities.</p> <p>It is important to note that the bulk storage of corrosives is likely to be limited to discrete areas of a site. Specialised containers, tanks or vessels are necessary to contain large volumes of corrosives. Therefore, before assigning a site to this HAIL activity, check whether another HAIL activity best fits the actual site use.</p>
Contamination setting	<p>As with many manufacturing processes, the transfer, dispensing and mixing of chemicals is required. This category is only concerned with the liquid and solid compounds because they have the potential to accumulate in soils or migrate to groundwater. Potentially impacted areas would be where equipment and machinery, storage vessels, tanks and piping are located. Also, areas where filling, spills and on-site disposal occur, particularly resulting from poor handling, storage and/or maintenance practices.</p> <p>Although the processes for formulating different corrosives may vary from compound to compound, the potential mechanisms for ground contamination will be similar. For this reason, the physical processes of manufacturing and formulating corrosives have been captured in the table below under the broad activity of 'manufacturing'.</p> <p>Corrosives are likely to be manufactured and formulated within buildings that have sealed floors and, in this case, spills could be readily cleaned up, however, as corrosives, they may corrode or etch surfaces over time generating cracks and fissures in floors, drains and pipework.</p>
Exclusions	<ul style="list-style-type: none"> • The storage or use of pre-manufactured corrosive-based products in the domestic setting (eg, cleaning products). • Retail shops where manufactured pre-packaged products are sold. The reason for this is that only small volumes of product would be handled at one time and any spills that were to occur would be readily contained (ie, likely to occur indoors on sealed surface) and cleaned up. • Gaseous corrosives are excluded because they are unlikely to contaminate soil.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>The storage of bulk quantities of corrosive materials in storage and manufacturing facilities.</p> <p>Corrosives could be present in a liquid or solid form (note: gases are not considered here as they are unlikely to contaminate soil) and could be stored either repeatedly or on a permanent basis in varying quantities ranging from large tanks and vessels, or drums to small, packaged goods.</p> <p>Due to the nature of these chemicals (potentially incompatible with other compounds), they could be stored in numerous locations across a site.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks of chemicals to ground. This could occur if there were fractures on the flooring or the storage took place on unsealed areas • spills or leaks on to or into the ground (could be associated with damaged containers or from poor handling processes) at storage location. 	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks or spills. • The volume and types of chemicals in the storage containers, their physical form and properties, including their persistence and toxicity. • Condition of storage vessels, tanks, bags and containers. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Manufacturing	<p>To manufacture corrosives, specialist equipment and plant is required, which will be specific to the corrosive being formulated. The manufacturing will most likely take place in closed vessels within a building with sealed floors.</p> <p>There will be some degree of product transfer and dispensing. This is likely to be automated but could be manual.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged or old tanks and fittings and equipment) of product and chemicals onto land • spills (including deposition of product) or leaks from transferring or dispensing chemicals during the manufacturing process on to or into the ground along transfer and dispensing route(s) • impermeable surfaces draining to sensitive receiving environments • migration into shallow soil profile and deeper to groundwater from corroded drainage pipes and channels • inappropriate disposal to land of chemicals or products that were not suitable for their intended use. 	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition and maintenance of the equipment and facilities. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period over which manufacturing took place. • How often corrosives were manufactured: continuous process or batch production. • Volume of chemicals used and corrosives manufactured.

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	<p>Corrosive manufacturing plants have the potential to generate a lot of waste. The following items may need to be disposed of:</p> <ul style="list-style-type: none"> excess chemicals and liquids chemical containers wash water excess wastes (liquids, product or containers) via burial or deposition on site. <p>Disposal of excess wastes (liquids, product or containers) would typically be carried out via specialised waste handlers. Recycling or neutralising of used acids may occur. However, these activities require specialist plants that are capable of combusting the acid with natural gas, fuel oil or other fuel sources.</p>	<p>Deliberate tipping of excess waste (liquids or solids) to ground or into drains and sewers. Corrosive products can destroy pipework and drains if they are made of improper materials.</p> <p>Spills or leaks from degraded or damaged containers and waste storage vessels. Note: inappropriately stored corrosives can degrade containers if they are made of unsuitable materials.</p> <p>Inappropriate on-site disposal of raw product materials and process residues.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Acids (hydrochloric, nitric, sulfuric, acetic, phosphoric, chromic and hydrofluoric)	Typically, low if in small quantities because soil will tend to neutralise.	1800s to present.	Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is. Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Alkalis (ammonium hydroxide, potassium hydroxide (caustic potash))	Typically, low if in small quantities because soil will tend to neutralise.	1800s to present.	Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
and sodium hydroxide (caustic soda))			Bases and alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Dehydrating agents (phosphorous pentoxide, calcium oxide)	Typically, low if in small quantities because soil will tend to neutralise. Will degrade rapidly when exposed to moisture.	1800s to present.	Dehydrating agents are not generally considered toxic to humans but can cause burns by all exposure routes. Dermal contact or eye exposure may result in damage to skin or eyes. An accidental release may pose a danger to fish (high toxicity), invertebrates (high toxicity) and aquatic plants (high toxicity) before degradation.
Oxidising agents (hydrogen peroxide (concentrated), sodium hypochlorite)	Typically, low if in small quantities because soil will tend to neutralise. Readily degradable in the environment.	1800s to present.	Oxidising agents are corrosive and exhibit variable human and environmental toxicity. Dermal contact or eye exposure may result in damage to skin or eyes.

Back to [Chemical manufacture, application and bulk storage list](#).

A5

Dry-cleaning plants, including dry-cleaning premises or the bulk storage of dry-cleaning solvents

HAIL activity intention

Description	<p>Traditionally, dry-cleaning was undertaken in centralised factories, however, there are now many smaller scale and widely distributed commercial dry-cleaning operations.</p> <p>The dry-cleaning process typically involves an initial solvent wash (with some addition of detergents), followed by a spin to remove the solvent, a rinse with distilled solvent, a further spin and then finally a drying cycle using warm air.</p> <p>Early dry-cleaning machines relied on manual labour to move clothes between the washing and drying stages, which meant solvents were handled manually when adding or removing solvents from machines. Modern machines are capable of internally recycling nearly 100 per cent of the solvent used, and wash, rinse and dry clothing in a single, automated machine, reducing the handling and risk of spills of solvents.</p> <p>Historically, dry-cleaning solvents were frequently stored in small underground tanks of 100 to 1000 litres located on the dry-cleaning premises. Dry-cleaning premises also frequently included underground storage tanks containing fuel oil for boilers. Where underground tanks are present, that part of the site should be considered under activity A17.</p>
Applicability	<p>This category is intended to cover sites where dry-cleaning takes place and sites where dry-cleaning solvents were stored in bulk. When reviewing dry-cleaning premises, the historical processes should be considered, including where, how and with what chemicals these processes were carried out, and the facility factors that affect the site.</p>
Contamination setting	<p>Historically, the cleaning and drying cycles were completed in separate machines. This required clothing saturated with solvents to be physically carried from one machine to the other, leading to spills. This was common practice until the late 1960s when combination machines were developed.</p> <p>In modern machines, solvents are recovered during the drying phase, where they are returned, condensed and distilled for reuse to the washing chamber. These processes all take place in the actual dry-cleaning machine, greatly reducing the potential for spills and contamination.</p> <p>Underground tanks and above-ground tanks and drums are known to be used to store dry-cleaning solvents. Waste solvent may be stored in drums, often outside the premises, awaiting collection or disposal. Poor storage practices, deteriorated containers or tanks and inappropriate disposal all increase the likelihood of soil contamination.</p> <p>Chlorinated solvents can penetrate concrete floors, even if the concrete appears to be impervious, through pores in the concrete. Plumes of chlorinated solvents in soil and groundwater can also generate vapours that can migrate through soil into buildings and build up in poorly ventilated confined spaces.</p>
Exclusions	<ul style="list-style-type: none"> • The manufacture or formulation of dry-cleaning chemicals. • Agents for dry-cleaners, that is, any drop off or collection point for clothing requiring dry-cleaning, but where no dry-cleaning activities take place. • Commercial laundries that did not use solvents for cleaning, such as in prisons and hospitals. • Self-service laundromats where conventional washing machines and dryers are available for the public to use.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage of chemicals	Perchloroethylene (PCE) is the standard solvent used in dry-cleaning. Historically, PCE or other solvents would have been continuously dispensed into the machine over time, so there would have been a lot more storage of solvents at the facility.	<p>Spills or leaks on to or into the ground from underground storage tanks.</p> <p>Potential for migration into drains, shallow soil profile and development of groundwater plumes.</p>	<ul style="list-style-type: none"> • Single-skin steel underground storage tanks, which pose a high risk of oxidation and leaks. • Waste PCE stored in drums or tanks, which pose a risk of leaks and spills, especially when decanting and handling the containers, tanks or drums. • Condition of containers, drums or tanks, which will affect the risk of spills or contamination.
Dry-cleaning	Most dry-cleaning machines are built around a main cage, so they are fully enclosed. Most modern systems will also be automated and will contain a holding tank for the solvent. A pump is used to circulate the solvent through the machine.	<p>Spills or leaks from degraded or damaged containers and waste storage vessels, for example, poor seals in machines.</p> <p>Drips off wet clothing while transferring garments (and potentially accumulation) between the separate washing and drying machines.</p> <p>The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. The greatest risk for localised high-concentration contamination is from concentrated liquids around machine locations, especially where saturated clothing was transferred between the washer and dryer manually.</p> <p>Given the machines were or are located within factories or commercial buildings (ie, not outdoors on unpaved ground), the potential extent of contamination will be affected by the integrity of building floors and proximity to drainage conduits, and penetrations through walls and floors. PCE is known to penetrate concrete floors that were not built to a specification that is able to contain spills, especially when given sufficient time, even if cracks are not visible.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used, which could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Management of wastes. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Housekeeping and cleaning practices used, as well as management of wastes. • Drains in the factory floor, sewer or trade waste connections, including any discharges to rivers, streams and canals.

Activity	Description	Mechanism of contamination	Risk factors
		Older facilities, where separate washing and drying machines were operated, are more likely to be contaminated. Older style machines were not capable of effectively recycling the solvent, and separate machines for cleaning and drying require greater manual operation, including moving washing between machines, and dispensing and removing solvents. This raises the potential for spills, splashes and slops that could lead to contamination.	
Waste disposal	<p>The main wastes generated are the liquid residues that remain after the dry-cleaning process. Generally, in modern-day machines the liquids are recycled, so the remaining waste that cannot be recycled (the insoluble components) will often include the waste sludge or solid residue from the still or cooked powder residues.</p> <p>Still materials will generally be manually removed, or they might be pumped directly to a waste storage vessel.</p> <p>Used filters and used chemical containers will also need to be disposed of periodically.</p>	Deliberate tipping of excess waste or sludge to ground or into drains and sewers. (Note: discharge of solvents could lead to the degradation of the pipe network.)	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Solvents – chlorinated Chlorinated solvents, primarily tetrachloroethene (also called	Highly mobile in soils, generally low persistence in soils as volatile.	PCE: 1930s to present. Trichloroethene (TCE): 1930s to present.	Toxicity is specific to the solvent. Chlorinated solvents are generally toxic, and many are carcinogenic. Exposure

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
perchloroethylene, perc or PCE), have long been the preferred solvent in the dry-cleaning industry. Owing to the health risks associated with this chemical (it is a carcinogen), the use of other, low-toxicity solvents is increasing, as is the use of non-solvent processes.	Chlorinated solvents vapours are denser than air and can collect in confined spaces, such as basements or excavations. Some chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater depending on groundwater conditions. Degradation products may also persist.	Tetrachloromethane: 1890s to 1950s.	pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion. Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water. When in groundwater, DNAPL sinks through the water column, and only stops when a limiting layer of rock or clay is encountered, where it can remain for years or decades as it slowly breaks down. The break down products can be more persistent and toxic than the original solvent, for example, PCE, degrading to vinyl chloride.
Non-chlorinated solvents (white spirits and benzene) Newer chemicals include 1,1'-methylenebis(oxy)dibutane (K4) Modified alcohol solvents	Mobile in soils, generally low persistence in soils as volatile. Vapours may be denser than air and can migrate into confined spaces, such as basements or excavations. Some solvents will biodegrade in aerobic conditions. They persist in groundwater depending on groundwater conditions. Degradation products may also persist.	1800s to 1950s older solvents. Small amounts of white spirits still used today. New solvents to present.	Toxicity is specific to the solvent. These solvents are generally toxic, and some may be carcinogenic. Exposure pathways for non-chlorinated solvents include inhalation, dermal exposure and soil ingestion. Vapours can be flammable and, at specific concentrations, potentially explosive.
Cyclopentasiloxane, liquid silicone, D5	These solvents can be very persistent and bioaccumulative (vPvB). ¹ Vapours are denser than air and can migrate into confined spaces, such as basements or excavations. Mainly used for specialised cleaning of leather and fur products.	Around 2000 to present.	Toxicity is specific to the solvent but is generally considered to have a low human toxicity. Vapours are flammable and, at specific concentrations, potentially explosive.

Back to [Chemical manufacture, application and bulk storage list](#).

¹ See <https://echa.europa.eu/documents/10162/44c5f15a-a022-5084-762e-03bbb00599d5>, for further information.

A6

Fertiliser manufacture or bulk storage

HAIL activity intention

Description	<p>Fertiliser covers various products intended to support and optimise plant growth. Specific fertilisers contain a range of ingredients that provide plants with macro- and micro-nutrients. Many of the ingredients used in fertiliser can cause contamination at high concentrations in areas where it is produced and stored in bulk.</p> <p>Bulk storage of fertiliser is undertaken on a variety of scales from large quantities at manufacturing sites and regional storage areas to smaller but significant volumes at local distribution centres and on farms.</p>
Applicability	<p>This category is intended to apply to sites where hazardous substances are or have been used in the manufacture or formulation of fertilisers. This includes where contaminants contained in the raw products, associated chemicals or by-products, could be released to the environment.</p> <p>Due to the range of processes and substances that are used to produce fertiliser, other HAIL activities could have occurred on a site. These activities could include analytical laboratories, bulk storage of corrosives, bulk storage of chemicals, above and below ground storage tanks containing fuel oils (eg, for boiler use), engineering workshops, waste disposal, and large electrical transformers and switchgear.</p>
Contamination setting	<p>The mechanism and potential for contamination to occur during the manufacturing of fertilisers is essentially the same, with only the chemicals used in the production processes (including catalysts), the raw products and the fertilisers varying. As with many manufacturing processes, the transfer, dispensing and mixing of chemicals is required. Potentially impacted areas would be where equipment and machinery, storage vessels, tanks and piping are located. Also, areas where filling, spills and on-site disposal occur, particularly resulting from poor handling, storage and/or maintenance practices.</p> <p>Contaminants can be transported around the manufacturing plant and cause contamination across other parts of the site because of wind-blown dust, wash water, tracked and wheeled vehicles and machinery operating between buildings. Soil contamination can occur beneath and around bulk storage fertiliser stockpiles, and runoff from stockpiles can result in contamination of soil and sediment along flow paths, and sediment in waterways. Liquid ingredients and material can leak from pipelines or storage vessels, especially where failure or damage occurs.</p> <p>Waste management practices, including the temporary storage of waste or non-specification material and the burial of waste on-site, can increase the risk of contamination.</p>
Exclusions	<ul style="list-style-type: none"> • The manufacture, formulation or bulk storage of fertilisers comprised solely of natural products (ie, no hazardous substances are used in the processing), such as manure, composting of uncontaminated plant matter, including seaweed. • Compost manufacturing sites where pesticide-contaminated green waste or other contaminated material is part of the feedstock. This activity should be considered under HAIL activities H or I. • The storage and sale of fertilisers in retail packs, in retail settings. Product in retail packs in a retail setting is highly likely to be stored in an enclosed building or covered and sealed area, for example, a garden centre or hardware store. In this scenario, spills are likely to be small, cleaned up rapidly and unlikely to penetrate floors to the underlying soil.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage at fertiliser manufacturing plants may include bulk storage of:</p> <ul style="list-style-type: none"> raw product materials required to make the fertiliser in outside storage areas (eg, phosphate rock, sulfur) manufactured product (could be packaged into smaller volumes or transported off site in larger volumes for further blending and packaging elsewhere). <p>The products could be in a liquid or solid form and stored in underground or above-ground tanks and vessels.</p>	<p>Spills and leaks of liquid contaminants to ground.</p> <p>Direct deposition of solid raw materials and manufactured products to ground in and around bulk storage locations.</p> <p>Pathways for contaminants may also include drainage, or overland pathways, to watercourses and indirect discharges (deposition for air) of contaminants to land.</p> <p>Although many contaminants are present in low concentrations, repeat discharges of the raw products or manufactured products will enable the contaminants to accumulate and concentrations to increase.</p>	<ul style="list-style-type: none"> The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. The period over which substances were stored. Weather-tightness of buildings and shelters. Condition of any storage tanks or containers. Spills, leaks or discharges. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Cleaning and housekeeping practices, such as whether sweepings were collected or just swept outside on to unsealed ground. Discharges to air and deposition of airborne contaminants (mainly dust or powder). Maintenance of facilities and structures. Waste management practices, both current and historical.
Manufacturing	<p>Fertilisers are manufactured using specialised equipment (eg, prilling towers), and use materials and chemicals as per the formulation specifications.</p> <p>Bulk liquid raw materials are typically transferred by pump from delivery tanker to bulk storage vessels on site and dispensed via dispensing lines to reactors or mixing vessels.</p> <p>Bulk materials or solids are typically off-loaded from trucks and moved throughout the processing plant.</p> <p>Each of the compounds formulated are (or can be) granulated and blended together. The compounds can be granulated (with the addition of acid) in a</p>	<p>Spills and leaks of liquid contaminants (eg, solvents and acids) used in the manufacture of fertilisers.</p> <p>Direct deposition of solid raw materials and manufactured products to ground in and around manufacturing locations.</p> <p>The deposition of fertiliser beads to ground in and around the vessels, prilling tower, manufacturing or packaging locations.</p> <p>Pathways for contaminants may also include drainage, or overland pathways, to watercourses and indirect discharges (deposition for air) of contaminants to land.</p> <p>Although many contaminants are present in low concentrations, repeat discharges of the raw or manufactured</p>	<ul style="list-style-type: none"> The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. The industrial and material handling processes used. Condition and maintenance of the equipment and facilities. The period and duration of the activity, and what was considered best practice at the time. Housekeeping and cleaning practices used, as well as management of wastes.

Activity	Description	Mechanism of contamination	Risk factors
	<p>rotating drum, which creates spherical shapes that are then passed through a screen to sort the particle sizes. The particles are then dried ready for packaging.</p> <p>Manufacturing may also include the process of bagging and packaging the fertilisers (using a manual or automated system).</p>	<p>products will enable the contaminants to accumulate and concentrations to increase.</p>	<ul style="list-style-type: none"> Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Drains in the factory floor. Sewer or trade waste connections, including any discharges to rivers, streams and canals.
Waste disposal	<p>Disposal of chemical containers.</p> <p>Disposal of residues of raw products and impurities from the processing.</p> <p>Treatment of wastewaters, which may contain acids and solvents.</p> <p>Disposal of excess wastes (liquids, product or containers) via burial or deposition on site.</p>	<p>Deliberate tipping of excess waste (liquids or solids) to ground or into drains and sewers.</p> <p>Spills or leaks from degraded, or damaged containers or waste storage vessels.</p> <p>Although many contaminants are present in low concentrations, repeat discharges of the raw or manufactured products will enable the contaminants to accumulate and concentrations to increase.</p> <p>Deliberate burial of raw product materials and process residues.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<p><i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i></p>	<p><i>Assists identification of whether, and the length of time, a contaminant may have been in use</i></p>	
Ammonium salts (ammonium nitrates, phosphates and sulfates)	<p>Ammonia salts are generally soluble and therefore mobile in soil.</p>	<p>1880s to present. (1910s ammonia was first synthesised.)</p>	<p>Ammonium salts in soil are not generally toxic.</p> <p>Ammonium salts in water can have detrimental effects on aquatic ecosystems.</p>
Acids – hydrochloric, nitric, sulfuric, phosphoric	<p>Typically low if in small quantities, because soil will tend to neutralise.</p>	<p>1800s to present.</p>	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Alkalis – ammonium hydroxide, potassium hydroxide (caustic potash) and sodium hydroxide (caustic soda)	Typically low if in small quantities, because soil will tend to neutralise.	1800s to present.	Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes. Bases and alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Cadmium (from phosphate fertilisers) – cadmium is a contaminant in phosphate rock that passes through to the final product, superphosphate	Persistence and mobility are dependent on environmental conditions and soil properties, particularly soil pH. Metals are generally more mobile and available in acidic soils. Metals can often be found deeper in the soil profile.	1800s to present.	Cadmium toxicity is specific to the chemical form that it is in. Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs) .
Metals and metalloids (excluding cadmium – see above) arsenic, copper, boron, iron, lead, uranium, molybdenum, selenium magnesium, mercury, zinc	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	Arsenic: Late 1800s to late 1970s. Copper: 1800s to present. Lead: Late 1800s to 1970s. Mercury: 1940s to 1960s. Zinc: 1800s to present.	Toxicity is specific to the element or chemical form that the metal is in. Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs) .
Phosphates (and superphosphates; calcium phosphates)	Persistence and mobility are dependent on environmental conditions and soil properties. Phosphates have a low solubility and therefore are relatively immobile in soils. Phosphorus migration is more commonly associated with erosion and runoff. Phosphate bound to soil particles is carried away with eroded sediment.	1880s to present.	Phosphates in soil are not generally toxic. Phosphates in water can have detrimental effects on aquatic ecosystems. Further information can be found on the Australia and New Zealand guidelines for fresh and marine water quality web page .

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Sulfur (raw material and used as a coating material-secondary nutrient)	Persistence and mobility are dependent on environmental conditions and soil properties. Sulfur is very soluble and therefore can be highly mobile in soil.	1880s to present.	Sulfur in soil is not generally considered toxic. Excessive sulfur lowers the soil pH making the soil more acidic, which can: <ul style="list-style-type: none"> • prevent nutrient uptake limiting or prevent plant growth • increase the mobility of metals and other contaminants • affect concrete foundations.
Coagulants (iron or aluminium sulfate used for water treatment)	Persistence and mobility are dependent on environmental conditions and soil properties. Coagulants are very soluble and therefore can be highly mobile in soil.	1800s to present.	Coagulants are considered non-toxic; however, they may cause skin and eye irritation. If inhaled, they may also cause headaches, nausea and respiratory irritations. Iron sulfate has a low toxicity to birds. However, it is moderately toxic to mammals, fish and other aquatic organisms. Aluminium sulfate has a low toxicity in aquatic environments unless the water has a pH of 8.2 or greater when it can be toxic to fish.

Back to [Chemical manufacture, application and bulk storage list](#).

A7

Gasworks, including the manufacture of gas from coal or oil feedstocks

HAIL activity intention

Description	Gasworks were often large facilities with multiple storage and processing areas requiring a large amount of transfer and distribution of raw, processed and waste products. Most gasworks initially used coal as the feedstock to extract flammable gas used for lighting, heating and cooking, which was provided by local authorities and private companies from the 1860s to 1970s. Some changed to the use of oil feedstocks (or a combination of both) in the 1960s, however, the use of oil feedstocks was short-lived. Some sites may have also further processed the by-products from the coal and oil feedstocks. In essence, the process involved several stages of catalytic cracking (catalysts included nickel oxide, with uranium oxide and iron–chromium oxide being rarely used) and steam reforming from a liquid hydrocarbon feedstock.
Applicability	<p>This category is intended to cover sites that manufactured gas from coal or oil feedstocks. In New Zealand, smaller gasworks were progressively closed through the 20th century and totally phased out following the introduction of a reticulated natural gas network in the 1970s and 1980s. However, owing to the persistence and hazardous nature of many of the wastes and by-products generated from the manufacture of the gas, these sites have the potential to be highly contaminated. Furthermore, in some locations, gasworks wastes were commonly used as fill materials during the development of surrounding areas (ie, they were disposed of outside of the property).</p> <p>As with many large-scale industries, it is likely that gasworks sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks and electrical transformers may have been present as part of a gasworks.</p>
Contamination setting	<p>Gasworks operated in New Zealand at a time when sites were generally unsealed, and site housekeeping and waste disposal practices were of a much lower standard than the present day. Significant persistent contamination will likely be present at multiple locations on a gasworks sites, particularly the storage and processing locations.</p> <p>More information on the production of gas from coal feedstocks can be found in the Ministry for the Environment (1997) Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand.</p>
Exclusions	<ul style="list-style-type: none"> • The storage and use of coal and/or coke at facilities not associated with gasworks operations. • Sites that use or store bulk quantities of natural gas or liquifiable petroleum gas (LPG).

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	A range of raw products and waste materials were stored at gasworks.	Spills and leaks of by-products and wastes and direct deposition of wastes and solid products into and on to the ground.	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored.

Activity	Description	Mechanism of contamination	Risk factors
	<p>Large stockpiles of raw materials, including coal (and coke) and, for early gasworks, lime would have been present.</p> <p>Waste products, such as tar and spent oxide, might potentially have been stockpiled pending disposal.</p> <p>Liquid storage (in raw form or as a by-product as a result of the processing) would have been abundant. Storage could have been above or below ground.</p> <p>The bases of gasholders, in which the water became contaminated with tar and other substances, commonly leaked.</p>	<p>Leaks from underground tanks and unsealed surfaces increase the potential for contamination of deeper soils and groundwater (and surface water).</p> <p>Drainage and overland flow from the site would likely have picked up contaminants from stockpiles and discharged them to surface water.</p> <p>The unsealed surfaces and leaks provided a pathway for soil, surface-water and groundwater contamination to occur.</p> <p>It was common for large areas of these sites to be unsealed, apart from floors within the processing buildings.</p> <p>Brick-lined underground tanks containing tar and other liquids commonly leaked.</p> <p>Transport to and from stockpile areas, of a wide variety of solids, liquids, sludges and mixtures of materials on and around the site may have been done in open vehicles, allowing material to escape or leak onto the roads and drains.</p>	<ul style="list-style-type: none"> • Weathertightness of buildings and shelters. • Condition of any storage tanks or containers. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Waste disposal	<p>Gasworks facilities generated a lot of waste, and it was common practice to dispose of waste on site.</p> <p>Waste could include:</p> <ul style="list-style-type: none"> • liquid wastes • solid wastes • chemical containers and spent catalysts. <p>Waste was commonly buried on site, used as fill (perhaps at other sites) and surface paving. Common buried products included coal particles, coke, ash, clinker, tarry wastes, spent oxide and catalysts.</p> <p>Liquid wastes were sometimes poured onto the ground or remained in underground tar pits and pipework (including utility pipe works) when the gasworks closed.</p>	<p>Waste disposal from gasworks sites typically resulted in widespread contamination, as a result of:</p> <ul style="list-style-type: none"> • direct deposition of wastes as fill or burial of wastes (including containers) and sludge, which could leach into surrounding soils and groundwater • Direct application of liquid and solid wastes to ground, potentially resulting in significant depths of soil contamination, and migration to deeper soils and groundwater, as well as sediment and surface-water contamination • Seepage from underground structures and pits (including pipes) of liquid wastes and tar. 	<p>The potential for contamination from waste disposal processes is very high. Wastes were commonly disposed of on site, in low-lying areas as fill, as fill for harbour reclamation and in roading (as coal tar).</p>

Activity	Description	Mechanism of contamination	Risk factors
	<p>Sometimes tar, oils and water mixes were used for dust control measures, which could result in widespread contamination.</p>		
<p>Manufacturing</p>	<p>Manufacturing of gas required the handling of large quantities of raw products.</p> <p>The manufacturing was a staged process, which created different by-products at each of the individual processes. Processing occurred across large areas at a facility because many processes were often carried out in different buildings and areas.</p> <p>The raw products and by-products would have been handled by both manual and mechanical means, including rail-mounted hoppers and conveyors.</p>	<p>Large areas of the site were typically unsealed.</p> <p>Spillage on to unsealed ground of raw materials and by-products during transfer between the processing operations was common. Underground pipework transferring liquids and raw gas commonly leaked, resulting in tar and other contamination.</p> <p>Spills and leaks of liquid chemicals, direct deposition of solid products (including by-products) into and on to the ground.</p> <p>Potential for localised high concentrations of contaminants (liquids, sludges and solids) around main processing areas to reach ground, groundwater and perhaps surface water.</p> <p>Potential contamination of deeper soils and groundwater (and surface water) if tar pits and tanks were unlined or if surface spills or leaks were significant.</p> <p>Potential development of groundwater plumes (note: light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) could be present) and surface-water contamination.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The industrial and material handling processes used. • Condition and maintenance of the equipment and facilities. • The period and duration of the activity, and what was considered best practice at the time. • Housekeeping and cleaning practices used, as well as management of wastes. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Sewer or trade waste connections, including any discharges to rivers, streams and canals.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Polycyclic aromatic hydrocarbons (PAHs) (major component of coal tar)	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weight increases. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	Throughout life of gasworks, potentially from the 1860s to 1970s.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>
Benzene, toluene, ethylbenzene and total xylene (BTEX) (from tar)	<p>Persistence will be dependent on the compound, environmental conditions and soil properties. BTEX are stable but can undergo microbial degradation.</p> <p>BTEX are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	Throughout life of gasworks, potentially from the 1860s to 1970s.	<p>Toxicity is specific to the compound. BTEX are considered toxic, and some are known carcinogens.</p> <p>Exposure pathways for BTEX include inhalation, dermal exposure and soil ingestion.</p> <p>Vapours are flammable and, at specific concentrations, potentially explosive.</p>
Phenolics (phenol and creosol)	<p>Phenolic compounds can be persistent, however, dependent on the compound, environmental conditions and soil properties, they may biodegrade.</p> <p>Phenolic compounds are soluble and therefore highly mobile. However, their mobility will be</p>	Throughout life of gasworks, potentially from the 1860s to 1970s.	<p>Toxicity is specific to the compound. Phenolic compounds exhibit moderate to high human toxicity. Exposure pathways for phenolics include inhalation, dermal exposure and soil ingestion.</p> <p>Groundwater use (note: phenols can migrate through plastic, for example, pipes).</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	<p>dependent on environmental conditions and soil properties.</p> <p>Phenolic compounds can also be volatile so may be present in air and vapours.</p>		<p>Moderate to high environmental toxicity, especially in aquatic ecosystems.</p> <p>Phenolic compounds are not expected to bioaccumulate.</p>
Metals and metalloids (within ash and clinker)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	<p>Arsenic: Late 1800s to late 1970s.</p> <p>Copper: 1800s to present.</p> <p>Lead: Late 1800s to 1970s.</p> <p>Mercury: 1940s to 1960s.</p> <p>Zinc: 1800s to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
Cyanide (typically as ferri- and ferro-cyanide complexes but also thiocyanates)	<p>Complex cyanides are not particularly mobile in the soil, however, complex cyanides may break down to form free cyanide in the presence of ultraviolet light.</p> <p>Low-level free cyanide does not persist in the soil environment, due to chemical and biological reactions, although at higher concentrations free cyanide can inhibit biological processes.</p> <p>Anaerobic conditions favour the formation of cyanide complexes.</p>	Throughout life of gasworks, potentially from the 1860s to 1970s.	<p>Toxicity is specific to the compound. Ferri- and ferro-cyanide complexes typically have low human toxicity. Thiocyanates have a moderate human toxicity.</p> <p>Exposure pathways for cyanide complexes include soil and water ingestion.</p> <p>Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.</p> <p>In strongly acidic conditions, hydrogen cyanide gas can be released. Hydrogen cyanide is highly toxic.</p>
Sulfur (as sulfates and elemental sulfur)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Sulfur is very soluble and therefore can be highly mobile in soil.</p> <p>Many sulfates are soluble and therefore can be highly mobile in soil.</p>	Throughout life of gasworks, potentially from the 1860s to 1970s.	<p>Sulfur in soil is not generally considered toxic. Excessive sulfur and sulfates lower the soil pH making the soil more acidic, which can:</p> <ul style="list-style-type: none"> • prevent nutrient uptake limiting or prevent plant growth • increase the mobility of metals and other contaminants • affect concrete and steel structures and foundations installed in the soil. <p>Increased acidity levels can be toxic in aquatic ecosystems.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Ammonia	Ammonia is generally soluble and therefore mobile in soil. May be persistent in groundwater.	Throughout life of gasworks, potentially from the 1860s to 1970s.	Toxicity is specific to the compound. Ammonia has low human toxicity. It is corrosive, not toxic. Dermal contact or eye exposure may result in damage to skin or eyes. Ammonium salts in water can have detrimental effects on aquatic ecosystems.
Nitrates	Nitrates are soluble and therefore mobile in soil. May be persistent in groundwater.	Throughout life of gasworks, potentially from the 1860s to 1970s.	Toxicity is specific to the compound. Nitrates are classified as a possible carcinogen and may have reproductive and developmental effects. Nitrates in water can have detrimental effects on aquatic ecosystems.
Coke	Coke is persistent, but it is non-soluble and therefore not mobile in soils. However, coke dust can be subject to wind erosion when dry and to overland flow in wet weather.	Throughout life of gasworks, potentially from the 1860s to 1970s.	Exposure pathways for coke include soil ingestion and dust inhalation. Low human toxicity: almost pure carbon, although some coke can contain metals and metalloids. In general, petroleum coke has a low probability of causing adverse effects on aquatic and terrestrial terminals of plants and animals. However, coke is not inert, and metals and metalloids have been found in leachate, which may have detrimental environmental effects.

Back to [Chemical manufacture, application and bulk storage list](#).

A8

Livestock dip or spray race operations

HAIL activity intention

Description	Livestock dips and spray races are known to be located on farms, stockyards, railway yards and near wharves or other locations where livestock were aggregated for sale and transportation. Spray races were located above ground and comprise a narrow passage, linear or circular, lined with spray nozzles through which chemicals were applied to the livestock as they passed through the race. Livestock dips were in-ground baths of insecticide chemicals. Historically, the insecticide chemicals used were persistent and toxic, and included arsenic, dieldrin, DDT, aldrin and lindane.
Applicability	This category is intended to capture those areas of a site where treatment of stock for ectoparasites (eg, ticks and lice) and fungal infections has taken place, using pesticides, generally in liquid form, in dip or spray operations. Like most industries, over time the application methods and chemicals have changed. For further information on identifying and investigating these types of activities, refer to Ministry for the Environment (2006) <i>Identifying, investigation and managing risks associated with former sheep-dip sites</i> .
Contamination setting	<p>Contamination associated with this category is likely to be localised to those areas where the livestock dip and spray race operations took place. Some farms moved away from dips and to spray applicators located in a different area from the former sheep-dip site. It was also common practice to have communal sheep-dip and spray operations that were used by several land owners, so it should not be assumed that all properties historically used for farming purposes will have had a dip or spray race. Portable dips and spray operations may have occurred after 1935 on any area with good vehicle access. Areas in the vicinity of the dip, draining pen or spray race may also be impacted, including:</p> <ul style="list-style-type: none"> • exit races • holding pens where sheep were penned to drain excess liquid • runoff areas downhill from dip locations where site topography could have allowed excess chemicals to migrate away from the dip or race location, or where surplus chemicals could have been tipped • under woolsheds where surplus solution may have been disposed of.
Exclusions	<ul style="list-style-type: none"> • The administration of veterinary medicines, animal remedies and nutritional supplements to stock using small-quantity methods, such as drenching and pour-ons.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of chemical concentrate at a specified location.</p> <p>Note: mixing of chemicals (if required) may have occurred at this location or at the treatment location.</p>	<p>Spills or leaks.</p> <p>Contamination of surface soils in limited areas.</p> <p>Potential for migration into soil.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored. • Spills, leaks or discharges that took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder).
Application of chemicals	<p>Application of chemicals to livestock via methods described above. Animals will then enter a temporary holding (draining) pen.</p> <p>Chemicals used for dipping include arsenic-based liquids and organochlorine pesticides, among others. These were (and are) applied to livestock using a variety of methods, which may include:</p> <ul style="list-style-type: none"> • immersion – application of chemical over animals via dips or baths (often called ‘pot dips’, “swim through”, or “plunge”) whereby the animal is submersed into the chemical solution. These structures are dug into the ground and may be lined with concrete or timber. After submersion the animals enter a draining pen where the dip liquid drips off the animal, onto the ground. 	<p>Chemicals leak, spill or spray into or on to the ground (either directly at the source (or from equipment) from:</p> <ul style="list-style-type: none"> • Direct application to the ground from spray operations • Leakage from dips set into the ground • Drillage from animals in exit races • Drillage from animals in holding pens (including “downstream” of dips or sprays). <p>Potential for migration into deeper soil profile during failure of or sustained leak in lines and potential for migration to surface water bodies and groundwater if spraying is undertaken on unsealed ground.</p>	<ul style="list-style-type: none"> • The application of chemicals is almost certain to result in discharges to land. • Splashes and slops from the dip structure when dipping the animals. • Discharges of the liquid dip onto the ground as the animals leave the dip and are held in the holding pens.

Activity	Description	Mechanism of contamination	Risk factors
	<ul style="list-style-type: none"> • Spraying – Application of chemical (or dust powder) over animals via a spraying technique. Sprays are (and were) typically administered via a fixed line from a central storage location or are (and were) manually operated. After being sprayed, the animals typically enter a draining pen. • Spray shower techniques were designed to be used within some type of above-ground structure (for example, concrete or corrugated iron enclosures). • Tip spraying and more common spray practices tend to take place in the race structure. • Pour-on – Application of chemical directly to the back of an animal. 		
Waste disposal	<p>Disposal of surplus chemicals and dip sludge, including runoff areas below dip location on sloping ground and beneath woolsheds if nearby.</p> <p>Disposal of chemical containers in farm dumps</p>	<p>Deliberate tipping of excess waste or sludge to ground or to a designated burial pit.</p> <p>Spills or leaks from degraded or damaged containers.</p> <p>Contamination of surface soils over limited area.</p> <p>Potential for migration into deeper soil profile from tipping of waste to ground.</p>	<p>The potential for contamination from waste disposal processes depends on the waste disposal practices and locations, both historically and currently.</p> <p>Leftover dip is known to have been disposed of into nearby waterways, or onto ground. Containers of dip concentrate may have been buried in farm dumps.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guideline 5 – Section 3 Conceptual site Model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use.</i>	General comments
Metal and metalloids – arsenic, copper and zinc	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile</p>	<p>Arsenic: 1840s to 1980s (as a dip ingredient).</p> <p>Copper: 1950s to present.</p> <p>Zinc: 1950s to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Organochlorines (particularly aldrin, dieldrin, DDT and lindane)	<p>OCPs are characteristically described as persistent and bio-accumulating substances prone to long-range transportation.</p> <p>Organochlorines are also very persistent in the environment, often remaining in soil for years or even decades.</p>	<p>1940s to current.</p> <p>Dieldrin banned in 1987.</p> <p>Lindane was banned for most uses in 1989, and all uses in 2015.</p> <p>DDT banned in 1989.</p>	<p>Toxicity is specific to the compound or chemical form that the compound is in.</p> <p>Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain (bioaccumulation).</p> <p>Organochlorines are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats.</p> <p>Historical application of organochlorine pesticides was as an insecticide, and a defoliant, and they were widely used for this purpose from the 1940s to the 1960s</p>
Organophosphates & Organonitrogens (incl. carbamates) Common trade names include parathion, malathion, chlorpyrifos, diazinon,	<p>Persistence in soil increases with concentration as microorganisms that degrade OPPs are affected. Spills of concentrated herbicide, or prolonged repeated discharges of dilute OPP mixtures can compromise the ability of soil organisms to break down the</p>	<p>OPPs are widely used as pest control agents and represent about 50% of currently used insecticides.</p> <p>1940s – 1960s to present, some phased out before 2016.</p>	<p>Human health effects and environmental toxicity is specific to the compound and the chemical form that that compound is in.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use.</i>	General comments
dichlorvos, phosmet, fenitrothion, tetrachlorvinphos, azamethiphos, azinphos-methyl and Terbufos.	OPPs, and in such cases the contaminants may be persistent.		OPPs are generally acutely toxic to vertebrates (including humans) and invertebrates in terrestrial and aquatic habitats.
Synthetic pyrethroids	<p>Persistence in soil increases with concentration as microorganisms that degrade pyrethroids are affected.</p> <p>Spills of concentrate, or prolonged repeated discharges of dilute pyrethroid mixtures can compromise the ability of soil organisms to break down the substances and in such cases, the contaminants can be persistent.</p>	1970s to present.	<p>Human health effects and environmental toxicity is specific to the compound and the chemical form that that compound is in.</p> <p>Pyrethroids generally have low to moderate toxicity to vertebrates (including humans).</p> <p>Pyrethroids are highly toxic to invertebrates and fish.</p> <p>Pyrethroids are broad spectrum insecticides, effective against a wide range of insect pests.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A9

Paint manufacture or formulation (excluding retail paint stores)

HAIL activity intention

Description	<p>Paint covers a wide variety of substances that are applied to surfaces, for functional and decorative purposes. Manufacturing and formulation of paint uses a range of different methodologies and processes. Through these processes different chemicals and products are used to maintain the specifications of the formulation.</p> <p>Paint will be either solvent-based or water-based and will be formulated according to its specified use. The major raw materials used to manufacture paint are binders, such as resins and drying oils which allow the paint to stick to a surface, fillers to provide body, solvents (thinners) and pigments, which give the paint its colour and finish. Specialist ingredients are also added to enhance the desirable properties of the paint, which may include biocides and other hazardous chemicals. Additives are also used, to enhance certain properties such as ease of brushing, mould and fungal resistance, dirt resistance, scuff resistance, sag resistance, retarders (to increase working time in hot environments) and stain resistance (which may include Teflon® and other fluorinated chemicals). Some specialised antifoul paints include a variety of compounds, including copper and pesticides, and tributyltin (TBT).</p>
Applicability	<p>This category is intended to cover facilities that formulate or manufacture paint where hazardous substances are or have been used in the process. This includes where contaminants contained in the raw products, associated chemicals or by-products, could be released to the environment. As with many large-scale industries it is more than likely that facilities that formulate or manufacture paint encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. Examples include workshops, storage tanks and electrical transformers may have been present as part of a paint manufacturing facility.</p>
Contamination setting	<p>Paint is formulated in specialist facilities and may have several areas designated for the use and storage of hazardous substances. The various manufacturing processes may be undertaken in different locations at a facility with some form of product transfer required. The mechanism and potential for contamination to occur during the manufacturing and formulation of paint is essentially the same, with only the chemicals varying at the different steps. Modern facilities could have automated processes, reducing the potential for contamination associated with handling activities. The ground is likely to be sealed and ideally maintained to a high standard. The potential for contamination of the ground to occur from any spills or leaks would be minimised by this seal. With sites becoming more automated, additional infrastructure may have been installed at the site, and the site layout may have changed over time.</p>
Exclusions	<p>The storage of pre-manufactured paint in closed containers at retail businesses or in the domestic setting. This includes paint shops and hardware stores where paint tinting of small volumes (less than 20 litre containers) may take place. The reason is that only small volumes of product would be handled at any one time and any spills that were to occur would be readily contained (ie, likely to occur indoors on sealed surface) and are able to be readily cleaned up.</p>

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guideline 5 and as part of a PSI

Activity	Description	Mechanism of contamination	Risk actors
Manufacturing and formulation	<p>The production of paint involves the following basic steps and processes</p> <ol style="list-style-type: none"> 1. Dispensing and measuring the chemicals and products required to formulate the paint. The method for dispensing the chemicals could be manual or may involve some type of automated dispensing system. 2. Preliminary mixing and grinding of compounds in a mill or highspeed mixer: <ul style="list-style-type: none"> – Solvent-based paints will require a number of chemicals, such as resins, dry pigments (for example, to eliminate corrosion) and pigment extenders/binders to be mixed – Water-based paints will use water instead of solvents along with ammonia and dry pigments and pigment extenders/binders. 3. Final mixing and filtering. The paint base is transferred to an agitated tank where tints, thinners and resins, plasticisers and other final additives are added. Water-based paints may include the addition of a polyvinyl acetate emulsion. Once the paint has reached the proper consistency it is filtered to remove any non-dispersed pigment. Sometimes triple or single roll mills are used. 4. Repackaging. Once the paint is formulated (and in process lab testing has been completed), it is dispensed into smaller receptacles, such as tins or buckets and moved to a storage location(s). 	<p>Spills or leaks of chemicals and/or products (including powders) through various handling and manufacturing processes onto or into the ground potentially resulting in soil contamination.</p> <p>The start and end of a batch of paint can leave off-specification waste product that is not fit for sale. Machinery may need to be cleaned and maintained, requiring solvent to remove residues.</p> <p>Modern facilities could have automated processes, reducing the potential for contamination associated with handling activities. The ground is likely to be sealed and ideally maintained to a high standard. The potential for contamination of the ground to occur from any spills or leaks would be minimised by this seal.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties including their persistence and toxicity. • The handling and operational processes used which could involve moving materials chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Management of wastes. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk actors
Storage	<p>Generally, the storage of chemicals and products will include the following:</p> <ul style="list-style-type: none"> • Raw products required to make the paint • Large volumes of formulated paint that have not been decanted into smaller volumes • Smaller volumes of formulated paint as final packaged goods. 	<p>Spills or leaks onto or into the ground potentially resulting in soil contamination.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes if enough product is released to ground.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties including their persistence and toxicity. • The period over which operations and substances were stored. • Suitability and weathertightness of buildings/ shelters used for storage. • Condition of any storage tanks or container. Storage of pesticides in damaged or improper containers increases the likelihood of the containers failing, resulting in discharges that may contaminate land. Some powders liquify over time and can leak from their packaging which is not designed to contain liquid. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). • Maintenance of facilities and structures. • Waste management practices, both current and historical.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Solvents (for example, hexane, white spirits, mineral turpentine, toluene, xylene acetone)	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Many different solvents can be used in paint manufacture. They are used to thin the binding chemicals, to give paint the optimum viscosity for the particular application. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.
Solvents – chlorinated (dichloromethane, tetrachloromethane, tetrachloroethane)	Persistence will be dependent the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Used in the manufacture of chlorinated rubber paints. Used for cleaning of machinery and parts and degreasing parts covered with oil-based products.
Resins both natural and synthetic (eg, polyvinyl acetate and epoxies, which include bisphenol A)	Variable. Can be persistent at high concentrations. (Polyvinyl acetate is not persistent.)	Late 1800s to present.	Inhalation from volatiles, toxicity of individual types of resins varies and should be investigated individually.
Tributyltin (TBT)	TBT is persistent in soils and sediments. TBT has a low water solubility and lipophilic character, it adsorbs readily onto particles. Persistence and mobility are dependent on environmental conditions and media properties. TBT bioaccumulates in organisms because of its solubility in fat.	1960s to 1989 (used in antifouling paint on all vessels). 1989 to 2008 (restricted use to large vessels over 25 metres).	Organotins are used in antifouling paint for ship hulls, as a stabiliser in the manufacturing of plastic products, as a catalyst in poly(vinyl chloride) products, a biocide (fungicide, bactericide, insecticide) and as a preservative for wood, textiles, paper, leather and electrical equipment. Organotins are known to be toxic at relatively low levels of exposure not only to marine invertebrates but also in mammalian systems. Organotins have been demonstrated to have immunotoxic, teratogenic, neurotoxic and carcinogenic effects in mammals.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			Historical formulation of paints containing tributyltin in New Zealand is possible.
Metals and metalloids	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A10

Persistent pesticide bulk storage or use, including sport turfs, market gardens, orchards, glass houses or spray sheds

HAIL activity intention

Description	<p>Pesticides are chemicals designed to have a biocidal action and include insecticides, herbicides and fungicides. Intensive crop production and the management of some sports turfs rely on the use of pesticides, many of which are persistent and can remain present in the soil for years or decades, or whose breakdown products persist and are harmful. This category is intended to apply to the bulk storage or use of persistent pesticides in crop production and turf grass management, subject to intensive chemical management that involves the use of pesticides that do not readily break down in the soil, or whose breakdown products persist and are harmful.</p> <p>Persistence is defined under the Stockholm Convention on Persistent Organic Pollutants (POPs) as the half-life of a chemical that is greater than two months in water, or greater than six months in soil or sediment, or where the chemical is otherwise sufficiently persistent to justify its consideration.</p> <p>All pesticides that have been used at a site that have a half-life that exceeds these periods under New Zealand conditions should be considered persistent. Chemical persistence is not limited to POPs. Many modern chemicals have extensive half-lives.</p> <p>In line with HAIL activity A1, storage of individual containers with a capacity of 5 kilograms per litre or more of persistent pesticides should be considered bulk storage.</p>
Applicability	<p>This category is intended to apply to any land that has been subjected to the use of persistent pesticides, or where persistent pesticides have been stored in bulk. The category includes specific activities, namely sport turfs, market gardens, orchards, glass houses or spray sheds. However, the category is defined by the bulk storage of persistent pesticides and their use. Plant production, including viticulture, silviculture and horticulture, typically involves the application of pesticides to reduce crop damage, the characteristics of which may include toxicity, ecotoxicity and, in some cases, persistence in the environment. Therefore, careful consideration of the likelihood of contamination should be given where persistent pesticides have been used at sites other than those listed above. Orchards that have only ever used copper-based chemicals would be captured by this activity. While not toxic to humans, copper can be toxic to organisms in water or soil.</p>
Contamination setting	<p>Bulk storage of pesticides may have involved having multiple tanks, drums or containers stored in an area over a long period or on a permanent basis. Localised areas where contamination can occur include storage and spray sheds, and areas used for mixing of pesticides. At sites where turf grass management and crop production activities are undertaken, such as (but not limited to) sports turfs, market gardens, orchards, glass houses or spray sheds, the extent of the area(s) affected by the use of persistent pesticides, would depend on the type of crop, the nature of the pest, seasonality and the required method of application.</p>
Exclusions	<ul style="list-style-type: none">• The area where persistent pesticides are mixed for application and where containers are emptied or rinsed.• Sites that have artificial turf surfaces.• Grassed sports fields, such as council sports fields, school playing fields and playgrounds, which have been subject to infrequent application of non-persistent pesticides.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Storage of chemical concentrate in spray sheds or other storage locations, such as an implement shed or garage.	<p>Spills or leaks.</p> <p>Contamination of surface soils in limited area. Potential for migration into shallow soil profile.</p> <p>Poor storage practices, such as unsealed floors, leaking containers or evidence of uncontained spills and discharges to land indicate a greater risk of contamination.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored. • Suitability and weathertightness of buildings and shelters used for storage. • Condition of any storage tanks or containers. Storage of pesticides in damaged or improper containers increases the likelihood of the containers failing, resulting in discharges that may contaminate land. Some powders liquify over time and can leak from their packaging, which is not designed to contain liquid. • Spills, leaks or discharges . • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). Humidity affects some powders, resulting in clumps that need to be broken down, which can result in spills or dust being released. • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Mixing	Location for diluting and mixing chemicals with water. May include fixed storage tanks or mobile sprayer units.	Spills, slops, splashes or leaks resulting in localised contamination with concentrated liquids and powders in and around mixing locations, which are or were typically carried out on unsealed ground or concrete pads without runoff capture facilities.	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used that could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Management of wastes.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Flow paths should be considered, because contaminated runoff is likely to have permeated into the soil along the length of the flow path.
Application	<p>Application of persistent pesticides over broad areas via methods that may include:</p> <ul style="list-style-type: none"> • mobile sprayers • fixed lines from central storage • manually operated spray gun on a hose connected into line at various points • backpack sprayers. 	<p>Deliberate application to ground or spray fall-out on to ground during application to plants and trees.</p> <p>Failure of, or leaks from, fixed lines or outlets. Potential for migration into deeper soil profile during failure of, or sustained leaks, in lines.</p> <p>Generally little potential for deeper migration at normal spray application rates.</p> <p>Broad-scale application of liquid spray, dust, prills or other application of insecticide, miticide, fungicide or herbicide formulations applied at normal dilutions and rates over extended periods, often decades.</p> <p>It is not intended to apply to chemicals that break down rapidly in soil (days, weeks and months) when applied at normal application rates.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Widespread application of persistent pesticides even at low concentrations. • Persistence of the pesticide, especially where the applied formulation contains a chemical element that cannot break down (usually metals, such as arsenic, or combinations of metals, such as lead arsenate), or an organic chemical that breaks down slowly in soil. • Concentration and rate of application. • Number and frequency of applications. • Soil type and properties, climate and so on. • Poorly maintained equipment is more likely to fail or leak increasing the likelihood of localised hotspots of contamination.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (excluding chromium and cadmium) Monosodium methanearsonate (MSMA), copper formulations, lead arsenate formulations and mercury formulations, zinc formulations	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	Arsenic: Late 1800s to late 1970s. Copper: 1800s to present. Lead: Late 1800s to 1970s. Mercury: 1940s to 1960s, although not commonly sprayed over broad areas (typically used as a seed treatment). Zinc: 1800s to present.	Toxicity is specific to the element or chemical form that the metal is in. Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .
Current use fungicides (for example, fluxapyroxad, pentachloronitrobenzene (PCNB), triticonazole, fludioxonil, boscalid, fluopicolide, fluopyram, myclobutanil, tebuconazole, flutolanil, pydiflumetofen)	Variable, check individual formulations.	Current.	Toxicity and persistence are specific to the compound.
Organochlorines Organochlorine pesticides (OCPs) are generally categorised as chlorinated cyclodienes, chlorodiphenylethane, chlorinated benzenes and cyclohexanes	OCPs are characteristically described as persistent and bioaccumulating substances prone to long-range transportation. Organochlorines are also very persistent in the environment, often remaining in soil for years or even decades.	1940s to current. Dieldrin was banned in 1987. Lindane was banned for most uses in 1989, and all uses in 2015. DDT was banned in 1989. Chlorothalonil approvals were mostly revoked in 2017. Difocol was listed as a POP in 2020 and approval is currently being reviewed by the Environmental Protection Authority.	Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in. Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain. OCPs are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
		Endosulfan was deregistered in 2008.	Historical application of OCPs was as an insecticide and a defoliant, and they were widely used for this purpose from the 1940s to the 1960s.
Neonicotinoids	Neonicotinoids are water soluble and can remain active in soil for years. Rain or irrigation water can carry them long distances to contaminate new soil, plant life and water supplies.	1990s to present.	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Neonicotinoids are highly toxic to both terrestrial and aquatic insects. Evidence on their toxicity to birds, mammals, reptiles and fish is increasing, but further research is required.</p> <p>Neonicotinoids are a class of synthetic, neurotoxic insecticides that are widely used, including on agricultural crops, lawns, gardens, golf courses, and in flea and tick pet treatments.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A11

Pest control, including the premises of commercial pest control operators or any authorities that carry out pest control where bulk storage or preparation of pesticide occurs, including preparation of poisoned baits or filling or washing of tanks for pesticide application

HAIL activity intention

Description	<p>Pest control relies on the use of chemicals that are toxic to the target species. Chemicals used in pest control include insecticides, miticides, arachnicides and vertebrate toxic agents (VTAs). Intentional application of poisons by pest control operators will be done at prescribed application rates, which are too low to cause widespread contamination. The most likely means of contaminated land arising as a result of pest control is from unintended discharges to the environment of poisons or poisoned items such as bait, packaging and residues from tanks and containers.</p> <p>Pest control operators in New Zealand focus on exterminating a wide variety of animal pests. This includes:</p> <ul style="list-style-type: none">• vertebrate pests in forests, conservation land and reserves, and production land• insects and rodents from cargo and containers• invertebrate pests and rodents in buildings and their surrounds. <p>Commercial pesticides often require a qualification and/or certification to acquire, possess and use. This is due to the hazardous nature of the products and specialised handling and safety requirements. Small amounts of these products can result in localised contamination, if they are allowed to enter the environment without controls in place.</p>
Applicability	<p>This category applies to premises where pest control pesticides and poisoned baits are prepared, stored in bulk and where tanks are washed. In the field, soils in discrete locations can become saturated as a result of bait preparation.</p> <p>This HAIL activity is intended to cover the premises of:</p> <ul style="list-style-type: none">• commercial pesticide application contractors• local authority or commercial vertebrate pest control operations (rabbits, possums, rats, mustelids). <p>Premises of former vertebrate pest control boards, for example, rabbit boards. This category should be used in preference to A1 (agrichemicals) where the agrichemical concerned is used for pest control and the activity of storing and mixing (and likely container cleaning) is occurring. The more generalised category A2 (chemical manufacture, formulation or bulk storage) should not be used in this instance.</p>
Contamination setting	<ul style="list-style-type: none">• At any pest control premises discrete areas are likely to be allocated to the bulk storage and preparation of pesticides and to where tanks are filled and washed out. Field preparation can cause a hotspot of contamination when adding poison to bait, or when loading the poisoned bait into hoppers for aerial distribution. Broadacre application is not a contamination concern.
Exclusions	<ul style="list-style-type: none">• The manufacture or formulation of pesticides.• The use (including mixing and storage) of persistent pesticides that are not pest control products.• Storage or use of manufactured pest control products in the domestic setting, because only small volumes of consumer products would be handled at one time and any spills that were to occur would be limited in extent.

HAIL activity intention

- Field and property locations where individual traps are located (including the use of periodic bait stations on commercial and industrial properties).
- Storage in the retail setting where pest control products in small retail packs are stored in an enclosed building, for example, a garden centre or hardware store. In this scenario, any spills are likely to be small, be cleaned up rapidly and unlikely to penetrate floors to the underlying soil.
- Livestock dip or spray race operations, which fall into A8.
- Pest control pre-feed or monitoring operations where pesticides have not been used.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Storage of concentrated pesticide (liquid, paste, powder or granulated forms) by various authorities and commercial operators. Storage conditions have improved over time. Dust, powder and liquid spills inside storage structures can escape via entrances and exits to storage locations. This includes tracking by foot traffic, on vehicle wheels, as well as liquids flowing and dust and powder being moved by wind.	<p>Spills or leaks on to or into the ground potentially resulting in soil contamination.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes.</p> <p>Potential for migration to surface-water receptors including stormwater.</p> <p>Where storage has taken place in structures not designed to contain hazardous substances. Unsealed ground, especially where the soil is porous. Shallow groundwater can be contaminated and can transport contaminants as a plume.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored. • Suitability and weathertightness of buildings and shelters used for storage. • Condition of any storage tanks or containers. Storage of pesticides in damaged or improper containers increases the likelihood of the containers failing, resulting in discharges that may contaminate land. Some powders liquify over time and can leak from their packaging, which is not designed to contain liquid. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). Humidity affects some powders, resulting in clumps that need to be broken down, which can result in spills or dust being released.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Preparation, mixing and cleaning	<p>Pest control chemicals often need to be diluted, applied to bait or mixed before application. This can apply to solids in the form of powder or granules, and to liquid concentrates.</p> <p>Containers used for storage vary greatly in material, volume and construction. Most containers used for pest control chemicals are discarded after use. However, containers used for application are often reused and will be rinsed out between uses with water.</p> <p>These processes might occur at a dedicated location (eg, an area designed with sealed ground and a wash-down pad fitted with a trade waste facility) on a larger site, or occur at multiple different locations that could be sealed or unsealed (eg, field stations).</p>	<p>Spills or leaks of chemical residues (including spray out from cleaning processes) on to or into the ground at mixing, blending or cleaning locations.</p> <p>Discharge of solid products to unsealed land in and around the storage locations as a result of spills.</p> <p>Potential for spilled chemicals to migrate from the surface into soil.</p> <p>Preparation and mixing of baits for vertebrate pest control operations pose a risk when undertaken outdoors, because dust can travel some distance.</p>	<ul style="list-style-type: none"> • The types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used both historically and currently that could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Management of wastes, including the treatment or disposal of cleaning wastewater that is contaminated with pesticides. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>Disposal of surplus mixed liquids and granules.</p> <p>Disposal of chemical containers.</p> <p>Disposal of washout water.</p>	<p>Deliberate tipping of surplus chemical mixture to ground, or burial of waste, including packaging and contaminated PPE and equipment. Spills or leaks from degraded and damaged containers.</p> <p>Contamination of surface soils in limited area.</p> <p>Potential for migration into deeper soil profile from tipping of waste to ground.</p>	<p>The potential for contamination from waste disposal processes depends on the waste disposal practices and locations, both historically and currently.</p> <p>Burial of cyanide tubes and packaging is common practice. This was (and, in some cases, still is) written on the label of current use products.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Chemical persistence	Period of use	General comments
Arsenic	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile</p>	1800s to 1970s.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Potassium or sodium cyanide	<p>Cyanide compounds can be persistent in both soils and water; however, the persistence can be strongly influenced by the environmental conditions.</p> <p>Cyanide compounds, depending on the cyanide compound, can be highly mobile and transported by air or water.</p>	1880s to present.	<p>Cyanide is toxic, the toxicity varies on the cyanide compound present. Cyanide is absorbed following inhalation and ingestion and via the eye and skin, although the rate of adsorption depends very heavily on the form of cyanide (eg, free cyanide compared with complex cyanide). Further information on cyanide can be found in Ministry for the Environment (1997) <i>Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand</i>.</p>
Phosphorus	<p>Not persistent, oxidises rapidly. Unlikely to cause long-term contamination.</p> <p>In deep soil or sediments with little oxygen, white phosphorus may remain unchanged for many years.</p>	1920s to present.	<p>Phosphorus is toxic, the toxicity varies on the phosphorus compound present. Direct ingestion, inhalation or contact with phosphorus can be toxic to humans, but this is unlikely to occur in contaminated soil or water.</p> <p>Phosphorus is used to control mammalian pests. Excess phosphorus in soil can be toxic to plants, while excess phosphorus in water can result in algal blooms.</p>
Strychnine	<p>Strychnine strongly absorbs to soil particles. Environmental persistence is relatively short. Breakdown in soil is highly dependent on the presence and growth of particular microbial or fungal soil organisms. Strychnine is soluble in water but strongly</p>	Late 1800s: Phased out in favour of sodium monofluoroacetate (1080).	<p>Strychnine is toxic to vertebrates, including humans and birds. Direct ingestion, inhalation or contact with strychnine can be toxic to humans.</p> <p>Strychnine is typically used to control mammalian pests.</p>

Key contaminant of concern	Chemical persistence	Period of use	General comments
	absorbs to soil particles so limited migration is expected.		Strychnine is very toxic to aquatic organisms and may cause adverse effects in the aquatic environment. Unlikely to cause long-term contamination.
1080 (sodium monofluoroacetate)	1080 is not persistent, it is biodegradable and quickly breaks down into non-toxic by-products. In soil, the half-life of 1080 is less than 1 to 8. ²	1964 to present.	Sodium fluoroacetate is toxic to all mammals, including humans. It is also toxic to birds and potentially invertebrates. It is not considered to be toxic in aquatic ecosystems. Unlikely to cause long-term contamination.
Brodifacoum	Brodifacoum can be persistent, lasting 3 to 6 months in soil. Brodifacoum is sparingly soluble in water but strongly absorbs to soil particles so limited migration is expected.	1992 to present.	Brodifacoum is toxic to vertebrates, including humans and birds. Direct ingestion, inhalation or contact with brodifacoum can be toxic to humans. Brodifacoum is typically used to control mammalian pests. Brodifacoum is toxic to aquatic organisms.

Additional information about the active ingredients in hazardous substances that are approved for use in New Zealand can be found on the Environmental Protection Authority website: www.epa.govt.nz/pesticide-active-ingredients.

Back to [Chemical manufacture, application and bulk storage list](#).

² See <https://www.epa.govt.nz/assets/FileAPI/hsno-ar/HRE05002/79d5443f35/HRE05002-017.pdf>, for further information.

A12

Pesticide manufacture (including animal poisons, insecticides, fungicides or herbicides) including the commercial manufacturing, blending, mixing or formulating of pesticides

HAIL activity intention

Description	<p>Pesticides include classes of chemicals used as herbicides, insecticides, miticides, arachnicides (for killing spiders), nematicides (for killing nematode worms), fungicides, and vertebrate pest poisons (eg, 1080, cyanide, phosphorus, brodifacoum). Many different pesticides are manufactured or formulated in New Zealand. Manufacturing of pesticides will involve chemical precursors and chemical reactions, whereas formulation will involve physical processes with pre-manufactured components. For this reason, manufacturing (primary processing) and formulation (secondary processing) have been separated in the table below because the potential for soil contamination arising from these processes could be different.</p>
Applicability	<p>This category is intended to cover the manufacture and formulation of any form of pesticide. This category should be used in preference to A1 (agricultural) where the agricultural concerned is a pesticide, and category A2 (chemical manufacture, formulation or bulk storage), which covers general chemical manufacturing and storage. It includes storage of pesticides (including persistent pesticides) when that storage is associated with manufacturing of the pesticide (including the manufacture of active ingredients), as well as formulation of pesticides by mixing active ingredients with other substances to make it fit for its intended use.</p>
Contamination setting	<p>Pesticides are manufactured and formulated in specialist facilities and may have several areas designated for the use and storage of hazardous substances. This activity relates to discrete areas of a manufacturing and formulation premises where manufacturing, blending, mixing or formulating of pesticides occur.</p> <p>Pesticides come in a variety of forms, including powders, pellets, granules and liquids, each with a different likelihood of contaminating soil if spilled or leaked. Raw materials manufacturing, which is undertaken at the same premises, as part of the pesticide manufacturing, is included in this category rather than category A2. Storage locations, transfer mechanisms and processing techniques may all change with time. Changes should be reviewed when assessing a facility under this category.</p>
Exclusions	<ul style="list-style-type: none">• The preparation, use or application of pesticides.• Domestic or commercial situations where mixing of various pesticides before application is not considered formulation under this category.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation PSI.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Raw materials required for manufacturing could be stored in a variety of storage types (may be liquids, solids, gases) and could be located in underground or above-ground vessels.</p> <p>Common raw products are solvents, acids and bases, metals, other inorganic compounds and organic compounds commonly derived from petroleum.</p>	<p>Spills or leaks.</p> <p>Direct deposition of solid products to ground (and potentially groundwater) in and around the storage locations.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored. • Suitability and weathertightness of buildings and shelters used for storage. • Condition of any storage tanks or container. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). Humidity affects some powders, resulting in clumps that need to be broken down, which can result in spills or dust being released. • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Manufacturing – primary processing	<p>Primary batch manufacturing of pesticides involves processing the active ingredients into a raw product.</p> <p>Products will be transferred manually or via an automated system to a reaction vessel. Reactors, such as hydrocarbons (including chlorinated), will be used. Different reactions will take place to produce different pesticides, often with some form of heating. Purification processes, such as filtration or distillation, will be necessary. These processes may also involve the use of water, air or solvents.</p>	<p>Spills or leaks associated with manufacturing, including the transfer of products. The potential for contamination of the ground to occur from any spills or leaks would be minimised by good industry practice.</p> <p>Direct deposition of solid products to ground (and potentially groundwater) in and around the manufacturing locations.</p> <p>Pesticide manufacturing and formulation would normally take place in a specialist indoor facility,</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used that could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
		<p>using reaction vessels that are located above fully sealed floors.</p> <p>Failure of equipment or machinery during manufacture could result in leaks and spills or batches of product that are not to specification, requiring disposal.</p> <p>Recovery of spilled or deposited product would be expected. Therefore, minimal residues are expected to remain to cause contamination (unless bare soils are present). Secondary processing may also not include any liquid chemicals, therefore, further reducing the risk of contamination.</p>	<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Formulation – secondary processing	<p>Secondary processing will involve primarily physical processes, such as weighing, mixing, milling and granulation. Generally, chemicals are not used in secondary processing; however additives (which may include liquid chemicals) may be added to improve the formulations. Packaging of final products will then take place.</p>	<p>Direct deposition of solid products to ground (and potentially groundwater) in and around the storage locations. The potential for contamination of the ground to occur from any spills or leaks would be minimised by good industry practice.</p> <p>Spills or leaks associated with additive usage. Potential exists for more widespread (primarily surface) contamination if production results in spills or leaks of product or precursor chemicals.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used that could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>A range of wastes will be produced from primary processing activities (eg, distillation and purification) – liquid products, solid products and so on.</p> <p>Product that is contaminated by impurities, or below specification as a result of manufacturing process errors or machinery failure, will also require disposal.</p> <p>Used solvents may be collected and recovered on site.</p> <p>Waste will also include bags, containers and drums that raw products came in.</p>	<p>Leaks from degraded and damaged containers.</p> <p>Contamination of surface soils in limited area. Potential for migration into deeper soil profile from tipping of waste to ground.</p>	<p>The potential for contamination from waste disposal processes varies and depends on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
Metals and metalloids	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	<p>Arsenic: Late 1800s to late 1970s.</p> <p>Cadmium (as contaminant in fertiliser): 1880s to present.</p> <p>Copper: 1800s to present.</p> <p>Lead: Late 1800s to 1970s.</p> <p>Mercury: 1940s to 1960s mainly as a seed treatment, otherwise rare.</p> <p>Zinc: 1800s to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
<p>Acid herbicides</p> <p>Acid herbicides are a group of compounds that include derivatives of phenol (pentachlorophenol), benzoic acid (dicamba), acetic acid (2,4-D, MCPA, 2,4,5-T), propanoic acid (dichlorprop, fenoprop, mecoprop) and butanoic acid (2,4-DB, MCPB)</p>	<p>Persistence in soil increases with concentration as micro-organisms that degrade acid herbicides are affected. Spills of concentrated herbicide, or prolonged repeated discharges of dilute herbicide mixtures, can compromise the ability of soil organisms to break down acid herbicides and, in such cases, the contaminants can be persistent.</p>	<p>1950s to present.</p>	<p>Human health effects and environmental toxicity are specific to the herbicide and chemical form that the herbicide is in.</p> <p>Acid herbicides are used mainly for broadleaf weed control, there are many hundreds of brand name compounds, each with a specific purpose.</p> <p>The active ingredient used in each herbicide determines how the product works, how it persists and its mobility in soils. Contamination with dioxins during manufacture was a common problem. Acidic herbicides are used mainly for broadleaf weed control, there are many hundreds of brand name compounds, each with a specific purpose.</p>
<p>Organophosphates (OPPs) and organonitrogens (including carbamates)</p> <p>Common trade names include: parathion, malathion, chlorpyrifos, diazinon, dichlorvos, phosmet, fenitrothion, tetrachlorvinphos,</p>	<p>Persistence in soil increases with concentration because micro-organisms that degrade OPPs are affected. Spills of concentrated herbicide, or prolonged repeated discharges of dilute OPP mixtures, can compromise the ability of soil organisms to break down the OPPs, and in such cases the contaminants may be persistent.</p>	<p>OPPs are widely used as pest control agents and represent about 50% of currently used insecticides.</p> <p>1940s to 1960s to present, some phased out before 2016.</p>	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>OPPs are generally acutely toxic to vertebrates (including humans) and invertebrates in terrestrial and aquatic habitats.</p>

Key contaminants of concern	Chemical persistence	Period of use	General comments
azamethiphos, azinphos-methyl and terbufos			
Organochlorines Organochlorine pesticides (OCPs) are generally categorised as chlorinated cyclodienes, chlorodiphenylethane, chlorinated benzenes and cyclohexanes	OCPs are characteristically described as persistent and bioaccumulating substances prone to long-range transportation. Organochlorines are also very persistent in the environment, often remaining in soil for years or even decades.	1940s to current. Dieldrin was banned in 1987. Lindane banned for most uses in 1989, and all uses in 2015. DDT was banned in 1989. Chlorothalonil approvals mostly revoked in 2017. Difocol was listed as a persistent organic pollutant in 2020. Endosulfan was deregistered in 2008.	Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in. Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain. OCPs are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats. Historical application of organochlorine pesticides was as an insecticide and a defoliant, and they were widely used for this purpose from the 1940s to the 1960s.
Synthetic pyrethroids	Persistence in soil increases with concentration because micro-organisms that degrade pyrethroids are affected. Spills of concentrate, or prolonged repeated discharges of dilute pyrethroid mixtures, can compromise the ability of soil organisms to break down the substances and, in such cases, the contaminants can be persistent.	1970s to present.	Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in. Pyrethroids generally have low to moderate toxicity to vertebrates (including humans). Pyrethroids are highly toxic to invertebrates and fish. Pyrethroids are broad spectrum insecticides, effective against a wide range of insect pests.
Neonicotinoids	Neonicotinoids are water soluble and can remain active in soil for years. Rain or irrigation water can carry them long distances to contaminate new soil, plant life and water supplies.	1990s to present.	Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in. Neonicotinoids are highly toxic to both terrestrial and aquatic insects. Evidence on their toxicity to birds, mammals, reptiles and fish is increasing, but further research is required. Neonicotinoids are a class of synthetic, neurotoxic insecticides that are widely used, including on agricultural crops, lawns, gardens, golf courses, and in flea and tick pet treatments.

Back to [Chemical manufacture, application and bulk storage list](#).

A13

Petroleum or petrochemical industries, including a petroleum depot, terminal, blending plant or refinery, or facilities for recovery, reprocessing or recycling petroleum-based materials, or bulk storage of petroleum or petrochemicals above or below ground

HAIL activity intention

Description	<p>Most petroleum products originate from crude oil or natural gas, which is refined to create useful products by removing contaminants and breaking long carbon chain molecules into molecules with shorter carbon chains. These activities take place in an industrial setting, where large volumes of raw material, partially refined substances and finished product are processed and/or stored.</p>
Applicability	<p>This category is intended to cover industrial sites, where petroleum products are stored in bulk. The processes that are undertaken at petroleum processing sites include storage of raw products and processed materials, transfer between processes, and refining and blending a variety of chemicals.</p> <p>This HAIL activity is intended to cover those industries that process petroleum-based products in bulk for the purpose of blending or refining, including feedstocks and finished products. Examples include petrochemical plants, refineries, bulk terminals and petroleum product reprocessing or recycling plants. It also includes sites that store large quantities of petroleum products for distribution.</p> <p>As with many large-scale industries, it is likely that petrochemical sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, engineering workshops, storage tanks and drums, electrical transformers, analytical laboratories, among others, which may have been present as part of the activities undertaken at a petrochemical site.</p> <ul style="list-style-type: none"> • For further information on petrochemical sites and contamination, please refer to Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand</i> (revised 2011).
Contamination setting	<p>The infrastructure and number of chemical and industrial processes that take place on these types of sites are complex and varied. However, for the purposes of describing these sites, the various processes detailed below have been collectively grouped under the term 'processing'. The principal processes include:</p> <ul style="list-style-type: none"> • blending – physical process of adding and mixing different feedstocks and chemicals to the petroleum fraction to make the formulated product (eg, different carbon chain length hydrocarbons, and additives such as lubricants and detergents and corrosion inhibitors) • refining – involves the process of separating and removing impurities from raw materials (eg, crude oil for petroleum or a combination of natural gas or petroleum-based products for petrochemicals) into a range of homogenous petroleum fractions or petrochemicals chemicals by using heat and pressure. The techniques include fractionation, cracking and hydro-treating. The various distilled fractions are separated into different products ranging from light (eg, petrol) to heavy distillates (eg, heavy fuel oil and bitumen) • recovery, reprocessing, recycling – involves secondary processes to capture and further process residual petroleum or petrochemicals, or recycle waste containing hydrocarbons (in bulk quantities, ie, drums, intermediate bulk containers (IBCs) or tanks). This also applies to sites that only recycle or treat hydrocarbon wastes • product transfer – involves large volumes of products with significant pipework and infrastructure present above and below ground. <p>In any of the above processes, spills, leaks and discharges could occur. Preferential flow paths may also exist.</p> <ul style="list-style-type: none"> • The layout of petrochemical industry sites tends to change over time, as processes are modernised, added or decommissioned.
Exclusions	<ul style="list-style-type: none"> • Underground and above-ground bulk fuel storage at retail fuel sites, such as service stations and truck stops. • Fuel storage within airports.

HAIL activity intention

- Fuel storage within or as part of port operations.
- Low-volume solvent recovery, in purpose-built machines, such as those used by automotive painters, for recycling waste solvent generated by activities within their own business.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation PSI.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage is predominantly in large above-ground tanks or tank farms, with some storage also expected below ground. Pipes with multiple valves and pump assemblies typically connect the storage facilities.</p> <p>There may also be large volumes of storage in drums (stacks of 200 litre drums) that historically or currently may be on unsealed ground, or on concrete pads that may or may not be bunded.</p> <p>Refineries and terminals will have many storage tanks that will contain different petroleum-based chemicals required and developed throughout the processing phase.</p> <p>Storage of per- and poly-fluoroalkyl substance (PFAS) (specifically aqueous film forming foam (AFFF)) concentrates as part of ancillary activity of site fire-fighting capability.</p>	<p>Spills and leaks of liquid chemicals and fuels into and on to the ground from tanks. Some bulk tanks may have been designed to maintain leakage within specified parameters.</p> <p>Residues leaking from empty drums stored without seals or improperly sealed full drums.</p> <p>Spills and leaks into the ground from damaged pipelines, faulty pipeline connections, faulty valves or valves accidentally left open.</p> <p>Potential contamination of deeper soils/groundwater (and surface water).</p> <p>Older facilities had looser controls and lower regulatory standards to meet. As a result, the contamination potential at older facilities is significantly greater.</p> <p>Modern facilities might be fully sealed with bunds, impermeable liners and remote monitoring systems.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity • The period over which substances were stored. • Condition of any storage tanks, containers, pipework or processing equipment. • Suitability and weathertightness of buildings and shelters used for storage. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants. • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Processing	<p>The processes undertaken at these facilities require a significant amount of infrastructure. Processing will be carried out in different locations across the facility.</p> <p>Large pipeline networks will be present at these facilities (on and potentially off site).</p>	<p>Spills and leaks of liquid chemicals and fuels into and on to the ground from process locations and pipelines. Historically, areas of ground were unsealed, and manual handling practices associated with product transfer and processing were common.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used that could involve moving or

Activity	Description	Mechanism of contamination	Risk factors
	<p>Modern facilities will likely be fully automated from the raw product transfer phase through to the final storage of processed petroleum and chemicals.</p>	<p>Many modern processes are automated, with better process control, reducing the potential for out-of-specification products.</p> <p>Equipment failure at any point in the production process can result in leaks or discharges.</p> <p>Potential contamination of deeper soils and groundwater (and surface water).</p>	<p>transferring materials, chemicals and product between different areas.</p> <ul style="list-style-type: none"> • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Transport facilities	<p>Rail terminals for bulk supply of products or transport from the facility, with associated pipelines, pumps, valves and hoses.</p> <p>Tank wagon filling stands for filling of road tankers, with associated pipelines, pumps, valves and hoses.</p> <p>Pipeline entry points, valves, pumps and pump manifolds from port facilities or long-distance pipelines.</p>	<p>Transport facilities require connection and disconnection of high-volume hoses to tankers, and present opportunities for leaks from tanks, pressurised piping, hoses and valves. Spills and leaks during transfer of product to and from wagons as a result of faulty valve handling, not properly connecting hoses and overfilling.</p> <p>Spills from pipeline termination points from improper switching of valves during switching from one product to another.</p> <p>Damage to pipelines (above or below ground) due to deterioration or accident can also result in significant discharges.</p> <p>Spill containment measures, such as interceptors and catch pits, as well as associated drain lines, pipes and trenches (and other preferential flow paths) can also allow product to contaminate soil.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties including their persistence and toxicity. • The handling and operational processes that could be used to move or transfer materials, chemicals and products between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>A significant amount of waste is generated at these types of facilities from the processing activities.</p> <p>Generally, efforts are made to treat or recycle the waste directly through further processing efforts, such as recovery or recycling.</p> <p>Historical cleaning of leaded sludge from large petrol tanks and allowing it to 'weather' on outdoor pads to convert the</p>	<p>Waste disposal from these facilities could result in widespread contamination, as a result of:</p> <ul style="list-style-type: none"> • direct burial of wastes and sludge that could leach into surrounding soils and groundwater • direct application of liquid and solid wastes to ground could result in surface soil contamination and migration to deeper soils and groundwater, as well as sediment and surface-water contamination 	<p>The potential for contamination from waste disposal processes varies greatly and depends on the waste disposal practices and locations, both historically and currently.</p>

Activity	Description	Mechanism of contamination	Risk factors
	<p>lead from highly toxic organic forms to less toxic inorganic forms.</p> <p>Disposal of contaminated stormwater from bunded areas via separators.</p> <p>Disposal may be required to an offsite disposal facility for some items, such as spent catalysts or oily sludge from tank cleaning.</p> <p>Historical redundant pipelines and structures (both above and below ground) could still be present at sites.</p>	<ul style="list-style-type: none"> • seepage from redundant underground structures and pits (including pipes) of liquid wastes or sludge • use of persistent contaminants, such as organic lead additives in petrol • historical spillage of sludge at tank access points during transport to weathering pad and around weathering pad • historical disposal of sludge by burial on site. 	

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<p><i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i></p>	<p><i>Assists identification of whether, and the length of time, a contaminant may have been in use</i></p>	
<p>Benzene, toluene, ethylbenzene and total xylene (BTEX)</p>	<p>Persistence will be dependent on the compound, environmental conditions and soil properties. BTEX are stable but can undergo microbial degradation.</p> <p>BTEX are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	<p>Throughout life of gasworks, potentially from the 1860s to 1970s.</p>	<p>Toxicity is specific to the compound. BTEX are considered toxic, and some are known carcinogens.</p> <p>Exposure pathways for BTEX include inhalation, dermal exposure and soil ingestion.</p> <p>Vapours are flammable and, at specific concentrations, potentially explosive.</p>
<p>Polycyclic aromatic hydrocarbons (PAHs)</p> <p>Component of crude oil, heavy fuel oils (bunker oil) and distillates, such as diesel and fuel oils</p>	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weight increases. This limits their mobility in soil and groundwater. However, PAHs can bind to</p>	<p>Throughout life of gasworks, potentially from the 1860s to 1970s.</p>	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	small particles leading to migration in surface water and air.		<p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Aliphatic hydrocarbons – aliphatic hydrocarbons do not have a benzene ring and have carbon atoms arranged in straight chains or branched structures	Major component of petrol, diesel, jet fuel (Jet A1) kerosene, white spirits, turpentine and similar substances.	Late 1800s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon or hydrocarbon mixture.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the hydrocarbon or hydrocarbon mixture.</p>
Tetraethyl lead (TEL) $Pb(C_2H_5)_4$ An additive used in petrol as an anti-knock compound	Persistent and mobile in petroleum plumes.	1920s to 1980s.	<p>Organic lead is highly toxic and ecotoxic. It is soluble in petrol, a property that also allows it to accumulate in fat tissue and cross the blood–brain barrier in mammals.</p> <p>When TEL burns, it produces carbon dioxide and water, lead and lead(II) oxide.</p>
Tetramethyl lead (TML) $C_4H_{12}Pb$ An additive used in petrol as an anti-knock compound	Persistent and mobile in petroleum plumes.	1920s to 1980s.	Organic lead is highly toxic and ecotoxic. It is soluble in petrol, a property that also allows it to accumulate in fat tissue and cross the blood–brain barrier in mammals.
Methyl tertiary-butyl ether (MTBE) $(CH_3)_3COCH_3$ A lead-free anti-knock additive in petrol	Moderately persistent in groundwater. Floats on water. If product enters soil, it will be highly mobile and may contaminate groundwater.	1980s to present. MTBE enters groundwater, along with petrol, from leaking underground storage tanks. MTBE can travel faster and further than other components of petrol because of its higher solubility in water.	<p>MTBE is slightly toxic to humans.</p> <p>MTBE gives water an unpleasant taste at very low concentrations. Mainly an unwanted contaminant of imported petrol in New Zealand.</p> <p>Unless at high concentrations, MTBE is not acutely toxic to aquatic life.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Non-chlorinated solvents (white spirits and benzene)	<p>Most non-chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater, depending on groundwater conditions. Degradation products may also persist.</p> <p>Mobile in soils, generally low persistence in soils because volatile.</p> <p>Vapours are denser than air and can migrate into confined spaces, such as basements or excavations.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent. Exposure pathways for non-chlorinated solvents include inhalation, dermal exposure and soil ingestion. These solvents are generally toxic and some may be carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.</p> <p>Vapours are flammable and, at specific concentrations, potentially explosive.</p>
Solvents – chlorinated solvents (primarily tetrachloroethene, also called perchloroethylene, perc or PCE)	<p>Highly mobile in soils, generally low persistence in soils because volatile.</p> <p>Chlorinated solvent vapours are denser than air and can collect in confined spaces, such as basements or excavations.</p> <p>Some chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater, depending on groundwater conditions. The degraded products may also persist in the environment.</p>	<p>PCE: 1930s to present.</p> <p>Trichloroethene (TCE): 1930s to present.</p> <p>Tetrachloromethane: 1890s to 1950s.</p>	<p>Toxicity is specific to the solvent. Chlorinated solvents are generally toxic, and many are carcinogenic. Exposure pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion.</p> <p>Chlorinated solvents are also referred to as dense non-aqueous phase liquids (DNAPLs) because they are denser than water.</p> <p>When in groundwater, DNAPL sinks through the water column, and only stops when a limiting layer of rock or clay is encountered, where it can remain for years or decades as it slowly breaks down. The break down products can be more persistent and toxic than the original solvent, for example, PCE, degrading to vinyl chloride.</p> <p>Exposure pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Lubricating oil	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Lubricating oils commonly include metals such as zinc and molybdenum in additives to improve performance.</p>
<p>Per- and poly-fluoroalkyl substances (PFASs)</p> <p>Aqueous film forming foam (AFFF) chemicals used in firefighting and, in particular, per- and poly-fluorinated compounds (eg, perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and related compounds)</p>	Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.	<p>1950s to present.</p> <p>Use of some compounds within the PFAS grouping (eg, PFOS) phased out since 2002 but others remain in common use.</p>	<p>Human toxicity not well understood.</p> <p>Some PFAS compounds are highly toxic to environmental receptors.</p> <p>Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A14

Pharmaceutical manufacture, including the commercial manufacture, blending, mixing or formulation of pharmaceuticals, including animal remedies or the manufacturing of illicit drugs with the potential for environmental discharges

HAIL activity intention

Description	<p>Pharmaceuticals are substances specifically manufactured to treat health conditions and/or support and maintain healthy biological functioning in humans and animals. Pharmaceuticals include drugs, medicines, vaccines and supplements (vitamins and minerals).</p> <p>The manufacturing of pharmaceuticals is typically undertaken in industrial premises; however, the manufacture of illicit drugs may be carried out within a broad range of facilities or buildings.</p> <p>The two main processes in the manufacture of these substances are as follows.</p> <ul style="list-style-type: none"> • Primary manufacturing processes are those required to produce the active ingredient of the drug. Primary manufacturing includes chemical synthesis, chemical reaction, fermentation and extraction processes. These processes will use raw and intermediate materials, acids, bases, oxidisers and solvents. Extraction uses natural and biological sources, such as plants, animals and fungi. • Secondary manufacturing processes are those required to produce the drugs in a form that is appropriate to the intended use. Secondary manufacturing includes processes such as compression, blending, milling, formulation and granulation. Generally, the secondary processes involve working with a dried product, if tablets, pills or capsules are being manufactured. An aqueous or solvent solution will be used in the wet granulation methods. Oral or topical liquids will also be prepared by mixing the active ingredient with a solvent, oil or emulsion vehicle, as well as additives such as colouring, flavouring, fragrance and preservatives and anti-oxidants.
Applicability	<p>This category is intended to cover sites that manufacture or formulate pharmaceuticals used for the treatment of health conditions in humans and animals, as well as sites where illicit drugs have been manufactured. These activities encompass a broad range of manufacturing, mixing, blending, materials handling, and storage equipment and processes.</p> <p>As with many large-scale industries, it is likely that pharmaceutical manufacturing sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. Examples of these activities include workshops, storage tanks for chemicals and wastes, and analytical laboratories, which may have been present as part of or in support of the pharmaceutical manufacturing activity.</p>
Contamination setting	<p>Areas most likely to be affected by contamination are sites where equipment and machinery, storage vessels, tanks and piping are located. Other areas include where materials were transferred, where filling of containers occurred, and where spills and on-site disposal took place, particularly resulting from poor handling, storage, housekeeping and maintenance, and waste disposal practices. Newer premises are more likely to be operated and maintained at a higher standard with fewer opportunities for discharges to the environment.</p>
Exclusions	<p>This category does not cover potential contamination of the building fabric associated with the manufacturing of illicit drugs. For more information, refer to Department of the Prime Minister and Cabinet (2018) Methamphetamine contamination in residential properties: Exposures, risk levels, and interpretation of standards.</p>

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Chemical manufacturing	<p>The broad nature of this activity can cover a wide range of equipment, processes and substances used in the manufacturing of active ingredients.</p> <p>The scale of the operation can also vary significantly. This activity can be a large industrial plant producing a wide range of chemicals or a small unit producing a bespoke chemical.</p> <p>Pharmaceutical and veterinarian medicine manufacturing will be undertaken in controlled, specialist facilities. Materials will be transferred between process vessels or equipment in pipes or hoses. Sometimes products are manually weighed.</p> <p>Illicit drug manufacturing will not be undertaken in specialist facilities and is more likely to occur at residential properties, in temporary accommodation (eg, motels) or at another clandestine, uncontrolled location. Occasionally, mobile homes or caravans are used.</p> <p>The primary production of pharmaceuticals involves the formulation of the active drug ingredient. This could involve chemical synthesis, fermentation or extraction processes, and use a wide range of chemicals and processes. Illicit cannabis oil extraction may result in significant quantities of wastes, including ethanol.</p>	<p>Opportunities for contamination to occur are mainly through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged and old tanks and fittings and equipment) of product and chemicals onto land • drips, spills and leaks onto unsealed land • drips, spills and leaks on impermeable surfaces draining to sensitive receiving environments • migration into the shallow soil profile and deeper to groundwater from corroded or damaged drainage pipes and channels. <p>Inappropriate disposal to land of chemicals or products that were not suitable for their intended use.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity • Condition of the equipment. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period over which manufacturing took place. • How often chemicals were manufactured – continuous process or batch production.
Pharmaceutical formulation	<p>The broad nature of this activity can cover a wide range of equipment and multiple processes and methodologies used in the formulation of active ingredients, and an even wider range of products and chemicals.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged and old tanks and fittings and equipment) of product and chemicals onto land 	<ul style="list-style-type: none"> • The volume and types of chemicals and products used in, or formulated by, the process, their physical form and properties, including their persistence and toxicity. • Condition of the tanks, lines and equipment, and any leaks that could occur in old or damaged equipment.

Activity	Description	Mechanism of contamination	Risk factors
	<p>The scale of the operation can also vary significantly. This activity can be a large industrial plant mixing or blending a wide range of chemicals or a small unit using one or two chemicals to produce a bespoke formulation.</p>	<ul style="list-style-type: none"> • impermeable surfaces draining spills away to sensitive receiving environments • migration into the shallow soil profile and deeper to groundwater from corroded drainage pipes and channels • inappropriate disposal to land of chemicals or products that were not suitable for their intended use. 	<ul style="list-style-type: none"> • The period over which formulation took place. • How often chemicals were formulated – continuous process or batch production. • Volume of chemicals used. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Bulk storage of chemicals	<p>Storage of one or more raw products, precursors, intermediates and final products involves having tanks, bins, bags and stockpiles of the components used in the chemical manufacturing or formulation stored in an area either repeatedly or on a permanent basis. Storage will primarily be in tanks, drums, intermediate bulk containers (IBCs) or containers and will involve liquids and powders comprising organic and inorganic compounds.</p> <p>Storage will occur throughout the manufacturing processes and could be in several different locations across a plant.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks (through damaged and old tanks and fittings and equipment) of agrichemicals onto land at cleaning locations • point source of contamination for surface soils in a limited area • overland flow paths to surrounding and/or wider area and to sensitive receiving environments • impermeable surfaces could drain spills towards sensitive receiving environments • migration into the shallow soil profile and deeper to groundwater. <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater.</p>	<p>Storage of raw products, precursors, intermediates and final product risk factors include:</p> <ul style="list-style-type: none"> • the volume and types of chemicals, their physical form and properties, including their persistence and toxicity • the period over which substances were stored • measures to control leaks or spills • condition of any storage tanks, containers, pipework or processing equipment • suitability and weathertightness of buildings and shelters used for storage • permeability and topography of soils and surfaces and proximity to sensitive receiving environments • discharges to air and deposition of airborne contaminants • maintenance of facilities and structures • waste management practices, both current and historical.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Active ingredients may include hazardous substances and contaminants	Varies according to the substance.	Varies by substance.	<p>Many active ingredients may be toxic and/or ecotoxic. Each ingredient exhibits an influence over biological functions as part of their mode of action. Spills and leaks result in discharges at dosage rates well outside what is recommended.</p> <p>The physicochemical and environmental characteristics of the substance</p>
Solvents (including benzene, toluene, ethylbenzene and total xylene (BTEX), acetone, toluene, ketones) used throughout manufacturing	<p>Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Many different solvents can be used in pharmaceutical manufacturing. They are used to extract active ingredients from other matrices.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.</p>
Chlorinated solvents, including trichloroethene (TCE) and 1,2-dichloroethene or dichloroethylene (DCE), possibly used to clean parts in workshops or machinery in situ.	<p>Persistence will be dependent the solvent, on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can be and have been used in laboratories. Their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p>
Alcohols	Low persistence, biodegradable, generally high solubility in water, volatile.	1800s to present.	Toxic to aquatic organisms, ecotoxic in soil.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Acids (organic synthesis process)	Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade. Will likely be mobile in the environment.	1800s to present.	Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is. Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Bases and alkalis (such as sodium or potassium hydroxide)	Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade. Will likely be mobile in the environment due to their water solubility.	1800s to present.	Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes. Bases and alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Metals and metalloids (eg, zinc, selenium, copper, iron in supplements)	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	1800s to present.	Toxicity is specific to the element or chemical form that the metal is in. Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .
Phenol, detergents and disinfectants (cleaning and sterilisation)	Persistence and mobility are dependent on the specific compound and the environmental conditions and soil properties. Because these compounds are likely to be water soluble, they are likely to be highly mobile.	1800s to present.	Toxicity is specific to the compound or chemical form that the compound is in. Phenolic compounds may exhibit moderate to high human toxicity. Exposure pathways for phenolics include inhalation, dermal exposure and soil ingestion. Phenolic compounds may exhibit moderate to high environmental toxicity, especially in aquatic ecosystems.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Nitrogen, phosphates and other nutrients (from spent fermentation)	Generally soluble and can be mobile in soil.	1800s to present.	<p>Toxicity is specific to the compound or chemical form that the compound is in.</p> <p>Nitrogen and phosphorous compounds may exhibit low to moderate human toxicity.</p> <p>Nitrogen and phosphorous compounds may exhibit moderate to high environmental toxicity, especially in aquatic ecosystems.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A15

Printing, including commercial printing using metal type, inks, dyes or solvents (excluding photocopy shops)

HAIL activity intention

Description	Printing broadly covers the application of an ink, dye or coating to a plate or directly onto the print media. The types of chemical substances associated with printing, and the composition of inks, dyes or coatings, vary widely and include solvents, binders, resins and pigments, as well as glues, films, etchants, metals and metalloids, petroleum products and solvents.
Applicability	This category applies to premises involved in printing activities where metal type or plates are used to print inks, dyes and coatings on to a product.
Contamination setting	Printing premises may have discrete areas where the various processes occur as well as areas where raw materials and chemicals are used and stored, and where wastes are generated. The contaminants for each of these areas will be specific to the activities undertaken.
Exclusions	<ul style="list-style-type: none">• Sites where chemicals, such as inks or dyes, are manufactured.• Premises that solely use photocopiers or laser printers, because these machines use fully sealed ink cartridges and toners, which are operated indoors and where the potential for soil contamination is negligible.• Premises where low-volume printing with presses is done, with substrates that do not contain metals and metalloids, and do not require chemical etching (eg, woodcut, woodblock, linocut collagraph, lithograph or silkscreen).

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage and transfer	<p>Storage of manufactured inks, dyes, acids and solvents. Storage will usually be in above-ground structures (tanks, intermediate bulk containers (IBCs), drums and so on); however, underground storage tanks may also be present.</p> <p>The transfer of product from the bulk storage area to the printer(s) could be undertaken manually or the site may have an automated bulk delivery system.</p> <p>Manual means of dispensing could involve simply pouring the chemical, using a funnel, or perhaps the container may have a tap fitted. This process could be undertaken at the storage location or printing press (consider the transportation route for chemicals).</p>	<p>Spills, splashes, slops and leaks on to or into the ground, for example, when decanting substances from large volume containers to smaller containers.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater.</p> <p>The condition and construction of storage areas affect containment ability of the area, and secondary containment prevents spills from moving further afield and especially into drains.</p>	<p>Storage and transfer includes general housekeeping practices and how substances are transferred between containers and locations. Risk factors include:</p> <ul style="list-style-type: none"> • the volume and types of chemicals, their physical form and properties, including their persistence and toxicity • the period over which substances were stored • the type of equipment used to store and transfer substances • manual handling practises • measures to control leaks or spills • condition of any storage tanks, containers, pipework or processing equipment • suitability and weathertightness of buildings and shelters used for storage • permeability and topography of soils and surfaces and proximity to sensitive receiving environments • discharges to air and deposition of airborne contaminants • maintenance of facilities and structures • waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
Production and use of hot metal type	<p>Casting of metal type (lead, tin, antimony alloy) in a print foundry.</p> <p>Manually making up printing plates using metal type.</p> <p>Hot metal typesetting of complete lines or plates in typesetting machines (eg, linotype).</p> <p>Melting down of used type for reuse.</p>	<p>Metal particulates getting into the ground.</p> <p>Vaporised metal can be deposited on any surface as it cools. This contaminates surfaces such as bench tops and equipment, and when the dust is disturbed, it can move and further contaminate indoor spaces. If the type casting area is ventilated, metal vapour can be ejected from the building and settle near or downwind of the vents. The vents can also be heavily contaminated. Cleaning and maintenance of the extraction system can result in contaminants reaching the ground.</p> <p>Activities carried out within buildings with impermeable floors present little potential for solid materials to penetrate floors.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments • The period and frequency over which production and use of hot metal type took place.
Operation of printing presses	<p>Presses rely a great deal on oil to lubricate the workings of a printing press, which can generate oily waste.</p> <p>Inks contain a variety of chemicals, including pigments, resins, flow modifiers, thinners and drying agents.</p> <p>Cleaning of presses and plates may rely on alcohols, petroleum hydrocarbons or chlorinated solvents.</p> <p>Acids may be used to etch print plates.</p>	<p>Leaks or drips through floors on to or into the ground.</p> <p>Older presses required far greater human intervention to operate. As presses became more modernised, and with increasingly computerised controls, the need for manual intervention decreased.</p> <p>Where solvent-based cleaners and degreasers are used on the printing machinery, there is potential for localised high concentration contamination with concentrated liquids in and around machine locations, especially where chlorinated solvents such as trichloroethene (TCE) or 1,2-dichloroethene or dichloroethylene (DCE) have been used.</p> <p>Given that the machines were or are located indoors, the potential extent of contamination will be constrained by the integrity of the floors, presence of drip trays, maintenance practices and so on. Floor integrity is a critical aspect in preventing soil contamination from occurring.</p> <p>Historically, dirty solvent-soaked rags have been a difficult-to-manage waste stream.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period and frequency over which the use of printing presses took place.
Cleaning of printing equipment	<p>Cleaning products, such as washes for rollers, blankets and presses, have traditionally been petroleum-based products, solvents and degreasing</p>	<p>Spills or leaks on to or into the ground.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals use, their physical form and properties, including their persistence and toxicity.

Activity	Description	Mechanism of contamination	Risk factors
	<p>agents, typically containing naphtha, mineral spirits, methanol and toluene.</p> <p>Chlorinated hydrocarbons (perchloroethylene (PCE), TCE) and ketones, such as methyl ethyl ketone (MEK) may also be used.</p>	<p>Potential for residues to reach on-site drainage network if site surface was washed down using water.</p> <p>Potential for localised high concentration contamination with concentrated liquids in and around machine locations. Given that the machines were or are located within factories or commercial buildings (ie, not outdoors on unpaved sites), the potential extent of contamination will be constrained by the integrity of the site seal.</p>	<ul style="list-style-type: none"> • Condition of the equipment. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period and frequency over which the cleaning of printing equipment took place.
Waste disposal	<p>The printing industry can generate a lot of waste.</p> <p>Typical waste includes:</p> <ul style="list-style-type: none"> • un-used products, such as inks, dyes, photographic chemical waste and solvents • lubricating oils from machinery • cleaning equipment and materials (often containing solvents) • empty tins, drums or cartridges • spent etchants. <p>In the past, liquid wastes may have been poured directly into drainage systems or disposed of on site.</p>	<p>Deliberate tipping of waste to ground or into drains and sewers.</p> <p>Spills or leaks from degraded or damaged containers.</p> <p>Contamination of surface soils in limited areas. Potential for migration into deeper soil profile from tipping of waste to ground or disposal to drainage system.</p> <p>Discharge of corrosive chemicals via wastewater could lead to the degradation of the pipe network, which could become a preferential flow pathway for contaminants in the pipes. Pipelines are often laid in a trench with gravel surrounding the pipe, which allows relatively free lateral movement of contaminants once they escape from the pipe, resulting in long contaminant plumes.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p> <p>Historically, dirty solvent- and ink-soaked rags have been a difficult-to-manage waste stream, often containing high levels of ink and chlorinated solvent. These are often disposed of to landfill after treatment to remove some of the solvent.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Solvents (variable, depending on use, may include ethanol, isopropanol in inks, methyl ethyl ketone (MEK), white spirits, kerosene)	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Human health effects and environmental toxicity are specific to the solvent. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant. Many different solvents can be used in the laboratory. They are used to extract contaminants from other matrices and as a solution in which samples are analysed
Solvents – chlorinated (trichloroethene (TCE) and perchloroethylene (PCE), which are used for cleaning and degreasing and methylene chloride or dichloromethane (DCM) to clean printing blankets)	Persistence will be dependent on the solvent, environmental conditions and soil properties. Most chlorinated solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Different chlorinated solvents can and have been used in parts and machinery cleaning and degreasing. Their use has declined due to their toxicity. Chlorinated solvents are toxic, and some are considered carcinogenic. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.
Acids (such as hydrochloric acid, nitric acid and ferric chloride)	Low persistence and mobility if in small quantities because soil will tend to neutralise and degrade. Will likely be mobile in the environment due to their water solubility.	1800s to present.	A range of acids are frequently used in analytical laboratories. Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is. Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Alkalis (such as sodium or potassium hydroxide used for screen cleaning)	<p>Low persistence and mobility if in small quantities because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to their water solubility.</p>	1800s to present.	<p>Alkalis are frequently used in analytical laboratories.</p> <p>Alkalis are not generally toxic but can cause severe burns by all exposure routes.</p> <p>Alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>
Metals and metalloids (eg, lead, tin and antimony type metal)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils. The use and discharge of acidic etchants in association with lead antimony alloy plates or type may decrease soil pH.</p>	<p>Commercial printing 1800s to 1990.</p> <p>Artisan use of metal type to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
<p>Per- and poly-fluoroalkyl substances (PFASs)</p> <p>Surface coatings to repel grease and moisture may contain PFAS. Uses include non-food paper packaging (eg, cardboard, carbonless forms, masking papers) and food-contact materials (eg, pizza boxes, fast food wrappers, microwave popcorn bags, baking papers, pet food bags)</p>	<p>Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.</p>	<p>1950s to present.</p> <p>Use of some compounds within the PFAS grouping (eg, perfluorooctanesulfonic acid (PFOS)) phased out since 2002 but others remain in common use.</p>	<p>Human toxicity is not well understood. Some PFAS compounds are highly toxic to environmental receptors.</p> <p>Spills or leaks on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater.</p> <p>The potential for contamination of soil or groundwater from the storage of hazardous substances depends largely on housekeeping practices and the structural integrity of the building, as well as the specific substances used and how they are applied.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>
<p>Metals and metalloids</p> <p>Lead, cadmium and copper (used as pigments in inks)</p> <p>Manganese and/or cobalt may have been added to oil-based inks to speed drying time</p>	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	<p>Cadmium (as contaminant in fertiliser): 1880s to present.</p> <p>Copper: 1800s to present.</p> <p>Lead: Late 1800s to 1970s.</p> <p>Zinc: 1800s to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
<p>Vegetable dyes and inks (may contain metals and metalloids)</p>	<p>Varies, depending on composition.</p>	<p>1970s to present.</p>	<p>Potential contamination could result from spillages and drips of ink.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Oils and greases (eg, lubricating oils for printing presses)	<p>These materials are not expected to be readily biodegradable and so may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Lubricating oils commonly include metals such as zinc and molybdenum in additives to improve performance.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A16

Skin or wool processing, including a tannery or fellmongery, or any other commercial facility for hide curing, drying, scouring or finishing or storing wool or leather products

HAIL activity intention

Description	A fellmongery is a place that prepares animal skins and hides for tanning. A tannery is a place where skins and hides are treated to make them into leather. Animal skins and hides (referred to here as hides) must be processed to keep the hide from rotting, decomposing and putrefying. Tanning involves applying chemicals to the hide to permanently alter its protein structure, to make it more resistant to biological breakdown. Tanning chemicals can be natural plant-based tannins or synthetic chemicals, such as chromium salts. Tanneries often apply dye, coatings or surface treatments to leather, to alter its aesthetic or performance characteristics. This may include dyeing, colouring or applying waterproofing, ultraviolet resistant or antimicrobial treatments, to make the leather suitable for a specific purpose. Some taxidermists tan the hides of game animals. Wool scouring involves the removal of fats and lanolin from wool using heated water and chemicals.
Applicability	This HAIL activity is intended to cover the industries and commercial facilities that produce wool or leather from animal skins or hides.
Contamination setting	Tanning and fellmongering have a long history, and the use of chemicals to preserve leather includes many hazardous substances and industrial processes with the potential to contaminate land. <ul style="list-style-type: none"> As with many large-scale industries it is likely that sites where the processing of skin and wool took place encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. This could include analytical laboratories, bulk storage of corrosives, bulk storage of chemicals in tanks or drums, above- and below-ground storage tanks containing fuel oils (eg, for boiler use), engineering workshops and large electrical transformers and switchgear.
Exclusions	<ul style="list-style-type: none"> Sites where raw skins are stored, such as at a meat works or abattoir. Those industries where finished leather or wool products are stored. Those industries that use finished leather to manufacture products, such as furniture or shoes.

Activity factors – *Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.* The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Storage of hides or chemicals and acids associated with the processing of the animal skin. These chemicals could be contained in above- or below-ground storage tanks or structures or could be present in smaller quantities. Note that storage locations may change or there may be several storage locations.	Spills or leaks on to or into the ground. Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater. Direct flow path to surface soils in immediate and limited area.	<ul style="list-style-type: none"> The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. Condition of buildings and equipment. Processes and safeguards to prevent discharges. Permeability of soils and surfaces.

Activity	Description	Mechanism of contamination	Risk factors
		<p>Overland flow paths to surrounding and/or wider area and to sensitive receiving environments.</p> <p>Impermeable soils draining spills away to sensitive receiving environments.</p> <p>Migration into shallow soil profile and deeper to groundwater.</p>	<ul style="list-style-type: none"> • The period over which tanning took place. • How often tanks were filled. • Immediate and surrounding topography and proximity to sensitive receiving environments, including waterways.
<p>Mixing and dispensing of chemicals or refilling of storage containers</p>	<p>Could involve the piping (dispensing) of chemicals from storage tanks to processing baths, pits and vessels.</p> <p>Could involve manually mixing chemicals for distribution to other areas in the site.</p> <p>Recycling of chemicals may occur, or chemicals may be replaced by means of a tanker.</p> <p>Mixing or dispensing locations may change, and there may be several locations at a site.</p> <p>Over time, sites will have likely become more automated, so additional infrastructure may have been installed at the site, and the location of specific activities may have changed over time.</p>	<p>Spills or leaks from manual mixing, or from dispensing from the delivery lines, or when tanks are being refilled with chemicals.</p> <p>Potential for localised high concentration contamination with chemicals in and around mixing and dispensing locations and areas where refilling occurs.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater.</p> <p>Contamination potential will be lower where mixing and dispensing of chemicals or refilling of storage vessels is undertaken on sealed ground.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used, which could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Management of wastes. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Flow paths should be considered, because contaminated runoff is likely to have permeated into the soil along the length of the flow path.
<p>Processing and treatment</p>	<p>The processing of animal skins and wool is complex and involves several steps:</p> <ul style="list-style-type: none"> • desalting and washing the hides – this requires chemicals, including alcohols and phenolic compounds • hair removal and preparation for tanning – to remove the hair or wool from a hide, the hide is immersed into a chemical solution (typically of lime and sodium sulfide, could include cyanide). ‘Deliming’ of the hide is then undertaken using an acid (ammonium chloride, ammonium sulfate or carbon dioxide) until the desired pH is reached. Finally, the skin is agitated in a solution of sulfuric 	<p>Spills or leaks of liquid contaminants on to or into the ground.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes.</p> <p>Potential for migration to surface-water receptors including stormwater.</p> <p>Potential movement of contaminants along preferential flow paths in soil, such as gravel pipeline beds.</p> <p>Potential for localised high concentration contamination, with concentrated liquids being used continuously throughout the processing, particularly in historic operations when many processes were</p>	<ul style="list-style-type: none"> • The types and volume of agrichemicals used, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • Practices and process for disposal of contents. Historical practices varied, and, in worst cases, the remaining spray and/or wash water may have been dumped from the tanks to ground or into a watercourse. • The period and frequency over which these operations occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
	<p>acid for preservation purposes. This process is known as ‘pickling’</p> <ul style="list-style-type: none"> • tanning – following the initial preparation, the animal skin is then stabilised (‘tanned’) using a vegetable, mineral or synthetic tanning material. Chromium (III) sulfate is a common tanning agent. Other tanning products contain formaldehyde and fish oils. Historically, the tanning process took place in submerged baths or pits. Modern processes use large vessels that mechanically agitate the hides • oils, waxes and greases – these are used to impart specific properties to leather. They are usually proprietary products and formulations, and the composition may be a trade secret • treatment and dyeing – after tanning, the leather must be neutralised to remove unwanted acids using mild alkalis. Surface coatings (dyes or pigments within a protein or acrylic based binding agent) are then applied by pad or spray. Per- and poly-fluoroalkyl substances (PFASs) may have been used in coatings to repel water, oil and stains. • wool scouring – this is the washing of raw wool in hot water and detergent to remove lanolin, dirt and other foreign material, and excessive grease. 	<p>manually undertaken and tanks, pipes and channels for transferring liquids were set into the ground.</p> <p>Modern processes have a lower likelihood of spills and leaks. The potential for contamination of the ground to occur from any spills or leaks will be minimised by the presence of sealed surfaces.</p>	
Waste disposal	<p>Modern tanneries tend to recycle the tanning solutions or to dispose of waste liquids to trade waste. The main waste products from these sites are salts, alkalis and sulfides, acids, chromium and dyes. It is also noted that pesticides and insecticides can be present.</p> <p>Disposal of surplus mixed chemicals where recycling is not possible.</p> <p>Disposal of chemical containers.</p> <p>Waste liquids and sludge from wool scours contain grease (lanolin) and may contain chemical residues from</p>	<p>Deliberate tipping of waste to ground.</p> <p>Spills or leaks from degraded and damaged containers.</p> <p>Contamination of surface soils in limited areas. Potential for migration into deeper soil profile from tipping of waste to ground.</p> <p>Degradation of stormwater and sewer infrastructure from acidic solutions, if wastewater discharged directly, which could result in soil, groundwater or surface water contamination.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p> <p>Variable potential for contamination for disposal of scour wastes to land. Sludge will potentially result in higher dip residue concentration at disposal sites than irrigation of waste liquids over larger areas.</p>

Activity	Description	Mechanism of contamination	Risk factors
	<p>sheep having been recently dipped. Lanolin may be recovered as a useful product.</p> <p>Disposal of scour waste to land, particularly on rural sites. Refer to category G5 for an assessment of contamination potential.</p>	Disposal of scour waste to land, particularly in rural sites.	

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Metals and metalloids (eg, copper, total chromium (chromium III and chromium VI (hexavalent)))	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Sulfides	<p>Persistence and mobility are dependent on the sulphide compound present and environmental conditions and soil properties.</p>	1800s to present.	<p>Toxicity is specific to the sulphide compound or chemical form that the sulphide compound is in.</p> <p>Sulphides can be toxic to humans.</p> <p>Sulphides can be highly toxic to aquatic organisms and terrestrial plant life.</p>
Acids and bleaching agents	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p>	1800s to present.	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	Will likely be mobile in the environment due to their water solubility.		Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, they are not considered to bioaccumulate or bioconcentrate through the food chain.
Cyanides	<p>Low-level free cyanide does not persist in the soil environment, due to chemical and biological reactions, although, at higher concentrations, free cyanide can inhibit biological processes. Cyanide complexes can be more persistent.</p> <p>Anaerobic conditions favour the formation of cyanide complexes.</p>	Potentially from the 1860s.	<p>Toxicity is specific to the compound. Free cyanide can be acutely toxic. Ferri- and ferro-cyanide complexes typically have low human toxicity. Thiocyanates have a moderate human toxicity. Depending on its form, cyanide may cause toxicity through inhalation, ingestion and dermal absorption.</p> <p>Harmful to aquatic organisms and may cause long-term adverse effects in the aquatic environment.</p> <p>In strongly acidic conditions, hydrogen cyanide gas can be released. Hydrogen cyanide is highly toxic.</p>
Formaldehyde	Formaldehyde is usually used in solution, which means it can be mobile. However, is it not persistent in soil or water, and decomposition will be dependent on the environmental conditions.	1800s to present.	<p>Formaldehyde has been classified by the International Agency for Research on Cancer as carcinogenic to humans. The primary route of exposure is through inhalation. Occupational and consumer exposure can, however, also include dermal exposure.</p> <p>Formaldehyde, although it decomposes in water, it is harmful to aquatic organisms, and may cause long-term adverse effects in the aquatic environment.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A17

Storage tanks or drums for fuel, chemicals or liquid waste

HAIL activity intention

Description	<p>This category covers sites that store fuels, chemicals and wastes that do not undertake another HAIL activity.</p> <p>The storage of tanks or drums does not specify a particular industry and covers a wide range of substances under the general term ‘chemicals and liquid wastes’. Fuels stored in tanks or drums refers primarily to hydrocarbon blends, including kerosene (or jet fuel), petrol, ethanol and diesel, although more specialised fuels and fuel blends are also covered under this activity, when stored in drums and tanks. Chemicals in this category refers to sites where chemicals are stored in tanks or drums associated with an activity that is not a HAIL activity. Liquid waste refers to almost any substance that is no longer desirable to keep or does not serve a useful function, and that is stored in tanks or drums before disposal. This category is intended to be limited to liquids, to avoid overlap with activity A2. Activity A17 does not use the term ‘bulk’ and so applies to lesser volumes than activity A2, including tanks or drums of any volume.</p> <p>Some activities and industries that use hazardous substances are not listed on the HAIL. The risk associated with the presence of a significant quantity of hazardous substances increases the risk of contamination, mainly as a result of the increased likelihood of spills, leaks or other discharges to the environment. The types of chemicals that may be stored is almost limitless, and the variety of container types, sizes and specifications is very wide.</p>
Applicability	<p>This category applies to fuel, chemicals and liquid waste stored in storage tanks or drums. It does not cover a narrow set of substances specific to a particular industry. The variety of substances covered by this category is broader than activity A2, because fuels and liquid wastes are also included, but the activities are more limited in that only storage is included, and then specifically in tanks and drums. Due to the range of HAIL activities that require the storage of chemicals, fuels and liquid wastes, this HAIL activity should only be applied to a site when no other, more specific, HAIL activity can be assigned.</p> <p>This category should not apply to sites where the quantity and hazard classification of the chemicals concerned does not trigger regulatory controls on the premises, personnel or equipment.</p> <p>Activity A2 does specify the types of substances and storage containers that are captured by this category.</p> <p>Activity A17 covers sites where the quantities of hazardous substances are sufficient to trigger legislative controls. This includes requirements to certify the premises, personnel or equipment that the hazardous substances are used by or stored in.</p>
Contamination setting	<p>Contamination is possible at any sites where drums of fuels and oil, including oily waste, are stored on unsealed land, especially where the drums have been stored for extended periods. Pinhole leaks in drums stored outdoors can, over time, result in the contents of the drum being replaced with rainwater. This slow process is a result of repeated expansion and contraction of the drums’ contents as they heat and cool during the day–night cycle.</p> <ul style="list-style-type: none">• Any storage of hazardous substances in a tank or drum that triggers regulatory controls should be considered to meet the threshold for being classified as a HAIL activity.
Exclusions	<ul style="list-style-type: none">• Solid hazardous substances, such as prills, powders and granules, which should be considered under HAIL activity A2.• Sites where fuel is stored in containers other than tanks or drums.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of fuel, chemicals or liquid waste could occur on almost any part of a site and may not be in an area dedicated to storage.</p> <p>Storage may be inside or outside a building.</p> <p>These chemicals could be contained in above- or below-ground storage tanks or drums.</p> <p>Note that storage locations may change or there may be several storage locations.</p>	<p>Spills or leaks from tanks or drums on to or into the ground. Leaks can vary from extremely slow, causing contamination over years or decades, or as the result of catastrophic failure.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors, including stormwater.</p> <p>Direct flow path to surface soils in immediate and limited area.</p> <p>Overland flow paths to surrounding and/or wider area and to sensitive receiving environments.</p> <p>Impermeable soils draining spills away to sensitive receiving environments.</p> <p>Migration into shallow soil profile and deeper to groundwater.</p>	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks or spills. • The volume and types of chemicals in the storage containers, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, tanks, bags and containers. • The period and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
A broad range of chemicals may be present at these sites, therefore, the contaminants of concern are usually specific to the operation	Persistence and mobility are dependent on the specific contaminant of concern and environmental conditions and soil properties.	The period of use for contaminants of concern in this category is dictated by the date the contaminant was first developed, the date of any regulation restricting or banning any individual chemical or product, or by the period during which the manufacture, formulation and storage were undertaken at the specific site.	<p>Because this activity is not specific to a particular type of industry or any specific group or individual chemicals, a broad range of chemicals and facility types could fit within this activity.</p> <p>The contaminants of concern and their period of use would need to be identified through the development of a conceptual site model (CSM) as part a preliminary site investigation.</p> <p>Physicochemical characteristics of contaminants dictate how and in what containers they can be stored. The volume, type of container and storage conditions will determine the likelihood of discharges. Each HAIL activity A17 site should be carefully examined on its own merits.</p>

Back to [Chemical manufacture, application and bulk storage list](#).

A18

Wood treatment or preservation, including the commercial use of antisapstain chemicals during milling, or bulk storage of treated timber outside

HAIL activity intention

Description	<p>New Zealand's timber industry relies largely on softwoods that require treatment with chemicals to preserve and protect wood from deterioration that results mainly from fungi, insects and marine worms. Timber treatment is intended to increase the durability of wood, and therefore relies on chemicals that have a long half-life and do not break down rapidly, to ensure the wood remains protected for long periods. There are many types of timber treatment, but this category relates to the application of preservative chemicals to wood, either by immersion or pressure impregnation. The term 'timber treatment' includes the use of antisapstain chemicals at sawmills, to prevent the fungal stain that occurs on freshly peeled logs or freshly sawn timber. It also includes the use of preservative chemical treatment of poles and posts, milled timber planks and boards.</p>
Applicability	<p>This category is intended to cover sites where chemical treatment methods have been used to preserve timber to prevent fungal or invertebrate infestation of the wood. For historical sites, where softwoods were milled and/or treated, the potential for ground contamination is high and such sites are covered by this category.</p> <p>It is also intended to cover storage of treated timber in bulk quantities outdoors, on sealed and unsealed ground, including at timber yards and building supply premises. There is significant potential for ground contamination at these sites, because the treatment chemicals can leach, leak and, in some cases, drip directly onto the ground.</p> <p>As with many large-scale industries, it is likely that wood treatment sites encompass other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. Examples of these activities include workshops and storage tanks for chemicals and wastes, which may have been present as part or in support of the wood treatment activity.</p>
Contamination setting	<p>Timber mills may encompass a broad range of processes that include chemical storage, mixing and application, and the handling and storage of wastes containing timber treatment chemicals. Due to the nature of the timber treatment processes, the chemicals used and the layout of timber treatment sites, the treatment activity presents numerous opportunities for soil to become contaminated. Potentially impacted areas would be where equipment and machinery, storage vessels, tanks and piping are located. Also, areas where filling, spills and on-site disposal occur, particularly resulting from poor handling, storage and/or maintenance practices. Areas include:</p> <ul style="list-style-type: none"> • locations where timber treatment chemicals are stored • locations where timber is allowed to drip dry after treatment • spills, leaks and drips of chemicals adjacent and beneath immersion baths • spills, leaks and drips at the loading and unloading port of pressure treatment vessels • drips along transport paths for treated timber • drips beneath timber stacked to dry after treatment • along rainwater flow paths and stormwater drainage infrastructure • around pressure vessels, in the event of a plant leak or pressurised pipe failure • anywhere where chemicals are handled, and spills or leaks could occur <p>Like most industries with a long history of operation, the types of chemicals used to preserve timber have changed with time. The main chemicals of concern associated with the treatment process are provided in the substance factors table below. When assessing the contamination potential from timber storage, consideration should be given to the quantity of timber stored, the duration over which timber storage has occurred in the same location, the chemicals used to treat the timber, and whether the timber is</p>

HAIL activity intention

	exposed to rainfall, which will cause the timber treatment chemicals to leach. Recently treated timber can continue to drip chemicals for some time and may rapidly increase contaminant concentrations in soil.
Exclusions	<p>This category does not intend to cover:</p> <ul style="list-style-type: none"> • locations where historical sawing and storage of native timbers occurred. Chemical treatment of timber is generally restricted to exotic softwoods. • sites where wood-based materials are manufactured, including plywood, chipboard and fibreboard.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Bulk storage	<p>Bulk storage will include liquid and dry chemicals required for the treatment of the wood. These chemicals could be stored in multiple locations and in varying quantities. Storage could be in above- or below-ground structures, tanks or drums.</p> <p>Storage of treated wood may also result in contamination, depending on how much is stored, the location and manner of storage, whether the ground is sealed and the storage area is protected from the elements, and the duration of storage.</p>	<p>Spills or leaks on to or into the ground from storage in vessels, tanks and containers.</p> <p>Drips and particulates from treated timber stored on unsealed surfaces.</p> <p>Large losses from above- and below-ground tank failures.</p> <p>Spillage of dry chemicals during handling.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors including stormwater.</p>	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks or spills. • The volume and types of chemicals in the storage containers, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, tanks, bags and containers. • The period and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Mixing and chemical preparation	<p>Location for diluting and mixing chemicals with water. Note: modern treatment facilities will tend to recycle chemicals and add concentrated chemicals automatically.</p>	<p>Spills or leaks on to or into the ground.</p> <p>Spillage of dry chemicals.</p> <p>Localised high concentration contamination with concentrated liquids and powders in and around mixing locations. The extent of contamination could be limited by surface conditions (eg, fully sealed site with trade waste facility) and storage locations (eg, stored in a covered area).</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used, which could involve moving materials and chemicals between different areas. • The period and duration of the activity, and what was considered best practice at the time. • Management of wastes.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Flow paths, which should be considered because contaminated runoff is likely to have permeated into the soil along the length of the flow path.
<p>Preservation of timber with chemicals</p>	<p>The process of treating timber can be essentially carried out using two methods:</p> <ul style="list-style-type: none"> • pressure treatment • non-pressure (immersion, brush or spray) treatment. <p>The pressure treatment involves applying chemicals via a high-pressure spray or by immersion within a closed vessel that is under pressure. A vacuum is frequently used to extract excess moisture from the timber before treatment and to remove timber treatment chemicals after treatment.</p> <p>Non-pressure treatment methods involve applying chemicals, including immersing the wood in chemicals in an open-top vessel, and brushing or spraying the treatment chemical onto the wood.</p> <p>The type of chemical used, amount of preservation required and chemicals used vary, depending on the intended use of the timber.</p> <p>Antisapstain treatment prevents wood from being discoloured by fungus, and involves dipping or spraying after poles or logs are peeled or timber is sawn. Treatment may have been as simple as manual spraying of poles and posts in a yard, or a spray tunnel or dip bath immediately after sawing and before going to sorting.</p> <p>It was common practice at older facilities to add other chemicals, such as pentachlorophenol (PCP), to the treatment solutions in dip vessels.</p>	<p>Spills or leaks of liquid contaminants on to or into the ground at location of outdoor dip baths.</p> <p>Spillage from pressure vessels when first opened.</p> <p>Overflows from drip pads, particularly uncovered pads, during rain.</p> <p>Leakage from sumps at the entrance to pressure vessels and collecting runoff from drip pads.</p> <p>Spillage and overflows at antisapstain baths and spray tunnels.</p> <p>Overspray from antisapstain spraying in unpaved yards.</p> <p>Dripping from freshly applied antisapstain between sawmill and sorting table, and under sorting table.</p> <p>Equipment failure, such as leaking pipes, hoses or fittings on pressurised equipment. This may send a jet of chemicals a significant distance.</p> <p>Where the pressure vessel is located outdoors, a bund around the vessel may overflow during heavy rainfall, allowing captured chemicals to escape.</p> <p>Transfer of aerosols if spraying was not carried out in an enclosed spray cubicle or tunnel.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors including stormwater.</p>	<ul style="list-style-type: none"> • The types and volume of agrichemicals used, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • Processes and safeguards to prevent discharges. • The period and frequency over which tank filling took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
	Dioxins are likely to be present in soils where PCP is present, as it is a contaminant of PCP.	<p>Containers of chemical mixtures left in the open, and flooded by rainfall, will discharge chemicals to the environment. This includes bunded areas that are not maintained to remove chemicals before rainfall, which can cause the bund to overflow.</p> <p>The extent of contamination could be limited by surface conditions or treatment vessels (eg, fully sealed floors and fully enclosed spray tunnels), however, historically, the process areas were often unpaved.</p>	

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Chromated copper arsenate (CCA)	<p>Mobile when spilled.</p> <p>CCA binds to treated wood and has limited mobility but does contaminate soil immediately adjacent to buried treated wood. Persistent.</p> <p>Soluble in water, toxic and persistent in the environment. Binds strongly to wood fibres.</p> <p>CCA is released when the treated wood is burned, creating an ingestion, inhalation and deposition risk.</p>	1950s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Boron	Persistence and mobility are dependent on environmental conditions and soil properties.	1950s to present.	Toxicity is specific to the chemical form and the environmental conditions.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	Boron salts are very leachable and mobile in the soil environment.		Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .
Pentachlorophenol (PCP) (and other chlorinated phenols)	Persistence will be dependent on environmental conditions and soil properties, but PCP slowly biodegrades and breaks down under ultraviolet light.	1950s to 1988.	Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . The presence of PCP may also be an indicator of the presence of dioxins. However, dioxins may still be present after any PCP has completely degraded.
Creosote (polycyclic aromatic hydrocarbons (PAHs), cresols, phenols) Creosote does not have a chemical formula but includes several chemicals at a range of concentrations that vary widely between batches.	Persistence varies according to the composition of the batch.	Historically, on some sites for railway sleepers. Not commercially used in New Zealand now.	Spillage or dripping creosote where it is applied to wood. Seepage from the wood to the soil beneath or surrounding the wood. Sites where creosote-treated timber has been stored or stockpiled.
Solvents (white spirits in light organic solvent preservative (LOSP) treatment process)	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1870s to present.	A variety of solvents can be used in timber treatment. They are used as a vehicle for preservatives. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.
Tributyltin (TBT)	TBT is persistent in soils and sediments. TBT has a low water solubility and lipophilic character, it adsorbs readily onto particles.	1982 to present.	Organotin compounds are used in antifouling paint for ship hulls, as a stabiliser in the manufacturing of plastic products, as a catalyst in poly(vinyl chloride) products, a biocide (fungicide, bactericide, insecticide) and as a preservative for wood, textiles, paper, leather and electrical equipment.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	<p>Persistence and mobility are dependent on environmental conditions and media properties.</p> <p>TBT bioaccumulates in organisms because of its solubility in fat.</p>		<p>Organotins are known to be toxic at relatively low levels of exposure not only to marine invertebrates but also in mammalian systems. Organotins have been demonstrated to have immunotoxic, teratogenic, neurotoxic and carcinogenic effects in mammals.</p>
Dioxins and difurans (impurities in PCP)	<p>Dioxins and furans are characteristically described as persistent and bioaccumulating substances prone to long-range transportation.</p> <p>Dioxins and furans can remain in the environment for years or even decades.</p>	1950s to 1988.	<p>Dioxins and difurans accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain.</p> <p>Dioxins and difurans are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats. Some dioxins are classified as human carcinogens.</p>
Organochlorines – organochlorine pesticides (OCPs) are generally categorised as chlorinated cyclodienes, chlorodiphenylethanes, chlorinated benzenes and cyclohexanes (excluding dioxins and furans)	<p>OCPs are characteristically described as persistent and bioaccumulating substances prone to long-range transportation.</p> <p>Organochlorines are also very persistent in the environment, often remaining in soil for years or even decades.</p>	<p>1940s to current.</p> <p>Dieldrin was banned in 1987.</p> <p>Lindane banned for most uses in 1989 and all uses in 2015.</p> <p>Dichloro-diphenyl-trichloroethane (DDT) was banned in 1989.</p> <p>Chlorothalonil approvals mostly revoked in 2017.</p> <p>Difocol was listed as a persistent organic pollutant (POP) in 2020, and approval is currently being reviewed by the Environmental Protection Authority.</p> <p>Endosulfan was deregistered in 2008.</p>	<p>Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain.</p> <p>OCPs are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats.</p> <p>Historical application of organochlorine pesticides was as an insecticide and a defoliant, and they were widely used for this purpose from the 1940s to the 1960s.</p>
Synthetic pyrethroids (LOSP formulations)	<p>Persistence in soil increases with concentration because micro-organisms that degrade pyrethroids are affected.</p> <p>Spills of concentrate, or prolonged repeated discharges of dilute pyrethroid mixtures, can compromise the ability of soil organisms to break</p>	1970s to present.	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Pyrethroids generally have low to moderate toxicity to vertebrates (including humans).</p> <p>Pyrethroids are highly toxic to invertebrates and fish.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	down the substances and, in such cases, the contaminants can be persistent.		Pyrethroids are broad spectrum insecticides, effective against a wide range of insect pests.

Back to [Chemical manufacture, application and bulk storage list](#).

B Electrical and electronic works, power generation and transmission

B1 Batteries, including the commercial assembling, disassembling, manufacturing or recycling of batteries (but excluding retail battery stores)

HAIL activity intention

Description	<p>A battery contains hazardous substances that react to create electricity. The hazardous substances used are determined by the type of battery, and include:</p> <ul style="list-style-type: none"> • lead–acid vehicle and storage batteries • carbon–zinc • alkaline and lithium batteries (potassium or manganese oxides) commonly used in torches and consumer electronics • mercuric oxide, silver oxide and zinc-air used for specialist applications, such as hearing aids and cameras • nickel–cadmium, nickel metal hydride and lithium–ion rechargeable batteries used in consumer electronics, vehicles, and increasingly in larger banks for storage purposes • other types of batteries that rely on a range of other metals, such as antimony, copper, aluminium, sodium, chromium and iron • battery types relying on new chemical processes are being developed and brought into production (eg, electric vehicles and personal devices). <p>The commercial manufacturing, assembling, disassembling and recycling of batteries requires the storage, handling and processing of hazardous substances, as well as wastes generated during these activities.</p> <p>The methods associated with these activities include specific processes that involve a range of chemicals.</p> <p>The most commonly manufactured and recycled batteries in New Zealand are lead–acid batteries. However, lithium–ion batteries are increasing in use and currently represent a significant portion of the battery market in New Zealand.</p> <p>There is a significant difference between the manufacturing processes for lead–acid batteries and rechargeable batteries, such as lithium ion. The former relies on relatively large plates and components, while the latter relies on films and foils covered in very thin layers of chemicals, which cannot readily be made by hand. Virtually all lithium–ion batteries in New Zealand have been imported.</p> <p>While most batteries used in New Zealand have been imported, some commercial facilities have existed in New Zealand that manufactured or assembled batteries. The number of sites that disassemble and recycle batteries is likely to increase, as battery powered devices and appliances and hybrid and battery electric vehicles become increasingly common.</p> <p>In New Zealand, there are limited industries remaining that still manufacture, assemble or rebuild lead–acid vehicle batteries, but several sites existed in the past. There is no known manufacture of dry-cell and rechargeable batteries (other than lead–acid) in New Zealand. Lead–acid and carbon–zinc batteries are known to have been manufactured in New Zealand.</p>
Applicability	<p>This category is intended to apply to commercial or industrial sites where batteries have been assembled, disassembled, manufactured (or remanufactured) or recycled.</p> <p>Battery factories or assembly lines, as well as recycling plants where used batteries are disassembled and recycled to make new batteries, are the primary focus of this HAIL activity. However, this category also applies to sites where bulk quantities of batteries have been collected before being shipped to a recycling facility, because the condition</p>

HAIL activity intention	
	<p>of batteries could result in leaks, and handling practices could result in discharges of contaminants to the environment. This category can also apply to sites where a significant number of batteries have been disassembled and recycled to recover metals, for example, lead for use in dive weights and fishing sinkers.</p>
Contamination setting	<p>Lead–acid batteries are the most common battery type to have been manufactured, assembled, disassembled and recycled in New Zealand. These activities are usually undertaken inside a dedicated facility, although this is not always the case for battery recycling and disassembly. Battery assembly requires a relatively clean indoor environment, free from dirt and contaminants that could affect the quality and performance of the batteries being produced. The production of the component parts involves smelting lead to manufacture plates.</p> <p>Contaminants can enter the environment through spills, dust and the handling and disposal of waste products, as well as deposition of particles emitted via chimneys or stacks, or via the building fabric. There could be a halo of contamination around the buildings, which will vary in extent, depending on where the contaminants leave the building, and environmental factors, such as prevailing wind speed and direction.</p> <p>Battery disassembly and recycling does not require the precision required for battery manufacture and assembly. Facilities where batteries are disassembled and recycled tend to offer more opportunities for contaminants to escape and generate significantly more waste that is mixed and more difficult to treat and dispose of properly.</p> <p>The ground surface within buildings will usually be concrete, although the level of finishing is likely to be variable, especially at older sites.</p> <p>The risk of contamination is greater at older sites, especially sites used for long periods. Historical facilities and practices may have been subject to fewer controls. Discharges over a long period have a cumulative effect, due to the persistence and relative mobility of contaminants. On-site disposal of wastes, including empty containers, floor sweepings, scrap and broken or outdated equipment are more frequently encountered with older industrial sites.</p> <p>Metal ion batteries (such as lithium–ion) are not commercially recycled in New Zealand, although this may change in the future. Battery packs are, however, currently disassembled to remove faulty cells and replace individual cells to refurbish battery packs.</p> <p>Where large numbers of faulty cells are stored for recycling or disposal, there is a possibility of contaminants escaping containment, resulting in localised contamination.</p> <p>This category encompasses raw material storage, such as whole and broken batteries, cells and components, metals, and the chemical electrolytes used in the manufacture of batteries. Manufacturing may involve processes such as smelting and casting metals, pressing powders into forms, cutting and grinding, soldering and welding. Battery casings need to be filled with acid before manufacturing is complete.</p> <p>Disassembly and recycling of batteries require intact batteries to be opened, their contents removed and sorted for different treatment processes, releasing liquid and solid contaminants.</p>
Exclusions	<ul style="list-style-type: none"> • Commercial or retail facilities that store or sell batteries in a finished state, including wholesalers that specialise in battery retail activities, if these sites do not disassemble batteries for repair or recycling, or hold significant stocks of damaged batteries. • Sites that collect small volumes of batteries (that are not disassembled or broken down) for bulk storage and/or recycling elsewhere.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation PSI.

Activity	Description	Mechanism of contamination	Risk factors
Storage of raw materials	<p>Raw materials in batteries, whether being assembled or disassembled, will typically include metals, metal salts, alkalis and acids. These materials could be liquids, solids or solutions. These may be stored in drums, plastic containers, intermediate bulk containers (IBCs) or tanks, all of which could be located within or outside of a building.</p> <p>Pre-packaged finished products will be stored before dispatch.</p> <p>Lead–acid batteries collected for recycling may be leaking and could cause discharges of contaminants.</p> <p>Note: storage locations may have changed over time.</p>	<p>Spills or leaks of raw or processed liquids and substances or powders on to or into the ground.</p> <p>Movement of contaminants on the ground by foot traffic or vehicles, such as forklifts, trolleys or carts, used to move components and finished batteries around the factory.</p> <p>Sweeping can raise dust, which is distributed on to surfaces and objects and can spread contamination.</p>	<ul style="list-style-type: none"> • The types of chemicals and their physical form. • The period over which substances were stored. • Spills, leaks or discharges that took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Discharges to air and deposition of airborne contaminants (mainly dust or powder).
Manufacturing and assembly of batteries	<p>The manufacturing and assembling of batteries involve numerous processes that use a variety of materials, chemicals and solutions.</p> <p>Metal fabrication or plastic moulding are used to produce the battery casing. This may be produced at a different facility. Welding or soldering of connector straps to lugs in the production of lead–acid batteries.</p> <p>Modern rechargeable batteries differ markedly from lead–acid batteries in the process of assembly.</p> <p>Manufacturing of electrode cells (anodes, cathodes and electrolytes). Battery cells are composed of zinc (small dry cells) and lead.</p>	<p>Spills and leaks of raw materials, solutions or finished products on to or into the ground.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals and their physical form. • The industrial processes used. • The period and duration of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Processes that heated, cut, ground, welded or melted metals, causing vapour, dust or spatter. • Housekeeping and cleaning practices used, as well as management of wastes. • Drains in the factory floor. • Sewer or trade waste connections, including any discharges to rivers, streams and canals. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas.

Activity	Description	Mechanism of contamination	Risk factors
Electrolyte addition to batteries	<p>Electrolytes are solutions (often applied as a gel) that produce electrical connections between the anode and cathode. In lead–acid batteries this is sulfuric acid. In carbon–zinc batteries this is ammonium or zinc chloride.</p> <p>Sealants are often used to protect against leakages and historically may have included paraffin wax or bitumen. More recently, thermoplastic washers have been used.</p> <p>Transferring of materials and products will be necessary between the different assembly and manufacturing areas.</p> <p>Packaging of finished products will involve automated and manual processes.</p>	<p>Spills of electrolytes or the raw acid are possible during the filling stage of assembly and during maintenance of lead–acid batteries.</p> <p>Cracked or damaged battery casings can leak.</p> <p>Some floors have slot drains to remove liquid spills. If these are connected to trade waste or a dedicated collection sump, this should not spread contamination further. However, if connected to a stormwater system, the receiving environment can become heavily contaminated over years or decades, particularly sediments in affected waterways.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals and their physical form. • The industrial processes used. • Attention to plant maintenance and general housekeeping. Dust and floor sweepings can contaminate adjacent areas of the factory, and contaminants can be more widely spread. • Condition of floors and paved areas, cracked concrete or openings for pipes and services can allow liquids to penetrate soils beneath. Over time, this can result in significant contamination of the underlying soils.
Recycling and disassembling	<p>Currently in New Zealand, recycling and disassembling of small batteries do not occur. Most small battery waste goes to landfill. Small amounts are collected and stored before being exported for recycling.</p> <p>Lithium–ion batteries are not yet recycled, but this may change as technology develops.</p> <p>Most lead–acid batteries are collected for recycling and remanufacturing in New Zealand.</p> <p>Batteries can be potentially disassembled using several different processes. These may include:</p> <ul style="list-style-type: none"> • mechanical processes, including grinding, crushing and sieving • neutralising the acid • disassembling the battery components • smelting and casting of lead. <p>The recovered materials are used in a variety of applications, including new batteries.</p>	<p>Mechanisms of contamination may include:</p> <ul style="list-style-type: none"> • fugitive emissions, usually from poorly scrubbed or filtered chimneys or stacks and open factory doors, deposited on to roof surfaces and surrounding ground, including nearby roads and pavements • contaminated runoff (from roof surfaces and impervious ground) entering stormwater drains • insufficient cleaning of outdoor impervious surfaces allowing metallic debris to enter drains or on to unsealed ground and soil • corrosive material spillage onto unsealed surfaces, entering the stormwater system • escape of process water via doorways, in-floor channels or slot drains • spills and leaks of spent materials, solutions or finished products on to or into the ground. Deposition of metallic contaminants to ground from the mechanical processes used to disassemble a battery. 	<ul style="list-style-type: none"> • The types of chemicals and their physical form. • The industrial processes used, especially for disassembling or removing contents from spent batteries. • Attention to plant maintenance and general housekeeping. Dust from cutting and grinding components, and floor sweepings containing this dust, can contaminate adjacent areas of the factory, and contaminants can be more widely spread. • Condition of floors and paved areas, cracked concrete or openings for pipes and services can allow liquids to penetrate soils beneath. Over time, this can result in significant contamination of the underlying soils.

Activity	Description	Mechanism of contamination	Risk factors
		<p>Historically, smelting of lead, including for recycling, has resulted in soil contamination from the fall out of lead particulates from stack and fugitive emissions from open doors and windows in factories.</p> <p>Fallout of contaminants on adjacent sites that could have an adverse effect on human health is captured by HAIL activity H.</p> <p>The potential for contamination from this type of activity increases where the activity is not done in a specialist facility with good housekeeping and on-site waste management.</p> <p>Some floors have slot drains to remove liquid spills. If these are connected to trade waste or a dedicated collection sump, this should not spread contamination further. However, if connected to a stormwater system, the receiving environment and, in particular, sediments can be heavily contaminated over years or decades.</p>	

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
On-site waste management	<p>As with any factory, waste is generated when manufacturing or recycling takes place. If waste is not well managed to ensure the best environmental outcome, the potential for contamination to occur as a result of waste disposal processes should not be overlooked. The risk of impacts arising from waste management within the facility vary, depending on site practices.</p> <p>Waste products may include:</p> <ul style="list-style-type: none"> • disposal of reject battery cells and casings (including off-cuts) • disposal of chemical containers • disposal of excess solutions (eg, acids and electrolyte solutions) or spills from handling activities • slag from smelting of lead during recycling • dust and particulates from cutting and grinding of terminals, conductors and casings. 	<p>Stockpiling, dumping or burial of sweepings, reject or spent batteries, excess solutions or excess metal, smelting slag, and waste from fabrication materials into or on to ground.</p> <p>HAIL activities G3 (landfills) or G5 (waste disposal to land) may apply where on-site waste disposal has occurred, which can result in chemicals leaching into soils, groundwater or surface water.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently. Areas where wastes have been stockpiled are especially likely to have high levels of metal contaminants present.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (eg, lead, zinc, cadmium, nickel, lithium)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
<p>Acids and alkalis</p> <p>Sulfuric acid in lead–acid batteries, ammonium chloride or zinc chloride in carbon–zinc cells, potassium and magnesium hydroxide</p>	<p>Changes to soil pH are usually not permanent but can take years to return to background levels. The acids and alkalis usually include a component of dissolved metals.</p> <p>Changes in pH can increase the solubility and mobility of other contaminants, especially metals.</p>	1800s to present.	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is. Acids can be highly toxic to aquatic organisms and terrestrial plant life.</p> <p>Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes. Bases and alkalis can be toxic to aquatic organisms.</p> <p>Changes to pH in soil and freshwater can have significant adverse effects on biota, and soil and water chemical characteristics and processes.</p>

Back to [Electrical and electronic works, power generation and transmission](#).

B2 Electrical transformers, including the manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment

HAIL activity intention

Description	<p>Electrical transformers are devices that modify the electrical current in activity electrical circuits. The electrical current must be modified where it is generated to transmit it across long distances and distribute it at the destination in a form that makes the current usable in domestic or industrial equipment. Transformers range in size from grams to several tons. Large electrical transformers can be found on many commercial or industrial sites, as well as on public land (such as road reserves) where they form part of the electrical distribution network.</p> <p>Transformers and other large electrical equipment are manufactured in an engineering workshop setting, with much in common with HAIL activity D5. What sets heavy electrical equipment apart from regular engineering workshops is the use of dielectric fluids. Electrical transformers and other electrical equipment (including large capacitors, fluorescent light ballasts and some types of high-voltage switches and circuit breakers) use dielectric fluids (typically some form of non-conductive oil) for insulation and cooling.</p> <p>Historically, these oils included polychlorinated biphenyls (PCBs), which are carcinogenic and environmental pollutants that are classified as persistent organic pollutants (POPs) under the Stockholm Convention on Persistent Organic Pollutants. PCBs are non-corrosive, non-conducting, fire-resistant chemicals that were widely used in transformers, fluorescent light ballasts and hydraulic machinery until the late 1960s. The production, importation and use of dielectric fluids that contain PCBs have been phased out since the 1980s in New Zealand and banned in 2016. Because of the toxicity and persistence of PCBs, their presence should be considered when undertaking assessments on a range of sites, particularly large-scale industrial plants, where large electrical supplies were needed to power machinery and plant.</p>
Applicability	<p>This category intends to capture the manufacturing, repair or disposal of electrical transformers and other heavy electrical equipment, such as capacitors, that contain dielectric (non-conductive) oils or fluids.</p> <p>Sites where manufacturing or maintenance take place are generally inside buildings, but parts, faulty equipment and materials may be stored outdoors. Electrical switchyards associated with power generation and high voltage transmission, as well as transformer yards that reduce the voltage for distribution to houses and commercial customers, are also within the scope of activity B2.</p>
Contamination setting	<p>Contamination can occur during the manufacture, repair and disposal of transformers. The principal feature that distinguishes contamination of transformers from that of other engineered machinery is the potential discharge of dielectric transformer oil.</p> <p>The greatest risk of leaks to land exists where transformers and heavy electrical equipment operate and need to be repaired and maintained in situ. Transformers can become damaged due to factors such as overloading, lightning strikes and fires during operation, as well as physical damage, for example, vehicles driving into transformers or poles on which they are mounted. Any of these factors could result in fluid leaks or spills. The discharge of dielectric fluid to land in the past could have resulted in PCBs being released.</p> <p>Maintenance and repairs to transformers and large electrical equipment can take place at a variety of locations, either in the field where the equipment is installed, or in workshops. Maintenance that takes place at the site where the equipment is installed requires mobile workshops, and the setting is usually not on impervious ground or in a bunded area where spills can be easily contained and managed.</p> <p>The risk of contamination at maintenance depots depends greatly on engineering practices and housekeeping, as well as storage of new and used dielectric oil.</p> <p>Careless or negligent emptying of damaged transformers, storage of new and used fluids, cleaning, and the degreasing and welding of parts increase the risk of contamination.</p>

HAIL activity intention

In general, the manufacture, maintenance and disposal of electrical transformers that do not use PCBs containing dielectric oils present a low risk of significant, long-lasting ground contamination.

Modern transformers and capacitors (which may use mineral oil or similar alternatives to fluids containing PCBs) may still cause contamination if proper industry practices are not followed. However, the less toxic and ecotoxic nature of modern transformer oils means the risk to human health and the environment is low.

As with many large-scale industries, it is likely that sites where heavy electrical equipment and transformers are manufactured could encompass other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks and electrical transformers may have been present as part of a gasworks. Where possible, before assigning a gasworks site to HAIL activity A7, check whether parts of the site can be assigned another HAIL activity that more closely matches the actual use for that part of the site.

Exclusions	<ul style="list-style-type: none"> • The production of transformer oils or other chemicals and degreasers used in the manufacturing of these products. PCB oils were not manufactured in New Zealand, all having been imported. • Sites where solvents and degreasers are used should be recorded as HAIL activity B2, where these substances are associated with transformer and heavy electrical equipment production, cleaning, maintenance and disposal. • Heavy engineering workshops that manufacture high-tension pylons (refer to HAIL activity G5 for sites where metal is cut, welded and fabricated, and activity D3 for sites where components are galvanised). • The recycling of the electrical components and appliances that do not contain PCBs, covered by HAIL activity G4 (scrap yards including automotive dismantling, wrecking or scrap metal yards). • This HAIL activity does not apply to the operation of transformers that do not rely on dielectric fluids for insulation and cooling, because these are unlikely to cause contamination.
------------	---

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of chemicals, transformer oils, materials and plant.</p> <p>May include the raw products at the manufacturing facility, the storage of damaged equipment, which may leak, storage of spent liquids and oils (see Waste disposal and decommissioning below).</p>	<p>Spills and leaks of liquids (transformer oils, impregnation solutions) into or on to ground.</p> <p>Poor housekeeping practices increase the risk of spills, leaks and discharges to land or water.</p> <p>Contamination may occur where polychlorinated biphenyl- (PCB-) containing equipment has been maintained, stored or disposed of in on-site landfills.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which operations and substances were stored. • Suitability and weathertightness of buildings and shelters used for storage.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Condition of any storage tanks or containers. • Condition of buildings, equipment, storage vessels, tanks, bags and containers. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground • Maintenance of facilities and structures • Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
Manufacturing	<p>Electrical transformers are manufactured in engineering workshops with much in common with HAIL activity D5. Transformers have an iron core, copper wire windings, cooling fins and some form of case. The fabrication of the metal components is similar to any metal fabrication and is not the principal concern of this category. There may be some overlap with HAIL activities D2 (metal treatment and coatings) and D5 (engineering workshops and metal fabrication).</p> <p>On completion of large transformer fabrication, the coils are placed in a casing, which is filled with transformer oil. The oil might be dispensed manually or via an automated system.</p> <p>Dielectric fluids containing PCBs were used historically to cool transformers, whereas modern transformers use a variety of fluids, including vegetable oils and stable silicon fluid.</p> <p>Large capacitors are also made of metal casing (steel or aluminium) and may be cleaned and degreased using hydrocarbon or chlorinated solvents.</p> <p>PCB-containing capacitors typically have paper impregnated in PCB, separating aluminium foil that is wound around a core before being installed into the casing. Capacitors will generally be welded closed once manufactured, to form a sealed unit.</p> <p>PCB oils were often diluted with solvents, for example, chlorobenzenes.</p>	<p>Spills and leaks of liquids (transformer oils, impregnation solutions) into or on to ground during filling of transformers and capacitors, or impregnation of paper insulation in capacitors.</p> <p>Manufacturing is likely to have been undertaken indoors where sealed ground was present.</p> <p>Recovery of surplus raw products for the purposes of reuse and recycling is likely.</p> <p>Factory floor and housekeeping practices could affect the risk of contaminants accumulating.</p> <p>Waste disposal practices can vary widely and have a significant impact on the risk of contamination.</p> <p>Chlorinated solvents can permeate through concrete over time and contaminate underlying soil. Chlorinated solvents sink through groundwater, due to their density, and present a risk of vapour intrusion in buildings.</p>	<ul style="list-style-type: none"> • Types and volume of chemicals used, including their persistence and toxicity. • Condition of the equipment, tanks and lines, from which any leaks could occur. • Processes and safeguards to prevent discharges. • The period and frequency over which manufacturing took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Operation and maintenance	<p>Transformers are installed in their working locations, and may operate for many years without any problems, requiring only periodic maintenance. However, repairs and maintenance may need to be undertaken in situ, rather than in a workshop, increasing the risk of discharges to land, because transformers are located on sites that are often unsealed. Maintenance and repairs are often carried out on the transformer in situ,</p>	<p>Transformers may leak oil, particularly if old or physically damaged.</p> <p>Large transformers could have tens to hundreds of litres of oil, depending on capacity.</p> <p>Capacitors tend to degrade and break down over time. Casings may corrode and PCB oil can leak from the</p>	<p>Localised contamination in soils from incidental spills and leaks during the operation and maintenance of the transformers.</p> <p>Transformers and capacitors are generally installed on concrete plinths but may be surrounded by unsealed land.</p>

Activity	Description	Mechanism of contamination	Risk factors
	<p>rather than a workshop or maintenance facility, to minimise disruption to the electrical supply.</p> <p>Retrofilling of transformers where they were installed occurred when the use of PCBs was banned. Transformers were drained, cleaned with hydrocarbon solvents and then refilled in situ or at a central maintenance facility.</p>	<p>capacitors. Capacitors may contain a fraction of a litre up to several litres of oil, depending on size.</p> <p>Potential for spillage of oils and solvents during removal of old oil and refilling.</p>	
Waste disposal and decommissioning	<p>Equipment that contains used PCB must be decommissioned once it is taken out of service³ (ie, it cannot be reused). Decommissioning may involve:</p> <ul style="list-style-type: none"> • removal and transportation of sealed capacitors and small transformers in sealed drums (without draining cooling oils) • removal of large transformers that have been drained of oils, which are collected into storage drums. <p>Disposal of these products is strictly managed. Wastes could be present at the facility where the transformer or capacitor is or was located, or they may have been removed from the site to a central waste storage location (refer to activity G4).</p>	<p>Spills or leaks from degraded, damaged or decommissioned transformers and capacitors to ground.</p> <p>Deliberate dumping (or burial) of wastes. Could include excess solutions or oils into or on to ground. May result in chemicals leaching into soils, groundwater or surface water.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p> <p>Wastes containing PCBs are currently not able to be disposed of in New Zealand (they must be exported overseas for disposal).</p>

³ See <https://www.epa.govt.nz/assets/Uploads/Documents/Hazardous-Substances/Guidance/d678c5e5d4/Safe-Management-of-PCBs.pdf>, for further information.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence and mobility	Period of use	General comments
Polychlorinated biphenyls (PCBs) used in dielectric transformer oils	<p>These compounds are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>They have low solubility and mobility in soil and groundwater.</p>	<p>Imported between 1940s to 1970s but may have been used in small quantities after this period, and could be a contaminant of non-PCB oil in older transformers.</p> <p>Programme of phasing out in 1980s, banned from use and storage from 2016.</p>	<p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Non-PCB transformer oils (hydrocarbon, silicone or fluorocarbon-based)	<p>These oils are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These oils have low solubility and mobility in soil and groundwater.</p>	1940s to present.	<p>Human health effects and environmental toxicity are specific to the oil. These oils may cause long-term adverse effects in the aquatic environment.</p>
Solvents (including chlorinated) (used for cleaning)	<p>Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can be and have been used in laboratories. Their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p>

Back to [Electrical and electronic works, power generation and transmission](#).

B3

Electronics, including the commercial manufacturing, reconditioning or recycling of computers, televisions and other electronic devices

HAIL activity intention

Description	<p>The commercial manufacturing of computers, televisions and other electronic equipment is likely to be undertaken within large industrial buildings that are well maintained to create a clean environment for the manufacturing processes. These processes include the etching of circuit boards, semiconductor production and assembly of various electronic and non-electronic components to make a product. Given the fine level of detail required to make electronic components, these building often contain clean rooms.</p> <p>The reconditioning of computers, televisions and other electronic equipment is likely to be undertaken within smaller industrial buildings that are well maintained to create a clean environment for this process. These processes include the removal and replacement of unserviceable electronic components and the reassembly of the product.</p> <p>Recycling of the electronic equipment is often undertaken to recover valuable components or rare or precious metals within the componentry. This process requires the disassembly of the products to access the parts to be recovered. This process is likely to be undertaken within smaller industrial buildings but can be undertaken externally. Due to the chemicals used in electronic products, this process is only likely to recover a small amount of reusable or recoverable materials with the remaining materials likely sent to landfill or to be reprocessed.</p> <p>All electronic equipment contains materials that can contaminate land, primarily metals and metalloids and organic compounds.</p>
Applicability	<p>This category is intended to cover sites associated with the manufacturing, reconditioning or recycling of electronic devices (including computers and televisions) that are not otherwise captured by activities B1 or B2. The range of electronic devices covered under this category is large and includes consumer electronics, cell phones, appliances, toys and other household goods. Most electronic goods contain substances that could cause contamination of the ground (and be harmful to human health) if not stored or handled appropriately. These compounds are generally related to the production, reconditioning or recycling of the conducting or insulating components of the devices (and not, for example, the casing). Most components are in solid form, and imported, but manufacturing processes may include use of liquids, such as acids for etching.</p>
Contamination setting	<p>Given the technology involved in manufacturing (and reconditioning) and assembling electronics, manufacturing processes are highly likely to be conducted in specialist plants using advanced equipment, which is primarily automated. However, the process of recycling is likely to occur at a different location from the manufacturing and could involve more manual activities. The release of contaminants from electronic components can occur in premises in areas where the products are dismantled, crushed, exposed to water or solvents and burning (eg, where copper cables are recovered by burning the insulation off the wire). Where the ground is sealed, washing down the area mobilises solid particles in surface water via stormwater drains or wastewater, depending on the layout of the site. Burning of electronic waste releases chemicals as ash, which is transported on wind currents and eventually deposited onto land, vegetation and buildings.</p>
Exclusions	<ul style="list-style-type: none">• Retail or wholesale facilities that store already manufactured electronic devices.• The dismantling (and possible reconditioning) of electronic goods as part of repair.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Storage of raw materials required for manufacturing. Primarily will comprise solid materials (eg, metals for circuit boards), however, some liquid chemical storage will be necessary for processing (eg, chemical etching and cleaning).	<p>Spills or leaks of raw liquids and substances on to or into the ground.</p> <p>The outdoor storage of electronic waste creates opportunities for leaching of contaminants.</p> <p>The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on several risk factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which operations and substances were stored. • Suitability and weathertightness of buildings and shelters used for storage. • Condition of any storage tanks or containers. • Condition of buildings, equipment, storage vessels, tanks, bags and containers. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices, such as whether sweepings were collected or swept outside on to unsealed ground. • Maintenance of facilities and structures. • Waste management practices, both current and historical.
Manufacturing and primary processing	<p>Manufacturing of electronic goods will involve several raw materials (dominated by metals in solid form, including for chassis and cases, conductors, soldering, electronic components), moulding of plastics and processes such as polishing, etching, printing, soldering (de-soldering during reconditioning and recycling) and photographic processing for printed circuit boards.</p> <p>Some use of liquid chemicals will be necessary during etching processes, for cleaning (solvents) and for metal finishing (cleaning, painting). Metal finishing is covered in activity D3.</p>	<p>Spills or leaks of etching liquid solutions or other cleaning solutions into or on to the ground.</p> <p>Deposition of metallic contaminants to ground from manufacturing and reconditioning processes.</p> <p>Modern electronic manufacturing processes (including the handling and dispensing of products) are expected to take place inside specialist facilities. The ground is likely to be sealed and ideally maintained to a high standard. The potential for contamination of the ground to occur from any spills</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used, which could involve moving materials and chemicals between areas, and measures to mitigate or control leaks, spills or discharges. • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
	<p>Certain per- and poly-fluoroalkyl substance (PFAS) compounds may have been used for photoresists, top anti-reflective coatings, bottom anti-reflective coatings, and etchants, with other uses including surfactants, wetting agents, photo imaging-X-ray films and photo-acid generation.</p> <p>PFASs are used in electronic devices (eg, flat panel displays, liquid crystal displays), electronic devices and equipment used for testing (eg, sensors), as heat transfer fluids and cooling agents, in cleaning solutions, and for etching piezoelectric ceramic fillers.</p> <p>Fluoropolymers, including polytetrafluoroethylene (PTFE), are used to insulate cables in various electrical and electronic applications.</p>	<p>or leaks or from the direct deposition of metallic contaminants would be minimised by this seal. However, historical practices may have differed such that the risk of contamination of the ground was greater.</p> <p>Many processes may have been automated, further reducing the potential for contamination associated with the handling activities of materials.</p>	<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Condition and maintenance of the equipment and facilities.
Recycling	<p>The dismantling of electronic devices into their composite parts for reuse.</p> <p>May involve mechanical cutting or abrading processes to dismantle devices and remove parts, and/or the use of liquid chemicals to etch or clean recycled parts.</p>	<p>Spills or leaks of etching liquid solutions or other cleaning solutions into or on to the ground.</p> <p>Deposition of metallic contaminants to ground from cutting, crushing and compacting, or abrasive processes.</p>	<p>Parts removed from electronic devices must be in sound condition to realise their value through resale (or reuse). Therefore, it is expected recycling processes are likely to be undertaken inside specialist facilities. This may not be the case where electronic waste cannot be reused or repurposed.</p> <p>The ground is likely to be sealed and ideally maintained to a high standard. The potential for contamination of the ground to occur from any spills or leaks or from the direct deposition of metallic contaminants would be minimised by this seal. However, historical practices may have differed such that the risk of contamination of the ground was greater.</p> <p>Sites where scrap is stored outside on unsealed ground has a higher risk of soil contamination. The general nature of the activity that took place on the site will affect the risk of contamination. This includes all processing and housekeeping practices.</p>

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	<p>The potential for contamination to occur as a result of waste disposal processes will vary, depending on the site practices.</p> <p>Waste products may include:</p> <ul style="list-style-type: none"> • disposal of reject electronic parts (including off-cuts) • disposal of chemical containers and chemicals associated with etching and cleaning chemicals • disposal of unsuitable products from recycling. 	Deliberate dumping (or burial) of reject electronics or excess metal fabrication materials into or on to ground (may overlap with activities G3 or G5). May result in chemicals leaching into soils, groundwater or surface water.	<p>The potential for contamination from waste disposal processes depends on waste disposal practices and locations, both historically and currently.</p> <p>Evidence that e-waste or electrical cables or scrap have been burned significantly increases the risk of contamination.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence and mobility	Period of use	General comments
Metals and metalloids (including lead, mercury, cadmium, copper, nickel and lithium)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Acids and alkalis (sulfuric acid in lead–acid batteries, ammonium chloride or zinc chloride in carbon–zinc cells, potassium and magnesium hydroxide)	Changes to soil pH are usually not permanent but can take years to return to background levels. The acids and alkalis usually include a component of dissolved metals and metalloids.	1800s to present.	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life.</p> <p>Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes.</p> <p>Bases and alkalis can be toxic to aquatic organisms.</p> <p>Changes to pH in soil and freshwater can have significant adverse effects on biota and soil and water chemical characteristics and processes.</p>
Brominated flame retardants (such as polybrominated diphenyl ethers (PBDEs), polybromobenzenes (PBBzs), organophosphate esters (OPEs) and polychlorinated biphenyls (PCBs))	These compounds are generally persistent. Mobility is dependent on the specific substance and environmental factors.	1940s to present.	Human health effects and environmental toxicity are specific to the compounds. However, some compounds have adverse effects on human health and may cause long-term adverse effects in the aquatic environment.
Per- and poly-fluoroalkyl substances (PFASs)	Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental	1950s to present. Use of some compounds within the PFAS grouping (eg, perfluorooctanesulfonic acid	<p>Human toxicity is not well understood.</p> <p>Some PFAS compounds are highly toxic to environmental receptors.</p>

Key contaminants of concern	Chemical persistence and mobility	Period of use	General comments
	<p>conditions and soil properties. Specific substances should be assessed individually.</p>	<p>(PFOS)) phased out since 2002 but others remain in common use.</p>	<p>Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>
<p>Solvents – chlorinated (dichloromethane, tetrachloromethane, tetrachloroethane)</p>	<p>Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	<p>1940s to present.</p>	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used in laboratories. Their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p> <p>They are used to extract contaminants and constituents from other matrices and as a solution in which samples are analysed.</p>

Additional note: The production of electronic devices, such as very early models of the computer, began in the 1940s. The production of electronic equipment was generally undertaken on a small scale within specialist industries until the widespread production of consumer electronics began in the 1970s.

Back to [Electrical and electronic works, power generation and transmission](#).

B4

Power stations, substations or switchyards

HAIL activity intention

Description	<p>Power stations transform primary energy (such as sunlight, wind, water and geothermal heat) or chemical energy (such as fossil fuels, wood or waste) into electricity for distribution to consumers. Mechanisms used to convert energy to electricity include steam turbines, gas turbines, water turbines, internal combustion engines and wind turbines. The electricity generated cannot immediately be used by consumers, because the characteristics of the electrical current must be modified to transmit it over long distances (by increasing the voltage) and distribute it to consumers at the point of use (by decreasing the voltage).</p> <p>Substations convert electrical current in various ways, mostly by means of electrical transformers. Transformers are used to increase or decrease voltage levels in alternating current electrical circuits.</p> <p>Switchyards or switching stations are a type of substation without transformers that operate at a single voltage level.</p> <p>Electricity is produced at these facilities from:</p> <ul style="list-style-type: none">• coal – coal is pulverised before being used to fuel the boilers. Heavy fuel oil or diesel may also be used to start the turbines or as an alternative fuel at coal-powered stations. Coal ash and clinker is generated as waste from burning coal• oil – heavy fuel oil or diesel may be used to power the turbines at these facilities. Storage of liquid fuels should be considered under activity A17.• natural gas – gas-powered power stations use natural gas as a fuel. Diesel, often stored on site or nearby in bulk tanks, can be used as a back-up fuel.• geothermal energy – geothermal heated water and steam, containing dissolved metals and other contaminants, is used to drive turbines.
Applicability	<p>HAIL activity B4 is intended to cover those areas and activities that take place within power stations, substations or switchyards that could result in ground contamination. This activity is also intended to cover the fuels and wastes associated with coal-fired power stations and hazardous substances and contaminants likely to be found in, or associated with, geothermal electricity generation.</p>
Contamination setting	<p>The layout of a power station, substation and switchyard site will determine the areas that are potentially affected.</p> <p>The main processes at these types of facilities with the most potential to generate contamination are the storage of hazardous substances and fuel, and the generation of waste products (eg, ash from coal-powered power stations and geothermal mud at geothermal sites). Some electrical equipment is also known to contain hazardous substances. This includes transformers that contained polychlorinated biphenyls (PCBs) and mercury arc rectifiers that contain several litres of mercury.⁴</p> <p>Parts of the site, at areas other than where the key processes take place, can be affected by other activities, such as:</p> <ul style="list-style-type: none">• equipment maintenance, equipment failure, fires, lightning strikes, water blasting or accidental spills during routine operation, as well as waste disposal to land• scale deposits in piping caused by the mineral-laden geothermal water, which is also a source of contaminants, including metals and minerals in geothermal mud

⁴ See <https://www.motat.nz/collections-and-stories/stories/meet-motats-mercury-arc-rectifier>, for further information.

HAIL activity intention

- deteriorated painted or galvanised steel structures at outdoor substations and switchyards. These may be blast cleaned, resulting in zinc or lead-based paints falling to the ground.

As with many large-scale industries, it is likely that power stations, substations and switchyards could encompass other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, the presence of asbestos, engineering workshops, storage of fuels, chemicals and wastes in tanks or drums, chemical analytical laboratories, storage tanks and drums of hazardous substances may have been present as part of power stations, substations and switchyards. Where possible, before assigning a site to HAIL activity B4, check whether parts of the site can be assigned to another HAIL activity that more closely matches the actual use for that part of the site.

Exclusions	<ul style="list-style-type: none"> The generation component of hydro-electric and wind-power stations on the basis that the electricity is generated without fossil fuel combustion, and they are unlikely to store or use significant quantities of hazardous substances as fuel. Construction and operation of power stations typically created waste that may have been disposed of within or close to the site. Any on-site waste disposal should be treated as a landfill.
------------	---

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage may include stockpiles of coal or tanks of liquid fuel, such as fuel oil.</p> <ul style="list-style-type: none"> Raw materials, such as coal and coke, will be stockpiled at coal-powered plants (overlap with HAIL activity E5). Storage of fuel oil (primarily heavy fuel oil) in large containers (likely above-ground tanks). See activity A17 for storage of liquid fuels. Storage of cleaning and anti-corrosion solutions in containers (likely above-ground tanks and drums). Storage or detention of wastewater or sludge. 	<p>Leaching or deposition of contaminants from stockpiles on to or into the ground, and along flow paths. There is potential for surface-water contamination.</p> <p>Spills or leaks on to or into the ground potentially resulting in soil contamination.</p> <p>Dust and small particles (particularly of ash, coal and coke) carried on the wind.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p>	<ul style="list-style-type: none"> The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. Condition of buildings, equipment, storage vessels, tanks, bags and containers, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. The period and frequency over which the operations and storage took place. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. The extent to which runoff can reach unsealed land or surface water. Cleaning and housekeeping practices.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> Discharges to air and deposition of airborne contaminants (mainly dust). Maintenance of facilities and structures. Waste management practices, both current and historical.
Generation and operation	<p>Electricity is generated at fossil-fuel power plants by burning the feedstock to power boilers or turbines (see above). Handling factors need to be considered.</p> <p>Switchyards and substations are also present at hydroelectric plants, and asbestos insulation was also used at these sites.</p> <p>Cleaning of boilers and turbines must be undertaken periodically, to remove scale build up and avoid corrosion. This process typically uses acids and other chemicals.</p> <p>Geothermal power generation plants rely on geothermal water or steam, which is often contaminated with metals and metalloids, salts, acid and scaling substances. Hazardous substances are used as heat exchange fluids to drive turbines.</p>	<p>Spills and leaks of hazardous substances on to or into the ground.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p> <p>Deposition of fine particles dispersed in air from coal-fired power stations (not otherwise captured by engineering controls).</p> <p>Wastewater ponds and overland flow paths may receive contaminants as a result of discharges or overflows.</p>	<p>The potential for contamination as a result of HAIL activity B4 varies greatly and depends on the history of the construction, operations, site facility features and handling factors.</p> <p>Operational risk factors include:</p> <ul style="list-style-type: none"> types and volume of fuels used, including their persistence and toxicity condition of the buildings and equipment from which any leaks could occur processes and safeguards to prevent discharges the period and frequency over which operations took place permeability and topography of soils and surfaces and proximity to sensitive receiving environments waste management practices, both current and historical.
Waste disposal	<p>These sites have the potential to generate a lot of waste, which may include:</p> <ul style="list-style-type: none"> ash generated from the burning of coal, which may be disposed of on site sludge and scales of impurities that build up in boilers and turbines when hydrothermal steam is condensed discharge of processing and cleaning waters discharge of geothermal fluids, mud or brines disposal of containers, including chemicals, paints, lubricants and other substances used in the operation and maintenance of power plants. 	<p>Degradation of wastewater systems, ash or brine ponds resulting in contaminants leaching into the ground or along flow paths.</p> <p>Spills or leaks from degraded and damaged containers to ground.</p> <p>Deliberate tipping or burial of waste or residues containing hazardous substances to ground.</p> <p>The potential for contamination from waste disposal practices during the construction, operation and decommissioning of power generation sites depends on waste disposal practices and locations. In many</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Activity	Description	Mechanism of contamination	Risk factors
		<p>cases, waste from construction and operation was landfilled on site or in the immediate vicinity.</p> <p>Demolition of buildings may have resulted in construction and demolition waste, with fragments of asbestos becoming entrained in soil.</p>	

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Chemical persistence	Period of use	Risk factors
Metals and metalloids (in ash and mercury in switchgear)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1920s to present.	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Boron (in ash)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Boron salts are very leachable and mobile in the soil environment.</p>	1920s to present.	<p>Toxicity is specific to the chemical form and the environmental conditions.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Polychlorinated biphenyls (PCBs) used in dielectric transformer oils	Very persistent. Limited mobility in soil.	Imported between 1940s to 1970s but may have been used in small quantities after this period, and could be a contaminant of non-PCB oil in older transformers.	Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> .

Key contaminant of concern	Chemical persistence	Period of use	Risk factors
		Programme of phasing out in 1980s, banned from use and storage from 2016.	
Polycyclic aromatic hydrocarbons (PAHs) in coal	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	1920s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air, but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Asbestos	<p>Persistent and mobile (in air) when friable asbestos is disturbed.</p> <p>Can be mobilised in water, contaminating areas where it is washed to, when the water dries.</p>	1900s to 1980s.	Asbestos is a carcinogen when inhaled. Soil contaminated with asbestos can release fibres into the air when disturbed.
Hydrocarbon fuel, lubricating oils, greases	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p>	1880s to present.	Hydrocarbons, including fuels and oils, are toxic and ecotoxic when discharged to land and may also contaminate groundwater. Some hydrocarbons pose a vapour intrusion risk. For specific information, consult Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand</i> (revised 2011)

Key contaminant of concern	Chemical persistence	Period of use	Risk factors
	These materials have low solubility and mobility in soil and groundwater.		
Water treatment chemicals (acids and anti-corrosion chemicals)	Corrosives, buffers, anti-oxidants	1880s to present.	Specific risk factors depend on the chemical concerned.

Back to [Electrical and electronic works, power generation and transmission.](#)

C Explosives and ordnance production, storage and use

C1 Explosive or ordnance production, maintenance, dismantling, disposal, bulk storage or repackaging

HAIL activity intention

Description	<p>Explosives are chemical mixtures that are designed to react extremely rapidly, releasing a vast amount of energy mainly in the form of pressure and heat. As products, explosives are useful in a wide range of industries, including civil construction, agriculture, military and defence, quarrying and mining, and the performing arts.</p> <p>Explosives refer to a specific hazard category under the Hazardous Substances and New Organisms Act 1996. They include any substance used in bombs, artillery shells, missiles, rockets, explosive pyrotechnics for blasting, and pyrotechnic materials used in products such as fireworks, flares and some automotive components. The term explosives also includes gunpowder, black powder and propellants for ammunition or ordnance. Chemical reaction products created when explosives are detonated can be harmful to human health and the environment.</p> <p>Ordnance refers to the ammunition used in cannons, naval guns, artillery, and also applies to bombs, missiles, grenades and mortars. Such ammunition has explosive components in the propellant and (usually) in the warhead, whereas small arms ammunition has a small amount of explosive powder that is the propellant and an inert (usually lead and copper) projectile.</p> <p>This category includes the production, maintenance, dismantling, disposal and bulk storage of explosives or ordnance that may be used for a range of purposes and in a range of products, including:</p> <ul style="list-style-type: none"> • as part of military activities, including facilities dedicated to storage of ordnance and ammunition • as part of the mining and civil engineering industries, for rock blasting • as part of the entertainment industry, for example, in fireworks • in the production of pyrotechnics for use in safety products, such as flares. <p>In the context of this category, 'bulk' refers to amounts of substances that require a location certification under the Hazardous Substances and New Organisms Act 1996 (private locations) or Health and Safety at Work Act 2015 (occupational settings).</p> <p>Disposal relates to the action or process of getting rid of explosives or ordnance by means other than via intentional detonation. Deflagration or controlled burning of explosives (usually undertaken by specialist staff of the New Zealand Defence Force) is one method.</p> <p>Explosives and ordnance refer to materials that pose a risk to human health and the environment because of the physical and chemical hazardous properties of the materials, whether on their own or when used in explosive products.</p> <p>New Zealand has a history of military and civil explosives manufacture, storage, use and disposal. Commercial explosives and ammunition for the military and civilian markets, as well as ordnance for military use, have been produced, stored, used and disposed of in New Zealand.</p>
Applicability	<p>Most sites covered by this activity will be specialist manufacturing sites, defence (army, navy and air force) bases or locations operated by the New Zealand Defence Force, and magazines used to store explosives at production sites, mines and large quarries.</p>

HAIL activity intention

Contamination setting	Sites are likely to have buildings that are constructed specifically to store explosives, whether for military or civil purposes, and include magazine and ammunition depots. Discrete areas where explosives and ordnance are produced, handled, stored in bulk, and disposed will most likely be at separate locations.
Exclusions	<ul style="list-style-type: none"> • Engineering workshops that produce non-explosive components. • Chemical storage, other than of chemicals used in the production of explosives and ordnance. • Gun clubs or rifle ranges, including clay target clubs. • Training areas set aside exclusively or primarily for the detonation of explosive ammunition. • Locations (including pop-up outlets) where fireworks made for domestic use have been sold in sealed packages. • Sites used for reloading small-arms ammunition for personal use, where primers and gunpowder are the only explosive components. • Retail stores and warehouses where small-arms ammunition, gunpowder and primers are stored for resale.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Production	The fabrication of metallic munitions or pyrotechnic products components (eg, casings and primers), including the filling of such munitions or products with propellants and explosive compounds. New Zealand has little industrial history in producing munitions.	<p>The deposition of metallic contaminants to ground from the cutting, forming and casting of metals used to make bullets and casings; and from the plating of ordnance or pyrotechnic products components. The deposition of explosives compounds to ground from the filling of ordnance or pyrotechnic products.</p> <p>Housekeeping and waste-disposal practices are activities that could result in contaminants being discharged to land. Sweepings and waste from production could be left in containers for temporary storage before collection. If containers are not sealed, discharges could take place.</p>	<ul style="list-style-type: none"> • Highly likely to be undertaken indoors, in clean and tidy conditions. The risk of unintended explosion is too high, and the safety considerations outweigh any benefit in operating an untidy and unsafe workplace. • The volume and types of explosives and chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were produced. • Spills, leaks or discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Historical practices may have differed such that the risk of contamination of the ground was greater. • If wastes generated by the production of explosives or ordnance are disposed of.

Activity	Description	Mechanism of contamination	Risk factors
Maintenance – physical and mechanical repair	Primarily metallic component preparation and repair, for example, the maintenance of casings, electrical testing of components such as fuses.	Spills and leaks of liquid contaminants (eg, petroleum hydrocarbons such as solvents and lubricants) used in the maintenance and repair of casings. The deposition of metallic contaminants to ground from the cutting, grinding or scraping of metal components. The deposition to ground of remnant explosive compounds.	<ul style="list-style-type: none"> • Maintenance of ordnance is generally undertaken indoors, in areas set aside for this activity, for safety reasons. • The volume and types of explosives and chemicals, their physical form and properties, including their persistence and toxicity. • Risk increases when maintenance practices that allow components or products to be spilled or leak, and when these products are discharged to land.
Maintenance – washing	The cleaning of casings and parts.	The creation of contaminated wash water (primarily contaminated with metals and petroleum residues but also potentially with explosives residues) and the discharge of this wash water to ground.	<ul style="list-style-type: none"> • Maintenance of ordnance is generally undertaken indoors, in areas set aside for this activity, for safety reasons. • The volume and types of explosives and chemicals, their physical form and properties, including their persistence and toxicity. • Risk increases when maintenance practices that allow components or products to be spilled or leak, and when these products or wash water are discharged to land.
Dismantling	The decommissioning of pyrotechnic components by physical separation.	<p>Discharges of metallic contaminants to land from the cutting, grinding or scraping of metal components. The discharge to land of remnant explosive compounds.</p> <p>Equipment or procedures that do not use or allow good waste collection, storage and disposal practices can increase the risk of contamination. This includes sweepings or spills on to land or sealed areas that drain to stormwater or unsealed land, rather than to trade waste.</p>	<ul style="list-style-type: none"> • The volume and types of explosives and chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines from which any leaks could occur. • The period and frequency over which manufacturing took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Risk increases when dismantling practices that allow components or products to be spilled or leak, and when these products or wash water are discharged on to unsealed land.
Disposal (destruction) via steaming out	The decommissioning of munitions by melting the filling using high-pressure steam. Remnant solids may be filtered out for collection and further disposal.	The creation of contaminated wash water (primarily contaminated with metals and petroleum residues but also potentially with explosives residues) and the discharge of this wash water to ground.	<ul style="list-style-type: none"> • The volume and types of explosives, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines from which any leaks could occur.

Activity	Description	Mechanism of contamination	Risk factors
		<p>Equipment or procedures that do not use or allow good waste collection, storage and disposal practices can increase the risk of contamination. This includes sweepings or spills on to land or sealed areas that drain to stormwater or unsealed land, rather than to trade waste.</p>	<ul style="list-style-type: none"> • The period and frequency over which disposal took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Risk increases when dismantling practices that allow components or products to be spilled or leak, and when these products or wash water are discharged onto unsealed land. The potential for contamination from waste disposal varies, depending on practices and locations, both historically and currently. • Discharges to air, particularly of dust or heavy particles, can settle on to buildings or land, where the contaminants enter soil or stormwater runoff.
Disposal (destruction) via incineration	<p>The decommissioning of munitions, primarily small arms ordnance and/or other pyrotechnic products via incineration. Remnant solids may be collected for further disposal or recycling. Petroleum hydrocarbon accelerants may be used as fuel for the fire.</p>	<p>The creation of ash (primarily contaminated with metals and also potentially with explosives residues) and the discharge of this ash to ground. Spills or leaks of petroleum hydrocarbon accelerants and the potential deposition of petroleum hydrocarbon residues. The creation of polycyclic aromatic hydrocarbon (PAH) as a by-product of burning.</p> <p>Equipment or procedures that do not result in complete destruction of waste explosives, that produce undesirable daughter products or do not use or allow good waste collection, storage and disposal practices can increase the risk of contamination. This includes sweepings or spills on to land or sealed areas that drain to stormwater or unsealed land, rather than to trade waste.</p> <p>Sites where open burning of ammunition and explosives took place pose a significant risk of soil and groundwater contamination.</p>	<ul style="list-style-type: none"> • The potential for contamination from waste disposal varies, depending on equipment, methodologies used and locations, both historically and currently. • The volume and types of explosives, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and storage containers from which any leaks could occur. • The period and frequency over which disposal took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of products of incomplete combustion, can settle on to buildings or land, where the contaminants enter soil or stormwater runoff. Incinerators without effective scrubbers can cause significant contamination via this mechanism.
Disposal (destruction) via burning out	<p>The decommissioning of munitions, primarily incendiaries and/or other pyrotechnic products by operation (ie, activating incendiaries in the manner they were designed to function as a</p>	<p>The creation of ash (primarily contaminated with metals and also potentially with explosives residues) and the discharge of this ash to ground. The creation of PAH as a by-product of burning.</p>	<ul style="list-style-type: none"> • The potential for contamination from waste disposal varies, depending on equipment, methodologies used and locations, both historically and currently.

Activity	Description	Mechanism of contamination	Risk factors
	means of destruction). Remnant solids may be collected for further disposal.	<p>Equipment or procedures that do not result in complete destruction of waste explosives, that produce undesirable daughter products or do not use or allow good waste collection, storage and disposal practices can increase the risk of contamination. This includes sweepings or spills on to land or sealed areas that drain to stormwater or unsealed land, rather than to trade waste.</p> <p>Sites where open burning of ammunition and explosives took place pose a significant risk of soil and groundwater contamination.</p>	<ul style="list-style-type: none"> • The volume and types of explosives, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and storage containers from which any leaks could occur. • The period and frequency over which disposal took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of products of incomplete combustion, can settle on to buildings or land, where the contaminants enter soil or stormwater runoff. Incinerators without effective scrubbers can cause significant contamination via this mechanism.
Disposal via burial	The disposal of solid waste materials, such as metallic casings, via burial.	<p>Metallic, hydrocarbon and explosives residues leaching to ground and potentially groundwater, either via the infiltration of surface water or via contact with groundwater.</p> <p>Burial of explosives waste on a site has the greatest potential for causing contamination and represents a danger to any future land use. Explosives can destabilise over time and become sensitive to shock, friction and heat, any of which could result in detonation.</p>	<ul style="list-style-type: none"> • The volume and types of explosives, their physical form and properties, including their persistence and toxicity. • The period and frequency over which disposal took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Some explosive munitions may not detonate as intended when fired and essentially pose the same risks, although the location of the munition may not be known and recorded. • Physical risk of explosion if disturbed.
Repackaging	The movement of pyrotechnic materials from one package to another, for example, from bulk quantities into smaller containers or casings for use.	<p>The deposition of explosives compounds to ground from the filling of ordnance or pyrotechnic products.</p> <p>The potential for ground contamination to occur as a result of repackaging activities will be variable and dependent on the facility and materials handling factors (eg, presence or absence of sealed ground). Good housekeeping will reduce the likelihood of discharges to land occurring.</p> <p>Damaged and/or contaminated packaging could increase the volume of material that needs to be disposed of.</p>	<ul style="list-style-type: none"> • The volume and types of explosives and chemicals, their physical form and properties, including their persistence and toxicity. • The handling and operational processes used, which could involve moving materials and chemicals between different areas, and measures to mitigate or control leaks, spills or discharges. • The period and duration of the activity, and what was considered best practice at the time. • Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Condition and maintenance of the equipment and facilities.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
High explosives (including: 2,4 and 2,6-dinitro toluene (DNT), 2,4,6-trinitrophenol (picric acid), trinitrotoluene (TNT), cyclo-trimethylene trinitramine (RDX), ammonium, barium nitrate and so on)	<p>Persistence and mobility are dependent on the chemicals, environmental conditions and soil properties.</p> <p>Parent compounds also degrade and form multiple daughter compounds, some of which have moderate persistence in soil.</p>	From 1950s to present.	<p>Many explosives are toxic to some extent. Manufacturing inputs can also be organic compounds or hazardous materials that require special handling due to risks (such as carcinogens). The decomposition products, residual solids or gases of some explosives can be toxic, whereas others are harmless, such as carbon dioxide and water.</p> <p>Examples of harmful by-products include:</p> <ul style="list-style-type: none"> • metals and metalloids, such as lead, mercury and barium from primers (observed in high-volume firing ranges) • nitric oxides from TNT • perchlorates when used in large quantities.
Gun powder (charcoal, sulfur, potassium nitrate mixture)	Gun powder is not persistent. Unlikely to be found in soil, because it degrades quickly. Potassium nitrate and sulfur are soluble and therefore can be highly mobile in soil and groundwater.	1800s to present.	<p>Human health effects and environmental toxicity are specific to the chemicals in gun powder. Some components of gun powder may cause long-term adverse effects in the aquatic environment.</p> <p>Sulfur in soil is not generally considered toxic.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			<p>Excessive sulfur and sulfates lower the soil pH making the soil more acidic, which can:</p> <ul style="list-style-type: none"> • can prevent nutrient uptake limiting or preventing plant growth • increase the mobility of metals and other contaminants • affect concrete and steel structures and foundations installed in the soil • increase acidity levels that can be toxic in aquatic ecosystems. <p>Potassium nitrate can contaminate groundwater and surface water, leading to rapid algae growth. Algal growth has adverse effects on oxygen availability to other organisms in the water and affects drinking water quality and treatment processes.</p>
<p>Metals and metalloids</p> <p>Metals particularly associated with explosives include lead, mercury, barium, antimony, phosphorous, zirconium and aluminium (these can be found in detonators, primers, high explosives and incendiary components)</p>	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	<p>1800s to present.</p>	<p>Toxicity is specific to the element or chemical form that the metal is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>

Back to [Explosives and ordnance production, storage and use](#).

C2

Gun clubs or rifle ranges, including clay target clubs that use lead munitions outdoors

HAIL activity intention

Description	Outdoor shooting ranges include gun clubs or rifle and clay target ranges. Small arms (rifles, handguns and shotguns) discharge ammunition that contains a variety of metallic components. Most metallic ammunition consists of components made of copper, brass (an alloy of copper and zinc) and lead and lead alloys. Contamination from ammunition is caused by lead shot, lead-containing bullets and projectile fragments (shrapnel) fired by small arms (handguns, shotguns and rifles). As a result, places where small arms are repeatedly used are likely to have greatly elevated concentrations of metals present in soil. Additionally, at clay target shooting ranges, polycyclic aromatic hydrocarbons (PAHs), specifically high-molecular-weight persistent PAHs, occur as a result of clay target fragments containing coal tar or petroleum pitch.
Applicability	This activity applies to land, sites, or discreet locations within sites, where ammunition containing lead is or has been repeatedly discharged on unsealed land.
Contamination setting	An outdoor shooting range will include location(s) at which firearms are used, either to shoot at stationary or moving targets. Areas where bullets, shot, brass cartridge cases and/or remnants of clay targets fall may be discrete or widespread, depending on the layout of the shooting range.
Exclusions	<ul style="list-style-type: none"> Indoor shooting ranges, although these may have high levels of lead as dust on surfaces within the building. Areas where shooting is done for hunting or pest control purposes, where shooting takes place irregularly and over a wide area.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Firing ammunition – firing line and/or position(s)	The location(s) from which guns are fired, either at a stationary target (eg, at the end of a range) or moving target (eg, clay targets).	<p>The deposition to ground of metallic casings ejected during firing exercises, resulting in leaching of metals and metalloids to ground (mainly copper and zinc from brass alloy), as well as small amounts of lead deposited as dust from the vaporisation of lead at the rear of the bullet when fired.</p> <p>Discharges to ground may be leached over time, resulting in potential impacts on surface water and groundwater.</p> <p>There is potential for localised areas of soil contamination around shooting positions, if shooting position and surrounding ground is unsealed. Note: current and historic conditions must be considered.</p>	<ul style="list-style-type: none"> The volume and types of munitions used, their physical form and properties, including their persistence and toxicity. The operational time period. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Maintenance of facilities and structures, cleaning practices. Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
Firing rifle and pistol ammunition – range floor and/or target butt	The location(s) and areas(s) where bullets may fall or become lodged.	<p>An individual bullet generally weighs between 2 grams to 65 grams, depending on the calibre. The deposition on to the ground (eg, range floor) or into the ground (eg, stop butt) of bullets and fragments of bullets, resulting in direct discharges to land and leaching of metallic residues to ground over time, potentially affecting surface water and groundwater.</p> <p>Depending on the layout of the shooting range, bullets may be concentrated in a small area or across a wider area. Bullets may be completely intact or may disintegrate into tiny fragments, or partially break up when they strike the target and butt.</p> <p>Soil contamination is almost a certainty at the target butt, but less certain between the shooting point and target butt and soils beside and behind stop butts. Potential for moderate to low levels of contamination to be present beyond the range, where stray bullets may fall.</p>	<ul style="list-style-type: none"> • The volume and types of munitions used, their physical form and properties, including their persistence and toxicity. • The operational time period. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Maintenance of facilities and structures, cleaning practices. • Waste management practices, both current and historical.
Firing shotgun cartridges – clay target clubs	The location(s) and areas(s) where shot may fall on land.	<p>Shotgun cartridges usually contain between 300 and 580 individual pellets of 2 millimetres to 4 millimetres diameter and weighing around 32 grams of lead pellets.</p> <p>Depending on the layout of the clay target club range and shooting disciplines catered for, widespread contamination by lead shot across a broad area is likely.</p>	<ul style="list-style-type: none"> • The volume and types of munitions used, their physical form and properties, including their persistence and toxicity. • The operational time period. • Undulations in the ground may cause shot to concentrate in dense patches in hollows, where rainfall tends to accumulate. • Shot distribution depends on the distance and direction of the clay target and the trajectory it follows when launched. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Maintenance of facilities and structures, cleaning practices. • Waste management practices, both current and historical.
Destruction of clay targets	The location(s) and areas(s) where remnants of clay targets may fall.	The deposition on to ground of remnants of clay targets, resulting in the leaching of polycyclic aromatic hydrocarbons	<ul style="list-style-type: none"> • The potential for PAH contamination depends on the volume and composition of clay targets, some of which contain PAHs. Clay target

Activity	Description	Mechanism of contamination	Risk factors
		(PAHs) to ground and potentially to groundwater via the infiltration of surface water.	<p>remnants typically fall across a broad area, depending on the trajectory of the clay target.</p> <ul style="list-style-type: none"> • The period over which shooting has occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Maintenance of facilities and structures, cleaning practices. • Waste management practices, both current and historical.
Waste disposal	<p>The potential for contamination to occur from waste disposal processes will vary, depending on the site practices.</p> <p>The disposal via burial of waste created by the firing or ammunition and/or the destruction of clay targets.</p>	Metallic and PAH residues leaching to ground, and potentially groundwater, either via the infiltration of surface water or via contact with the groundwater table.	The potential for contamination from waste disposal processes depends on the waste disposal practices, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (eg, zinc, selenium, copper, iron in supplements)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal and metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Polycyclic aromatic hydrocarbons (PAHs)	Depending on their molecular weight, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.	1800s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>

Back to [Explosives and ordnance production, storage and use](#).

C3

Training areas set aside exclusively or primarily for the detonation of explosive ammunition

HAIL activity intention

Description	The New Zealand Defence Force requires areas for training in the use of equipment such as aircraft and vehicle mounted cannons, missiles and bombs. Munitions and ordnance include bombs, rockets, missiles and artillery shells, with explosive payloads ranging in weight from less than 1 kilogram to several hundred kilogrammes. Explosives relates to any substance that can be made to explode, especially any substance used in bombs or shells. As such, the category is considered to encompass ammunition, which is the material fired, scattered, dropped or detonated from any weapon, including the means of igniting or exploding such material, such as primers, fuses and gunpowder. This activity encompasses the detonation of explosives by operation (ie, activating explosives in the manner they were designed to function) and the destruction of explosives via detonation (ie, the use of explosives to cause the destruction of other explosive ordnance). The detonation of explosives may involve the destruction of targets and, therefore, the contamination potential of the activity is affected by the composition of any targets, for example, vehicles or buildings.
Applicability	This activity is intended to cover sites where explosives are detonated as part of training exercises, and where explosives and ordnance are disposed of via detonation.
Contamination setting	Sites, or discrete locations within sites, where explosive munitions are dropped or fired on to land may be contaminated by target fragments, munition fragments and products of explosion and combustion.
Exclusions	<ul style="list-style-type: none"> • Training areas and shooting ranges where ammunition not containing explosives has been exclusively used.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Detonation of explosives	The detonation of explosive munitions in the manner in which they were designed to function, with or without the destruction of targets.	The deposition of metallic contaminants to ground from the destruction of metal munitions components and/or metallic target structures. The deposition to ground of remnant explosive compounds. The deposition to ground of other contaminants associated with target structures.	<ul style="list-style-type: none"> • The type of explosives used will largely dictate the possible chemical by-products of detonation. • The volume of munitions used, their physical form and properties, including their persistence and toxicity. • Composition of targets: buildings or vehicles used as targets will leave fragments that potentially include contaminants. • The period over which the site has been operational and its frequency of use. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Maintenance of facilities and structures, cleaning practices. • Waste management practices, both current and historical.
Destruction of explosives by detonation	The destruction of excess, out-of-date or obsolete explosive munitions using explosive munitions.	The deposition of metallic contaminants to ground from the destruction of metal munitions components. The deposition to ground of remnant explosive compounds.	<ul style="list-style-type: none"> • The type of explosives used will largely dictate the possible chemical by-products of detonation. • The volume of munitions used, their physical form and properties, including their persistence and toxicity. • The period over which the site has been operational and its frequency of use. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Maintenance of facilities and structures, cleaning practices. • Waste management practices, both current and historical.
Storage	The temporary storage of explosive ammunition that may be used during on-site training exercises.	<p>Leakage from explosives or explosive-containing munitions as a result of damage or malfunction.</p> <p>Explosives and ammunition are primarily stored in specialist storage locations and packaging.</p> <p>Compromised or damaged packaging increases the risk of discharges to land.</p>	<ul style="list-style-type: none"> • The volume and types of explosive ammunition, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, tanks, bags and containers, and the standard of facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The extent to which runoff can reach unsealed land or surface water. • Cleaning and housekeeping practices. • Explosives may be degraded where they have been forgotten about.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
High explosives including: 2,4 and 2,6-dinitro toluene (DNT), 2,4,6-trinitrophenol (picric acid), trinitrotoluene (TNT), cyclo-trimethylene trinitramine (RDX), ammonium, barium nitrate and so on	Persistence is specific to the explosive compound. Parent compounds also degrade and form multiple daughter compounds, some of which have moderate persistence in soil.	From 1950s to present.	Many explosives are toxic to some extent. Manufacturing inputs can also be organic compounds or hazardous materials that require special handling due to risks (such as carcinogens). The decomposition products, residual solids or gases of some explosives can be toxic, whereas others are harmless, such as carbon dioxide and water. Examples of harmful by-products include: <ul style="list-style-type: none"> • nitric oxides from TNT • perchlorates when used in large quantities.
Metals and metalloids Metals that are particularly associated with explosives include lead, mercury, barium, antimony, phosphorous, zirconium, aluminium (they can be found in detonators, primers, high explosives and incendiary components)	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	Dependent on age of structure or component being blasted. 1800s to present for most metals and metalloids.	Toxicity is specific to the metal and metalloid or chemical form that the element is in. Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .

Back to [Explosives and ordnance production, storage and use](#).

D Metal extraction, refining and reprocessing, storage and use

D1 Abrasive blasting, including abrasive blast cleaning (excluding cleaning carried out in fully enclosed booths) or the disposal of abrasive blasting material

HAIL activity intention

Description	<p>Abrasive blasting is a common process routinely undertaken in many engineering workshops and is used extensively in light and heavy industries to clean and prepare items for coating or painting. The process is effective at cleaning but can also liberate contaminants. The contaminants can include metal, including metal coatings such as galvanising, paint, including metal-rich surface primers, antifoul paint from ships and marine structures (including tributyltin, banned in New Zealand, but still used in developing nations), as well as epoxies and other potentially harmful substances.</p> <p>Abrasive blasting, often referred to as sandblasting, is an aggressive form of cleaning that removes paint, corrosion, scale and other surface impurities from a range of items and surfaces. It involves a pressurised applicator that forces an abrasive grit, known as the 'abrasive media' or 'blasting media' or 'garnet' out of a nozzle at high velocity on to whatever surface needs to be cleaned.</p> <p>In cases where the abrasive blasting media comprises inert materials, such as sand, glass beads, plastic or walnut shells, or materials with a low contamination potential, such as steel shot, grit or sodium bicarbonate (soda blasting), the blasting media itself is not considered to constitute a contaminant. However, the abrasive blasting media may also comprise materials that constitute a potential contamination source, such as: aluminium oxide, copper slag, and copper, lead or zinc shot. In such cases, the blasting media itself may be considered to constitute a contaminant.</p>
Applicability	<p>This activity covers sites where abrasive blasting has been undertaken including where spent abrasive blasting media has been stockpiled or stored before disposal at a landfill.</p> <p>Where one-off in situ abrasive blasting has been done, an assessment of the activity will be needed before the site is added to a register.</p>
Contamination setting	<p>Abrasive blasting may be undertaken at a dedicated site or sites where objects have been repeatedly blasted in situ. The process may be done in a fixed location, either indoors or outdoors, or inside a building with or without dust containment, filtration and ventilation. Abrasive blasting may affect the immediate area and/or have caused contaminants to migrate and reach unsealed ground, for example, via the migration of dust and runoff.</p>
Exclusions	<ul style="list-style-type: none"> Workshops and other places where a small fully enclosed parts blasting machine is used, provided the grit has been properly disposed of to landfill.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Abrasive blasting	Blasting media is accelerated through a blasting nozzle at the surface being treated, using either compressed air or pressurised fluids (water and/or detergents). Abrasive blasting may be carried out by placing an object inside a stationary blasting cabinet or using a mobile unit to apply blasting media to an in situ object.	<p>Deposition of blasting media and/or abraded surface materials to ground.</p> <p>The potential for contamination from the activity of abrasive blasting varies greatly, depending on the handling (and clean-up) practices and locations, both historically and currently.</p> <p>Fine particles of blasted surface material have a large surface area to volume, increasing the potential for runoff to contain dissolved contaminants, including ecotoxic metals, such as chromium, copper and zinc.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used as the abrasive or cleaned from the surfaces, their physical form and properties, including their persistence and toxicity. • The duration and frequency of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Housekeeping and cleaning practices used, as well as management of wastes. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Curtains or screens can reduce the unintended spread of media and material removed, but not completely stop it.
Wet blasting	Pressurised wet slurry is applied to a surface for various cleaning or finishing effects. Also known as wet abrasive blasting, vapor blasting, vapor honing, dustless blasting or slurry blasting.	<p>Slurry (a mixture of water and abrasive grit) removes surface material and contamination, such as paint, rust or dirt, from the surface being cleaned.</p> <p>Fine particles of blasted surface material have a large surface area to volume, increasing the potential for runoff to contain dissolved contaminants, including ecotoxic metals, such as chromium, copper and zinc.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used as the abrasive or from the surfaces cleaned, their physical form and properties, including their persistence and toxicity. • The duration and frequency of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Housekeeping and cleaning practices used, as well as management of wastes. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Curtains or screens can reduce the unintended spread of media and material removed, but not completely stop it.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Detergent or alkaline substances may be added to the fluid to improve the performance of the wet blasting system. • Wet blasting may produce runoff where it is done without controls and wastewater collection, or where wastewater is discharged to land or water.
Waste deposition (to ground)	<p>Where a blasting cabinet is used, both the blasting media and abraded surface of the object that was blasted are contained within the cabinet.</p> <p>Where blasting is performed outside, or a mobile blasting unit is used to apply blasting media to an in situ object, both the blasting media and abraded surface of the object that was blasted are deposited to the ground.</p>	<p>Only applicable if media and/or abraded surface materials are left on unsealed ground.</p> <p>Gross contamination of ground surface with abraded paint, metal and so on is often visible.</p> <p>The leaching of contaminants associated with paint, oil and metals to ground and potentially to groundwater via the infiltration of surface water.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used as the abrasive or from the surfaces cleaned, their physical form and properties, including their persistence and toxicity. • The duration and frequency of the activity, and what was considered best practice at the time. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • The potential for contamination from waste deposition processes could be highly variable, depending on the site management, clean up and waste disposal practices, both historically and currently.
Storage	Storage of spent blasting media.	<p>Spent media stored on unsealed ground or where it can be blown by wind.</p> <p>The potential for contamination of soil or groundwater from the storage of spent media will depend on the blasting medium, process (wet or dry) and substrate that was blasted.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used as the abrasive or from the surfaces cleaned, their physical form and properties, including their persistence and toxicity. • The duration and frequency of the activity, and what was considered best practice at the time. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Facilities and structures: maintenance, cleaning and housekeeping practices. • Discharges to air and deposition of airborne contaminants (mainly dust). • Waste management practices, both current and historical.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (iron, aluminium, copper, lead, zinc and so on)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
Tributyltin (TBT)	<p>TBT is persistent in soils and sediments. TBT has a low water solubility and lipophilic character, it adsorbs readily onto particles.</p> <p>Persistence and mobility are dependent on environmental conditions and media properties.</p> <p>TBT bioaccumulates in organisms because of its solubility in fat.</p>	<p>1960s to 1989 (used in antifouling paint on all vessels).</p> <p>1989 to 2008 (restricted use to large vessels over 25 metres).</p>	<p>Organotins are used in antifouling paint for ship hulls, as a stabiliser in the manufacturing of plastic products, as a catalyst in poly(vinyl chloride) products, a biocide (fungicide, bactericide, insecticide) and as a preservative for wood, textiles, paper, leather and electrical equipment.</p> <p>Organotins are known to be toxic at relatively low levels of exposure not only to marine invertebrates but also in mammalian systems. Organotins have been demonstrated to have immunotoxic, teratogenic, neurotoxic and carcinogenic effects in mammals.</p> <p>Historical formulation of paints containing tributyltin in New Zealand is possible.</p>

Back to [Metal extraction, refining and reprocessing, storage and use](#).

D2 Foundry operations, including the commercial production of metal products by injecting or pouring molten metal into moulds

HAIL activity intention

Description	Foundry operations involve the melting of a metal or combination of metals in a furnace and pouring the molten metal or alloy into a mould or cast to form parts in a specific shape. Once the metal has been cast, several steps are undertaken to clean up the casting to produce the finished part. These include degating, fettling, grinding, sanding or machining the casting. Different metals can be used, depending on the properties required for the product. This activity is predominantly undertaken within a building usually found in an industrial setting. The furnaces used to melt the metal can have different heat sources: gas, electricity and coal or coke.
Applicability	This activity covers sites associated with foundry operations where metal has been heated until it is liquid then poured or injected into a mould for the purpose of making parts in a desired shape (castings).
Contamination setting	<p>Traditional foundry operations often had unsealed floors to prevent spalling of the metal on concrete or ceramic surfaces. Modern foundry operations are often undertaken in sealed buildings using fully automated, robotic processes reducing the potential for contamination. Foundry operation sites include discrete or dedicated areas where production takes place. Foundry operations also have stacks that discharge fumes and gases to the environment. These gases have the potential to deposit metals around the facility.</p> <p>As with many large-scale industries, it is likely that foundries encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks for chemicals and fuels, electrical transformers and water and waste treatment facilities may have been present as part of a foundry.</p>
Exclusions	<ul style="list-style-type: none"> • Casting of small items in a residential setting. • Manufacturing jewellery workshops that melt and cast items using precious metals.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Furnace heating	The heating of the furnace, which can be undertaken using coke as a fuel.	<p>The creation of ash that may then be deposited to ground or buried on site.</p> <p>The potential for contamination of soil or groundwater from the storage and disposal of ash residues from heating furnaces will be dependent on the storage and waste disposal factors.</p>	<ul style="list-style-type: none"> • The volume and types of fuel used and their properties, including their persistence and toxicity. • Condition of buildings, equipment and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices. • Discharges to air and deposition of airborne contaminants (mainly dust). • Waste management practices, both current and historical.
Processing	<p>Processing may involve the activities of:</p> <ul style="list-style-type: none"> • melting – the addition of metal components, alloys, fluxes and degassing agents to the furnace to create a molten metal or alloy • pouring – the transfer of molten metal into moulds to create a casting • shakeout – the removal of solidified castings from moulds • degating – the removal (cutting off) of the excess metal components (heads, runners, gates and risers within the moulds) from the casting process • fettling – removing excess metal by processes such as grinding, chipping and shot blasting. 	<p>The deposition to ground of solid metal fragments.</p> <p>Spills or leaks of liquid metals or alloys, or of fluxes.</p> <p>Spent casting sand may also contain metals and metalloids.</p> <p>The potential for ground contamination to result from processing activities at foundry sites will vary, depending on the facility factors (eg, presence or absence of ground seal), both present and historic.</p>	<ul style="list-style-type: none"> • The volume and types of metal, metalloids and other chemicals used, and their properties, including their persistence and toxicity. • Condition of buildings, equipment and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The time and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices. • Discharges to air and deposition of airborne contaminants (mainly dust). • Waste management practices, both current and historical.

Activity	Description	Mechanism of contamination	Risk factors
Surface cleaning via abrasive blasting	<p>Blasting media is accelerated through a blasting nozzle at the object, using either compressed air or pressurised fluids (water and/or detergents). Abrasive blasting may be carried out by placing an object inside a stationary blasting cabinet or using a mobile unit to apply blasting media to an in situ object.</p>	<p>Deposition of blasting media and/or abraded surface materials to ground.</p> <p>The potential for contamination from the activity of abrasive blasting varies greatly, depending on the handling (and clean-up) practices and locations, both historically and currently.</p> <p>Curtains or screens can reduce the unintended spread of media and material removed, but not completely stop it.</p> <p>Wet media can flow downhill to drains. Fine particles of blasted surface material have a large surface area to volume, ensuring that runoff can contain dissolved contaminants, including ecotoxic metals, such as copper and zinc.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used as the abrasive or cleaned from the surfaces, their physical form and properties, including their persistence and toxicity. • The duration and frequency of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Housekeeping and cleaning practices used, as well as management of wastes. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust). • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas.
Finishing	<p>Grinding, sanding or machining the casting to achieve the desired physical dimension and/or surface finish.</p>	<p>The deposition to ground of solid metal fragments.</p> <p>The potential for ground contamination to result from finishing, storage and maintenance activities at foundry sites will vary, depending on the storage facility and handling factors (eg, presence or absence of ground seal), both present and historic.</p>	<ul style="list-style-type: none"> • The volume and types of substances either used to finish surfaces and removed from the product, their physical form and properties, including their persistence and toxicity • The duration and frequency of the activity, and what was considered best practice at the time. • Condition and maintenance of the equipment and facilities. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust). • Housekeeping and cleaning practices used, as well as management of wastes.
Storage	<p>The storage of raw materials (eg, metals, alloys, fluxes), finished products and maintenance products.</p> <p>For the storage of fuel oils and/or fuels, such as petrol and diesel, refer to HAIL activity A17.</p>	<p>Spills or leaks of liquid chemicals to ground.</p> <p>The deposition to ground of solid metal fragments.</p>	<ul style="list-style-type: none"> • Types and volume of raw products and fuels, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, bins, tanks and containers.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> The industrial and material handling processes used and the processes and safeguards to prevent discharges. The period and frequency over which storage occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Maintenance	The routine maintenance of foundry machinery and buildings.	Spills or leaks of petroleum hydrocarbon products, such as lubricants and solvents, to ground. Release of asbestos fibres to air and land.	<ul style="list-style-type: none"> Types and volume of maintenance products used, their physical form and properties, including their persistence and toxicity. The condition of buildings and equipment. The industrial, housekeeping and cleaning practices used, the material handling processes used, and the processes and safeguards to prevent discharges. The period and frequency over which storage occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste	The foundry process will generate numerous waste streams, for example, metal trimmings, slag and used foundry sand.	<p>Inappropriate waste management practices have the potential to result in discharges to land and water.</p> <p>Deposition of wastes into or on to land may contaminate soil and generate leachates that could migrate to surface water or groundwater.</p>	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Metals and metalloids Commonly processed metals and alloys include aluminium, cast iron, bronze,	Persistence and mobility are dependent on environmental conditions and soil properties.	1800s to present.	Toxicity is specific to the element or chemical form that the metal is in.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
brass, steel, magnesium, copper, nickel, lead and zinc. Other metals and metalloids that may be included in the creation of castings are antimony, arsenic, bismuth, boron, cadmium, chromium, cobalt, manganese, mercury, molybdenum, niobium, platinum, silver, tantalum, titanium, tungsten and vanadium	<p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>		<p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
Polycyclic aromatic hydrocarbons (PAHs)	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	Late 1800s to present.	<p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans. PAHs are carcinogenic and can bioaccumulate.</p> <p>High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>
Solvents (including chlorinated) (used for cleaning)	<p>Chlorinated solvents are persistent and mobile, including as soil vapour.</p> <p>The persistence and mobility of hydrocarbon solvents are affected by the type of hydrocarbon, soil type and groundwater conditions.</p> <p>Chlorinated solvents can permeate through concrete over time and contaminate underlying soil. Chlorinated solvents sink through groundwater, due to their density, and present a risk of vapour intrusion in buildings.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will</p>	1940s to present.	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used, although their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Some solvents are toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	move vertically down into soil, before spreading laterally when groundwater is encountered. Solvents pose a risk of vapour intrusion if a plume is close to a building.		
Asbestos	Persistent and mobile (in air) when friable asbestos is disturbed. Can be mobilised by water, contaminating areas through overland flow, and risk increases when the soil dries.	1900s to 1980s.	Asbestos is a carcinogen when inhaled. Soil contaminated with asbestos can release fibres into the air when disturbed. May be present throughout building and furnace fabric, in friable or non-friable forms in lagging and insulation, and in panels or sheets.

Back to [Metal extraction, refining and reprocessing, storage and use.](#)

D3 Metal treatment or coating, including polishing, anodising, galvanising, pickling, electroplating, or heat treatment or finishing using cyanide compounds

HAIL activity intention

Description	Metal objects are treated or coated to change their physical properties, to prevent them from corroding or to give the metal an attractive finish. These activities are usually undertaken within an industrial setting. These industries use a variety of processes and often highly toxic and/or corrosive chemicals. With metal treatment and coating, a variety of different processes and substances are used to achieve the desired finish; and a combination of these processes is likely to be used as part of any one treatment or coating activity. The activities can be undertaken on a site providing a single specialist activity or as part of a larger engineering facility.
Applicability	This activity covers sites where metal treatment and coating processes are undertaken, including cleaning, electroplating, galvanising, hot dip tinning, polishing, heat treatment (case hardening) and anodising.
Contamination setting	<p>Metal treatment and coating processes take place in a variety of locations within the site. Depending on the layout of the site and scope of the activity, this could be multiple areas dedicated to a process. These areas can also be where spills and leaks of chemicals occur as well as discharges of metallic solids, particulates and aerosols. The condition of the equipment and infrastructure (eg, the integrity of tanks, pipes, drains and floors inside and outside of the facility), both present and historic, will also have a bearing on the areas potentially affected by contamination.</p> <p>As with many large-scale industries, it is likely it encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks for chemicals and fuels, electrical transformers and water and waste treatment facilities may have been present as part of a metal treatment and coating industry site.</p>
Exclusions	<ul style="list-style-type: none"> The pre-cleaning of objects via abrasive blasting.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Treatment and coating processes	<p>Common processes applicable to this activity include:</p> <ul style="list-style-type: none"> • pickling via a pickling line, which removes impurities and contaminants from the surface of the metal using strong acids • pre-cleaning via wiping, soaking, spraying, flushing or vapour degreasing with solvent and acid degreasers: the pre-cleaning of objects to remove dirt and oily residues from the metal • pre-cleaning via acid or solvent or acid or chromium VI baths: the pre-cleaning of objects via dipping into a pickling liquor that may contain a combination of acid and solvent, or acid and a chromium VI compound (usually a salt) to remove coatings from the metal • electroplating: coating an object in a thin layer of a metal or alloy by immersing the object in an aqueous solution of the applicable metal salt, in the presence of a current. Electroplating is known to have used mist-suppressants that frequently contain, per- and polyfluoroalkyl substances (PFASs). PFASs have also been used in corrosion prevention, mechanical wear reduction, aesthetic enhancement, surfactant, wetting agent and fume suppressant for chrome, copper, nickel and tin electroplating, and post-plating cleaner • galvanising and hot dip tinning: coating an object in a layer of zinc (galvanising) or tin (hot dip tinning), by immersing the object into a bath of the applicable molten metal. May occur in conjunction with the use of a flux solution, and in the case of hot dip tinning, oil. • polishing via abrasion: the mechanical removal of the outer metal surface of metallic components by abrasion 	<p>Spills or leaks of the liquids to ground.</p> <p>Deposition to ground of metallic solids, created during polishing processes.</p> <p>Deposition to ground of metal particulates released as aerosols during the plating process.</p> <p>The potential for ground contamination to result from processing activities at metal treatment and coating sites will vary, depending on the facility factors (eg, the integrity of tanks).</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.

Activity	Description	Mechanism of contamination	Risk factors
	<ul style="list-style-type: none"> polishing via electropolishing: causing the outer metal surface of a metal component to dissolve by immersing the component in an acid bath in the presence of a current heat treatment (case hardening) using cyanide compounds: the process of hardening the outer layer of a metal component by heating and/or submersing the component into a bath containing a cyanide compound solution anodising (infusion with pigments): the infusion of colour onto the exterior of an anodised component (usually aluminium) via immersion into a bath containing organic dyes or mineral pigments. 		
Storage	<p>The storage of raw materials (eg, metals, solvents, corrosives), finished products and maintenance products (including effluent treatment chemicals).</p> <p>The storage of wastes before disposal.</p>	<p>Spills or leaks of liquid chemicals (including oil) to ground.</p> <p>The deposition to ground of solid metal fragments.</p> <p>The potential for ground contamination to result from storage at metal treatment and coating sites will vary, depending on the storage facility and handling factors (eg, the integrity of storage tanks, presence or absence of ground seal), both present and historic.</p>	<ul style="list-style-type: none"> Types and volume of raw materials and chemicals, their physical form and properties, including their persistence and toxicity. The condition and weathertightness of buildings, shelters, tanks and containers The industrial and material handling processes used and the processes and safeguards to prevent discharges. The period and frequency over which storage occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Treatment of liquid waste (effluents) and waste disposal – to trade waste	<p>Metal treatment and coating results in waste liquids (effluents), sludges and solids. These are collected, stored and, in some cases, treated on site before disposal. Pre-treatment of liquid effluent before disposal should therefore be considered in addition to the more common waste-related activity factors of waste storage and disposal.</p> <p>The collection of metal and cyanide-containing effluents (including chromium VI-bearing effluent) in sumps for treatment either via the addition of chemicals, such as</p>	<p>Spills or leaks of effluents to ground from storage tanks.</p> <p>Spills or leaks of treatment chemicals to ground.</p> <p>Discharges of effluent to ground through leaking drains, pipework or tanks.</p>	<ul style="list-style-type: none"> The volume and types of chemicals in the effluent, and to treat the effluent, their physical form and properties, including their persistence and toxicity. Condition of the equipment, tanks and lines from which leaks could occur. The period and frequency over which these operations occurred.

Activity	Description	Mechanism of contamination	Risk factors
	<p>acids or alkalis, or via technologies, such as evaporation, ion exchange and reverse osmosis.</p> <p>Involves the collection, conveyance and storage of effluents in sumps, drains and/or pipes and tanks; and the treatment of effluents in tanks. Historically, these tanks were often below ground level.</p> <p>The disposal of treated and untreated effluent to trade waste.</p>		<ul style="list-style-type: none"> • Standard of measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal – on-site deposition or burial	The on-site disposal of sludge or solid waste by deposition to ground or via burial.	<p>The disposal on to or into the ground of:</p> <ul style="list-style-type: none"> • sludges (which may be alkaline in nature and are mainly precipitated metallic compounds, eg, hydroxides, carbonates and sulfides) • solid wastes (which may include de-watered effluent treatment sludge, carbon filter media, dust and solidified metal salts from air extraction systems, metal fragments, precipitates, residues and skimmings and so on). 	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (iron, lead, tin, nickel, copper, magnesium, zinc, aluminium, chromium, including chromium VI, cadmium, silver, manganese and so on)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Acids (hydrochloric, nitric, sulphuric, acetic, phosphoric, chromic, and hydrofluoric)	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Larger quantities will likely be mobile in the environment due to their water solubility.</p>	1800s to present.	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life, however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p> <p>The acids used in the process have the potential to corrode transfer and drainage pipework. Surface or subsurface leaks from failed pipework have the potential to erode the integrity of sealed floors and discharge contaminants directly to soil.</p>
Alkalis (ammonium hydroxide, potassium hydroxide (caustic potash), ammonium persulphate and sodium hydroxide (caustic soda))	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Larger quantities will likely be mobile in the environment due to their water solubility.</p>	1800s to present.	<p>Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes.</p> <p>Bases and alkalis can be toxic to aquatic organisms, however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>
Non-chlorinated solvents (including benzene, toluene, ethylbenzene and total xylene (BTEX), acetone,	Persistence will be dependent on environmental conditions and soil	1800s to present.	Human health effects and environmental toxicity are specific to the solvent.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
ketones, kerosene – used throughout manufacturing	<p>properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>		<p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>The solvents used in the process have the potential to melt transfer and drainage pipework. Surface or subsurface leaks from failed pipework have the potential to discharge contaminants directly to soil. Solvents also pose a risk of vapour intrusion if a plume is close to a building.</p>
Chlorinated solvents (including trichloroethene (TCE) and 1,2-dichloroethene or dichloroethylene (DCE)) possibly used to clean parts in workshops or machinery in situ	<p>Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can be and have been used, however, their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p> <p>The solvents used in the process have the potential to melt transfer and drainage pipework. Surface or subsurface leaks from failed pipework have the potential to discharge contaminants directly to soil. Solvents also pose a risk of vapour intrusion. if a plume is close to a building.</p>
Lubricating oil	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Lubricating oils commonly include metals such as zinc and molybdenum in additives to improve performance.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Per- and poly-fluoroalkyl substances (PFASs)	Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.	1950s to present. Use of some compounds within the PFAS grouping (eg, perfluorooctanesulfonic acid (PFOS)) phased out since 2002 but others remain in common use.	Human toxicity is not well understood. Some PFAS compounds are highly toxic to environmental receptors. Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors. Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).

Back to [Metal extraction, refining and reprocessing, storage and use.](#)

D4

Metalliferous ore processing, including the chemical or physical extraction of metals, including smelting, refining, fusing or refining metals

HAIL activity intention

Description	<p>Metalliferous ore processing activities will likely take place in an industrial or mining setting in large facilities that require a large source(s) of energy, for example, coke or electricity. These include sites where activities are undertaken to extract or process metalliferous ores or products to a pure metal or combine metals to make alloys. The processes include crushing, smelting and refining using heat treatment, aqueous solutions and fusing. Within each process, a variety of different techniques and substances may be used to ensure as much of the metal is extracted and processed. During each of these processes, waste products and by-products will be produced. Contamination is likely to be associated with the generation and handling of waste products, including fallout from air emissions, wastewaters and sludges, tailings, and the storage and handling of fuels, liquids and other chemicals required for extraction and processing. Historically, waste management and control of air emissions was of a much lower standard than the present day. Commonly processed metals in New Zealand include aluminium, iron and gold.</p>
Applicability	<p>This activity covers sites that extract or process metalliferous ores and produce metals or specialist alloys.</p>
Contamination setting	<p>An ore processing facility will have designated areas for each process, and their location will depend on the layout of the site, the site practices (including waste disposal) and the range of processes undertaken. These areas can be affected by spills or leaks of leaching solutions while dispensing and refilling, spills of molten metals to ground and leaks from tanks and associated pipework. The degradation of containers and vats or associated pipework can result in slow leaks or more substantial failures at these locations. As well, the site will have areas that are used for the storage of unprocessed stockpiled material, the storage and disposal of ash residues from heating furnaces, storage of ore bearing materials, chemicals required for leaching, waste materials and liquids, fuels and chemicals.</p> <p>The type of processing used in the extraction process should determine the potential for soil contamination. In assessing this category, it is necessary to have a detailed understanding of:</p> <ul style="list-style-type: none"> • the metal that is to be extracted and how it is to be processed • the mechanical processing of the source rock, for example, crushing, milling or screening • the heating process, if used, and fuel for the furnaces, which is critical to determining if the heating fuel may also be a source of contamination (eg, use of liquid fuels, coal or coke to heat furnaces) • chemical leaching processes, if used, and the waste produced • the final processing operations where the pure metal is further refined; these are likely to be undertaken in specialist facilities, so the potential for contamination is likely to be low. <p>As with many large-scale industries, it is likely that facilities that extract or process metalliferous ores or products encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. Examples include storage tanks and electrical transformers, fuel storage, wastewater treatment plants, coal and/or coke storage, and scrap metal storage.</p>
Exclusions	<ul style="list-style-type: none"> • Mining of the ore rock. • Disposal of waste rock and tailings. • Metal treatment or coating, especially pickling. • Further use of molten metal products by foundry operations. • Storage of scrap metal, which is covered by HAIL activity G4.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of ore bearing materials, chemicals required for leaching, waste materials and liquids.</p> <p>Possible fuel storage (refer to activity A17) and coal and coke storage for furnaces.</p>	<p>Rain leaching chemicals from the storage of extracted raw materials on to the ground.</p> <p>Dust from the extracted raw materials (stockpiles and from handling).</p> <p>Leaks from underground or above-ground tanks (and other storage containers) and associated pipework. Leaks could also occur during refuelling and may result in soil, groundwater or surface-water contamination.</p>	<ul style="list-style-type: none"> • The volume and types of ore, chemicals and tailings, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, tanks, bags and containers, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which the operations and storage took place. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The extent to which runoff can reach unsealed land or surface water. • Contamination of soil or groundwater from the storage of unprocessed stockpiled material will depend on the type of ore or rock (ie, ability to react or breakdown when exposed to the atmosphere) and whether or not the storage location is covered.
Smelting	<p>Smelting is the production of metal from either ore or scrap products (secondary smelting). Commonly used to extract base metals but also iron, aluminium and tin.</p> <p>Before smelting occurs, the ore will be roasted or sintered.</p>	<p>The creation of ash and slag in and around furnace areas, which may then be deposited to ground or buried as part of the disposal process.</p> <p>Spills of molten metals to ground.</p> <p>Potential fall out of metallic residues from historic smelting operations (ie, before stack emissions were controlled) could have resulted in heavy metal</p>	<ul style="list-style-type: none"> • The volume and types of ore and other chemicals used in the process, their physical form and properties, including their persistence and toxicity. • Condition of the equipment and tanks from which any leaks could occur.

Activity	Description	Mechanism of contamination	Risk factors
	<p>Smelting will be undertaken using a blast furnace, which could use coal or coke as a fuel, or electric furnaces. Carbon or other fluxes are needed as a purifying agent when heating the ore.</p> <p>Metal oxides are commonly produced during the smelting process, and it is from these compounds that the pure metal is smelted.</p> <p>Smelting processes may result in stack emissions.</p> <p>In the past, the areas around the furnaces may have been unsealed.</p>	<p>contaminants in soils around furnaces, retorts and stacks.</p>	<ul style="list-style-type: none"> • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land. • Waste management practices, both current and historical.
Refining using thermal treatment	<p>Involves purifying the metal by thermal treatment (pyro-metallurgical processes). May involve the use of a furnace or other plant.</p>	<p>Spills of powders or molten metals in and around heating source.</p> <p>The creation of ash and slag in and around furnace areas, which may then be deposited to ground or buried as part of the disposal process.</p> <p>Spills of molten metals to ground.</p> <p>Potential fall out of metallic residues from historic operations (ie, before stack emissions were controlled) could have resulted in heavy metal contaminants in soils around furnaces, retorts and stacks.</p>	<ul style="list-style-type: none"> • The volume and types of ore and other chemicals used in the process, their physical form and properties, including their persistence and toxicity. • Condition of the equipment and tanks from which any leaks could occur, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which these operations occurred. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land. • Waste management practices, both current and historical.
Refining using aqueous solutions	<p>Involves purifying the metal by the use of aqueous solutions (hydro-metallurgical processes). The aqueous solutions allow the desired metal to leach from the ore. Different</p>	<p>Spills (potential over filling) or leaks of leaching solutions while dispensing or refilling could result in ground contamination around these areas.</p>	<ul style="list-style-type: none"> • The volume and types of ore and other chemicals used in the process, their physical form and properties, including their persistence and toxicity.

Activity	Description	Mechanism of contamination	Risk factors
	<p>processes and additives will be used for different metals.</p> <p>Leaching can be undertaken using various methods:</p> <ul style="list-style-type: none"> • in situ leaching – solution is pumped directly into the ore body through hydraulic fracturing or use of explosives • stockpile leaching – the solution is sprayed over the ore, which is usually located in a lined bund. The leached solution (which contains the desired metals) is then collected in drains or sumps and will be processed further. 	<p>Degradation of containers and vats, or associated pipework, resulting in slow leaks or more substantial failures at these locations.</p> <p>Leaching of solutions applied to stockpiles if appropriate drainage or ground seal is not present, which could result in contamination of soils.</p> <p>Refining in modern facilities will be undertaken in specialist areas containing sealed ground, with many processes being automated. However, this may not have been the case historically.</p>	<ul style="list-style-type: none"> • Condition of the facilities, equipment, tanks and lines from which leaks could occur, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which these operations occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Waste management practices, both current and historical.
Leaching using chemicals or mercury	<p>Container or vat leaching – solution ‘baths’ within some type of vessel, which may be agitated to increase reactions.</p> <p>Metal chlorides can be produced during refining.</p> <p>Many processes could be automated, further reducing the potential for contamination associated with handling of materials. Processing areas and the technology used may change with time.</p>	<p>Spills (potential over filling) or leaks of leaching solutions while dispensing or refilling could result in ground contamination around these areas.</p> <p>Degradation of containers and vats, or associated pipework, resulting in slow leaks or more substantial failures at these locations.</p> <p>Leaching of solutions applied to stockpiles if appropriate drainage or ground seal is not present, which could result in contamination of soils.</p> <p>Leaching in modern facilities will be undertaken in specialist areas containing sealed ground, with many processes being automated. However, this may not have been the case historically.</p>	<ul style="list-style-type: none"> • The volume and types of ore, mercury and other chemicals used in the process, their physical form and properties, including their persistence and toxicity. • Condition of the facilities, equipment, tanks and lines from which leaks could occur, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which these operations occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Waste management practices, both current and historical.
Purification and metal recovery	<p>After leaching, the metal must be extracted or concentrated to allow extraction. Processes adopted to achieve this might include precipitation, cementation, solvent extraction, gas reduction and electrolysis.</p> <p>The resulting final metals will be cast into ingots (refer to activity D3). These types of processes would be undertaken within a specialist facility.</p>	<p>Spills of powders or molten metals to ground around the processing area.</p> <p>The processes of purification and metal recovery are likely to take place in specialist facilities, where the priority is to obtain as much of the pure metal as possible. Therefore, the ground is likely to be sealed and spilled processed products are likely to be collected for further processing.</p>	<ul style="list-style-type: none"> • The volume and types of leachate and other chemicals used in the process, their physical form and properties, including their persistence and toxicity. • Condition of the equipment and tanks from which any leaks could occur, and the standard of the facilities and measures to mitigate or control leaks, discharges or spills.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • The period and frequency over which these operations occurred. • The handling and transfer of products between processes, which could involve moving materials and chemicals between different areas. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Waste management practices, both current and historical.
Waste disposal	<p>May include:</p> <ul style="list-style-type: none"> • production of ash, slag and slurry from furnaces • generation of waste wash waters and liquid wastes (note: some sites may recycle this) • disposal of damaged or empty containers • stack discharges. <p>It is common practice now to recycle slag produced from furnaces for further processing. However, slurries are difficult to recycle.</p>	<p>Deliberate dumping (or burial) of wastes. Could include excess solutions, ash or slag products into or on to ground. Slurries may be placed into drying ponds. These practices may result in chemicals leaching into soils, groundwater or surface water.</p> <p>Fallout to soil from air discharges.</p> <p>Spills or leaks from degraded, damaged and decommissioned containers to ground.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Cyanide compounds (used for leaching metals during refining)	<p>Cyanide compounds can be persistent in both soils and water, however, the persistence can be strongly influenced by the environmental conditions.</p> <p>Cyanide compounds, depending on the cyanide compound, can be highly mobile and transported by air or water.</p>	1880s to present.	<p>Toxicity is specific to the compound. Free cyanide can be acutely toxic. Ferri- and ferro-cyanide complexes typically have low human toxicity. Thiocyanates have a moderate human toxicity. Depending on its form, cyanide may cause toxicity through inhalation, ingestion and dermal absorption.</p> <p>Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. In strongly acidic conditions, hydrogen cyanide gas can be released. Hydrogen cyanide is highly toxic.</p> <p>Further information cyanide can be found in Ministry for the Environment (1997) <i>Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand</i>.</p>
Metals and metalloids (iron, lead, tin, nickel, copper, magnesium, zinc, aluminium, chromium, gold)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Fluoride (used in smelting and refining as an electrolyte)	<p>Fluoride is persistent in soils.</p> <p>Fluorine compounds are generally soluble in water and are therefore highly mobile. However, mobility will also be dependent on environmental conditions and soil properties.</p>	1880s to present.	<p>Fluorine in soils may accumulate in plants. The amount of uptake by plants depends on the type of plant and type of soil and the amount and type of fluorine found in the soil.</p> <p>Animals eating fluorine-containing plants may accumulate large amounts of fluorine in their bodies. Exposure to high concentrations of fluorine can lead to dental decay and bone degradation.</p>
Solvents (including benzene, toluene, ethylbenzene and total xylene (BTEX), acetone,	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.	1800s to present.	Human health effects and environmental toxicity are specific to the solvent.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
and ketones, used to clean parts in workshops or machinery in situ)	Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.		Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant. Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered. Solvents pose a risk of vapour intrusion if a plume is close to a building.
Chlorinated solvents (including trichloroethene (TCE) and 1,2-dichloroethene or dichloroethylene (DCE)), used to clean parts in workshops or machinery in situ)	Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1800s to present.	Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used, however, their use has declined due to their toxicity. Chlorinated solvents are toxic, and some are considered carcinogenic. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent. Chlorinated solvents are used to extract contaminants and constituents from other matrices and as a solution in which samples are analysed.

[Back to Metal extraction, refining and reprocessing, storage and use.](#)

D5

Engineering workshops with metal fabrication

HAIL activity intention

Description	Engineering workshops may be discrete businesses or may be located within a larger facility, such as railway yards, airports, ports, factories, mines and quarries, and on some farms, defence sites and conservation stations. The processes involved in metal fabrication commonly use a variety of chemicals and include three basic processes, namely cutting, bending or forming and assembling. Each involves numerous methods and procedures, and a variety of specialised machinery and equipment, including lathes, milling machines, mechanical hammers, drills, saws, grinders, welders, and many other tools and machines that manipulate materials, mainly metals and alloys, but also plastics, resins and composite materials.
Applicability	This activity covers sites where metal fabrication has been undertaken. Metal fabrication includes a range of activities, including manufacturing, maintaining, repairing and modifying items and parts mainly made of metals.
Contamination setting	<p>Engineering workshop sites where metal fabrication processes have been carried out typically have a set layout. These sites will include designated areas for welding, fitting and machining for the fabrication and repair of tools, parts and machines, and the cleaning of machines and fabricated items and components. The areas can be impacted by materials handling activities, such as spills and leaks. The process can also result in the floor of the building and outside the building being affected. For example, metal filings, swarf or shavings may be swept outdoors, or milling or lathe swarf saturated with cutting fluid can drip on to the floor of the building or on to land if the swarf is collected, especially when stored outdoors and exposed to rainfall. Welding creates spatter, particulate and vapour, all of which have the potential to contaminate surfaces, and possibly ground or water if swept or washed out of the building or on to unsealed land during cleaning.</p> <p>As with many large-scale industries, it is likely that facilities that undertake metal fabrication encompass other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. Examples include abrasive blasting, storage of chemicals, fuel and waste in tanks and drums, bulk storage of corrosives, above- and below-ground storage tanks containing fuel oils (eg, for boiler use), waste disposal, and large electrical transformers and switchgear. While mainly a specialist activity, metal treatment and coating may also have been done on larger industrial sites.</p>
Exclusions	<ul style="list-style-type: none">• General carpentry and woodworking, which might have been undertaken at the same site or within the same workshop building.• Workshops in the domestic or educational setting (eg, metalwork rooms at schools).• Foundry operations where the metal is heated up to its molten state for forging.• Sites where engineering processes were undertaken as part of engine reconditioning.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>The storage of raw materials (eg, metal) and small volumes of lubricating, maintenance and cleaning products (eg, oils, greases and solvents).</p> <p>Storage and use of liquid contaminants within a workshop, either held in stock for use or as waste, including:</p> <ul style="list-style-type: none"> • lubricating and cutting fluids used with workshop machinery and on parts or equipment being fabricated or repaired • fuel for workshop machinery and equipment • cleaning substances and solvents, used to clean and degrease machinery and parts • metal preparation and finishing chemicals, such as pickling paste, rust remover, primers and paints, and specialist chemicals for a range of purposes. 	<p>Spills or leaks of liquid, paste or gel chemicals to ground could result from poor storage practices, degradation of chemical containers and associated pipework and valves. Potential for contaminants to reach groundwater or surface water.</p> <p>The accumulation and deposition to ground of solid metal fragments.</p> <p>Contamination from the storage of various chemicals, liquids, oils and metal parts at engineering workshop sites will vary, depending on the storage facility (eg, presence or absence of ground seal), and poor housekeeping will increase the risk of leaks, spills and slops from handling hazardous substances, both present and historic.</p>	<ul style="list-style-type: none"> • Types and volume of raw materials and chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling processes used, and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Machining (cutting, milling, lathing and drilling)	<p>Metal fabrication involves numerous processes that may result in contaminants landing on the ground, such as:</p> <ul style="list-style-type: none"> • cutting, grinding, filing or sanding • shaping, hammering, bending, rolling, extruding • milling, lathing, drilling or removal of stock material • joining, welding and soldering. <p>General machining practices may include welding, fitting and various machining techniques. Metals may be worked with in a cold or hot state.</p> <p>Most machining practices require a lubricating or cutting fluid, gel, paste or aerosol to be used. These</p>	<p>Spills, leaks or drips of liquid, gel or paste chemicals to ground.</p> <p>Cutting fluid can drip or spray away from where it is intended, on to the floor beside the machine.</p> <p>Machining produces flakes, chips, threads or spirals of waste, often referred to as swarf. This is often covered in cutting fluid, which can drip on to ground in bins where it is stored for disposal or recycling.</p> <p>Over time, significant contamination can result if there is a complete contaminant pathway.</p> <p>Poor condition of flooring, including slot drains, and cracks or holes in concrete. Old machine mounting</p>	<ul style="list-style-type: none"> • Types and volume of materials to be machined, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used, and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred.

Activity	Description	Mechanism of contamination	Risk factors
	<p>can be applied in several ways, which might include flooding, spraying, dripping, misting or brushing. In modern operations, these fluids are collected and reused many times before being recycled.</p> <p>Modern engineering facilities are increasingly becoming automated with many operations also undertaken robotically. However, an engineering workshop may have a long history in one place and may have been upgraded over time. The layout of the site in the past and workshop housekeeping and engineering practices that have changed over time will have a significant impact on the contamination potential of the site.</p> <p>Modern facilities will be located within specialist buildings and rooms with sealed floors and a high standard of cleanliness.</p>	<p>holes in concrete pads or floors that have not been filled in.</p> <p>Poor housekeeping, where spills of oils, solvents and cutting fluids are not cleaned promptly.</p> <p>Use of aggressive cleaning fluids and degreasers that can penetrate or degrade concrete flooring.</p> <p>Machining metals that contain high levels of contaminants, such as tungsten (containing high levels of cobalt) and lead.</p>	<ul style="list-style-type: none"> • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Welding, brazing and soldering	<p>Soldering – joining metal using molten lead or silver wire.</p> <p>Brazing – using molten brass or other alloys to join metal parts.</p> <p>Welding – using metal rods or wire and flux (often containing asbestos), which are melted by an electrical arc or high temperature flame.</p> <p>Pickling stainless steel after welding with a mixture of hydrofluoric and nitric acids.</p>	<p>Metal is vaporised at high temperatures and produces fumes, which include gases, vapours and particles, some of which are toxic. Welding vapour is distributed to where it can fall on surfaces and floors.</p> <p>Inadequate extraction and filtration of the workshop can result in depositing of metal dust and vapours on to surfaces.</p>	<ul style="list-style-type: none"> • Types and volume of materials to be machined, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or vapours).

Activity	Description	Mechanism of contamination	Risk factors
Maintenance and cleaning	<p>The routine maintenance and cleaning of metal parts and machinery.</p> <p>Note: corrosion inhibitors may be used to protect the machines and tooling.</p>	<p>Spills or leaks of petroleum hydrocarbon products, such as lubricants and solvents in and around maintenance areas. Contaminants may reach soil, if a sealed floor is not present or is in a poor condition, and potentially groundwater or surface water.</p> <p>Washing down factory floors could result in contaminants (metal and hydrocarbon residues) being discharged to stormwater or to land when washed out of the workshop.</p> <p>The potential for contamination to occur as a result of maintenance and cleaning will ultimately depend on the substances used, the cleaning practices, as well as the condition of the workshop floor.</p> <p>Other factors include the proximity to drains, whether these discharge to trade waste or stormwater, and housekeeping practices, such as handling of wastes (see Waste disposal below). Many modern facilities will have solid concrete floors.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals used to clean and maintain the equipment, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, older equipment may need more maintenance and cleaning. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period and frequency over which the cleaning of the equipment took place.

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	<p>Disposal of:</p> <ul style="list-style-type: none"> • off-cut metal parts (could be sent to scrap metal merchant) • fine shreds of metal, known as swarf (could be recycled) • metal-rich dusts • excess or spent oils and cutting fluids used in machines • disposal of empty or damaged containers • liquid wastes, such as solvents, lubricating oils and cutting oil. <p>In recent times, many metallic wastes will have been stored in skips and containers for disposal as scrap metal. In the past, these waste materials may have been stockpiled directly on the ground.</p> <p>Liquid wastes will likely be collected into containers for disposal.</p>	<p>Tipping of spent and used lubricating or hydraulic oils onto the ground. It used to be common practice to use sawdust to soak up oil spills and leaks. Often this sawdust was then dumped on the site somewhere.</p> <p>Deliberate dumping (or burial) of wastes into or on to ground. These practices may result in chemicals leaching into soils, groundwater or surface water.</p> <p>Spills or leaks from degraded, damaged or decommissioned transformers and capacitors to ground.</p>	<p>The potential for contamination from waste disposal processes varies greatly, depending on waste disposal practices and locations, both historically and currently.</p> <p>Factors include:</p> <ul style="list-style-type: none"> • temporary storage of recyclable materials where spills and drips of oils or other contaminants can reach ground • housekeeping practices and spill management • type of wastes produced and chemicals used in the production process • the age of the engineering workshop, which may affect the likelihood that waste disposal was not done in compliance with modern regulatory requirements.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Solvents (including white spirits, turpentine, methylated spirits, hexane and acetone)	<p>Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on contaminant.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered. Solvents pose a risk of vapour intrusion if a plume is close to a building.</p>
Chlorinated solvents (dichloromethane, tetrachloromethane, tetrachloroethane)	<p>Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used, however, their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the solvent.</p> <p>They are used to extract contaminants and constituents from other matrices and as a solution in which samples are analysed.</p>
Metals and metalloids (including iron, chromium, cadmium, nickel, titanium, cobalt, vanadium, copper and zinc)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p>	1800s to present.	Toxicity is specific to the metal, metalloid or chemical form that the element is in.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Sources include solid waste swarf, welding fumes, grinding dust (including metal coatings)			Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .
Lubricating oil (oils and greases, eg, lubricating oils for presses)	These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments. Lubrication oils and greases have low solubility and mobility in soil and groundwater.	Late 1800s to present.	These materials may cause long-term adverse effects in the aquatic environment. Lubricating oils commonly include metals, such as zinc and molybdenum, in additives to improve performance.
Alkalis (ammonium hydroxide, potassium hydroxide (caustic potash), ammonium persulphate and sodium hydroxide (caustic soda)) Alkaline substances, such as degreasers and paint strippers, are frequently used in engineering workshops to prepare metal items for work	Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade. Will likely be mobile in the environment due to their water solubility.	1800s to present.	Bases and alkalis are not generally toxic but can cause severe burns by all exposure routes. Alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.
Acids (hydrochloric, nitric, sulphuric, acetic, phosphoric, chromic and hydrofluoric)	Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade. Larger quantities will likely be mobile in the environment due to their water solubility.	1800s to present.	Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is. Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.

[Back to Metal extraction, refining and reprocessing, storage and use.](#)

E Mineral extraction, refining and reprocessing, storage and use

E1 Asbestos products manufacture or disposal, including sites with buildings containing asbestos products known to be in a deteriorated condition

HAIL activity intention

Description	<p>The manufacture of asbestos products was undertaken in industrial buildings where raw mineral asbestos was processed. The processed asbestos fibres were commonly mixed with other materials, such as plaster, cement or resins. These mixtures were then moulded or shaped to form specific products. Asbestos was used in many products, including pipes, roofing, panels and gaskets, which are commonly referred to as asbestos-containing material(s) (ACM(s)).</p> <p>Asbestos was used in the construction of both residential and industrial buildings. While these products are undisturbed or maintained in good condition, the risk of soil contamination remains low. However, if these ACMs are allowed to deteriorate to a condition where fibre can be released from the product, this creates potential for adverse health effects and soil contamination. Deteriorated means damaged, broken, crushed, friable, fragmentation, crumbling and smashed, or having surface abrasion or any other way of wearing down or reducing the integrity of the ACM. Some asbestos products are friable, such as pipe lagging and insulation, and may release fibre if disturbed.</p> <p>Asbestos is a term that covers a group of naturally occurring fibrous minerals, with many useful properties. However, when inhaled, it is carcinogenic to humans. Asbestos has been used to manufacture a wide range of articles, many of which have the potential to release respirable fibres.</p>
Applicability	<p>This activity is intended to be applied to sites where, as a result of ACM activities or from buildings with ACM that are in a deteriorated condition, ACM or asbestos fibres could enter soil.</p>
Contamination setting	<p>Asbestos is defined in legislation as the asbestiform varieties of mineral silicates belonging to the serpentine or amphibole groups of rock-forming minerals, including actinolite, grunerite (or amosite, also known as brown asbestos), anthophyllite asbestos, chrysotile asbestos (also known as white asbestos), crocidolite asbestos (also known as blue asbestos), tremolite asbestos, or a mixture that contains one or more of these minerals.</p> <p>This activity is intended to address an indirect risk from contaminated land, because the risk posed by asbestos is not directly from the soil but from the inhalation of fibres mobilised during soil disturbance. This can occur as part of earthworks or day-to-day activities, such as gardening. In addition, the health risks are different depending on the form of asbestos in the soil, which can be fragments of ACM or in friable or powder form.</p> <p>Products such as asbestos-cement roofing and cladding are a concern if they are in a deteriorated state. Wall cladding is likely to have a longer lifetime because it is not subject to the same sort of wetting and drying and thermal movement as a roof. Well-maintained, painted wall cladding should last indefinitely. Factors that can cause ACMs to become friable and release fibres include inappropriate demolition, fire, drilling, buffing, cutting, grinding or water blasting.</p>
Exclusions	<ul style="list-style-type: none"> • Sites where asbestos and ACMs are present in sound, well-maintained condition within, on or around a building or structure. • Sites where a natural source of asbestiform minerals are located.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Manufacturing of asbestos containing products	Any site where products were manufactured that contained any form of asbestos.	Handling and manipulating asbestos present many opportunities for asbestos fibres to become airborne or be directly or indirectly discharged to land. Mechanical handling of asbestos will release mineral fibres.	<ul style="list-style-type: none"> • The volume and types of asbestos and other chemicals used and their properties, including their persistence and toxicity. • Condition of buildings, equipment and the standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The period and frequency over which the operations and storage took place. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Cleaning and housekeeping practices. • Discharges to air and deposition of airborne contaminants (mainly dust). • Waste management practices, both current and historical.
Weathering	Exposed asbestos containing materials exposed to the elements.	<p>Over time, asbestos–cement products can begin to weather. Flaking or erosion of the material allows fibres to be released.</p> <p>Moss and algae growth degrades the cement that binds asbestos fibres.</p>	<ul style="list-style-type: none"> • The area of asbestos-containing material (ACM) exposed and types of asbestos. • Maintenance of buildings, and measures to mitigate or control exposure to the weather. • How long the ACM has been exposed. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
Inappropriate demolition	<p>Demolition of buildings with ACM, without identifying and removing the ACM, is likely to cause all the demolition material to become contaminated.</p> <p>Any uncontrolled demolition where ACM is present can result in soil contamination.</p>	Breaking ACMs into small particles.	<ul style="list-style-type: none"> • The volume and types of ACM within the demolished building. • Condition of building before demolition. • Measures, if any, to mitigate or control discharges to air and deposition of airborne particulates. • Cleaning and housekeeping practices. • Waste management practices.
Fire	Buildings with ACM that have been subjected to fire.	Fire causes many types of ACM to flake as water is heated to boiling point. Pressure as a result of steam causes the ACM to explode, releasing asbestos fibres that can travel on the wind and contaminate the site and possibly adjacent land.	<ul style="list-style-type: none"> • The volume and types of ACM within the building. • Wind speed and direction. • Severity of the fire. • Measures, if any, to mitigate or control discharges to air and deposition of airborne particulates. • Cleaning and housekeeping practices. • Waste management practices. • Presence of exposed, unsealed land.
Physical damage to ACM, including drilling, buffing, cutting, grinding or water blasting	Physical damage to ACMs can liberate asbestos fibres.	Flakes, chips or dust containing asbestos.	<ul style="list-style-type: none"> • Extent of the damage to the ACM. • Condition of the ACM before being damaged. • Presence of exposed, unsealed land.
Waste disposal	Disposal to land of wastes containing asbestos, except where the site is authorised to receive asbestos-containing waste.	<p>Inappropriate waste management practices have the potential to result in discharges to land and water.</p> <p>Poor handling and preparation of waste, such as wrapping and covering wastes.</p> <p>Failing to record the location of the waste within the landfill.</p>	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Asbestos fibres	Asbestos is a mineral and is very persistent. Mobility of fibres is affected by environmental conditions, such as soil characteristics and weather.	1900s to present. Asbestos-containing material is no longer produced but is still present in many buildings and structures.	Asbestos is a proven human carcinogen, and all forms of asbestos can cause cancer. The main way people are exposed to asbestos is by breathing in air that contains asbestos fibres. Asbestos causes cancer in a dose-dependent manner. The greater the exposure, and the longer the time of exposure, the greater the risk of developing an asbestos-related disease. No 'safe' lower limit of exposure has been identified with certainty – all exposure is thought to add to the overall risk of disease development – but the risk from a single, low-level exposure is considered to be extremely low. Further information is available in BRANZ (1997) <i>New Zealand Guidelines for Assessing and Managing Asbestos in Soil</i> .

Back to [Mineral extraction, refining and reprocessing, storage and use.](#)

E2

Asphalt or bitumen manufacture or bulk storage (excluding single-use sites used by a mobile asphalt plant)

HAIL activity intention

Description	<p>Asphalt plants are usually located in industrial or open areas. Commercial operators primarily use the asphalt and bitumen plants to produce a road pavement (mixed with aggregate as ‘hotmix’ (asphaltic concrete) or as sprayable binder for chip seal). Bitumen plants are likely to have storage tanks (horizontal or vertical) and associated piping, heating systems and controls, blending and mixing equipment, pumping plants and storage areas for aggregate materials.</p> <p>Bitumen is the heavy residue manufactured from refining crude oil. To keep the bitumen from hardening, it must be stored and heated to temperatures in excess of 150 degrees. To produce asphalt, the bitumen (the binder) is blended or mixed (in drums or mills) with the appropriate aggregate. Water, emulsifiers (called anionic or cationic) and other additives may be used to achieve the required asphalt specifications. The final product will then be transferred direct to trucks or could be stored on site in silos.</p> <p>Bitumen has many additional uses, such as a roofing product or in industrial flooring.</p>
Applicability	<p>This category is intended to cover those industries that manufacture, blend or store bitumen or produce asphalt in bulk quantities. While most plants will be permanent, blending operations could also be undertaken at ‘portable sites’. Portable sites should be assessed before they are considered as HAIL sites.</p>
Contamination setting	<p>Bitumen manufacturing is likely to be part of a refinery, although this is not always the case. Bitumen manufacturing or bulk storage sites may include storage tanks or drums for fuel, chemicals or liquid waste, including solvents, burner fuel, such as diesel or kerosene, and cutting liquids, such as kerosene. Bitumen will be transferred into storage (fixed tank, tank wagon or mobile wagon) from tankers.</p> <p>With the heating required as part of the bitumen manufacture processes, heating plant might be fuelled by natural gas or fuel oils. In addition, hydrocarbon solvents can be blended with bitumen as part of the production process.</p> <p>The mechanisms for contamination at a bitumen or asphalt plant are likely to be the same (eg, spills or leaks to ground), regardless of whether the source emanates from the storage, manufacturing or blending areas. However, the potential contaminants and therefore impacts could vary at each source location.</p> <p>Historically, coal tar has been used as a binder to make asphalt. Coal tar, a by-product of gasworks, is distinct from bitumen. Coal tar has a markedly different chemical composition and characteristics to bitumen and should be dealt with appropriately.</p>
Exclusions	<p>This category does not cover the application or use of bitumen or asphalt products.</p>

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation PSI.

Sub-activity and process	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of raw bitumen products in fixed or mobile structures in bulk quantities that are heated.</p> <p>Storage of emulsifiers and other additives used in the manufacture of bitumen emulsions and other blended products.</p>	<p>Spills or leaks on to or into the ground from storage containers (or from refuelling activities).</p> <p>The potential for contamination of soil or groundwater from bitumen is low because it sets solid on cooling.</p> <p>The potential for contamination of soil or groundwater from the storage of solvent and fuel hazardous substances at bitumen and asphalt sites will be dependent on the storage factors.</p>	<ul style="list-style-type: none"> • Types and volume of chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Manufacturing	<p>Blending hot bitumen with hydrocarbon solvents (kerosene and diesel) to obtain lower viscosity 'cutback' grades for spraying on roads.</p> <p>Blending hot bitumen with polymers to make polymer modified bitumen.</p> <p>Producing bitumen emulsion by mixing bitumen and water with an emulsifier (surfactant). May include hydrochloric acid.</p> <p>Manufacturing of roofing membrane by blending bitumen emulsion with asbestos (historical).</p> <p>Manufacturing and blending of aggregates with heated bitumen and other additives to make asphaltic concrete ('hot mix').</p>	<p>Spills and leaks from stored solvents, pipe leaks and/or failure, spills and slops of fuel, solvents or chemicals during delivery and decanting.</p> <p>Spills or leaks from mill or drum during blending or transfer of products (including fuel and solvent chemicals), which could result in contaminants getting on to or into the ground.</p> <p>Manufacturing and blending operations are often undertaken outside over ground that could be sealed or unsealed.</p> <p>The potential for spills or leaks from manufacturing and blending processes will be dependent on the handling factors, housekeeping and compliance with environmental and safety requirements.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, that can settle on to buildings or land.

Sub-activity and process	Description	Mechanism of contamination	Risk factors
	Cleaning of pipework and equipment following blending using organic solvent like diesel or kerosene. Could occur in a fixed batching facility or smaller facility, and could be fixed or portable.		
Waste disposal	Excess waste products during processing (including sludge). Note: it is possible to recycle asphalt and bitumen aggregates.	Deliberate tipping of waste to ground. Burial of waste (sludge or solid mixes) at disposal sites.	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Solvents (eg, kerosene, mineral turpentine)	Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation. Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.	1870s to present.	Human health effects and environmental toxicity are specific to the solvent. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the contaminant. Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered. Solvents pose a risk of vapour intrusion if a plume is close to a building.
Polycyclic aromatic hydrocarbons (PAHs) (major component of coal tar)	PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.	When gasworks were operating, potentially from the 1860s to 1970s.	Toxicity is specific to the PAH. PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.		<p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Hydrochloric acid (in bitumen emulsions)	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to its water solubility.</p>	1800s to present.	<p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>

Back to [Mineral extraction, refining and reprocessing, storage and use.](#)

E3

Cement or lime manufacture using a kiln, including the storage of wastes from the manufacturing process

HAIL activity intention

Description	<p>Cement and lime manufacturing sites are generally large, specialised industrial operations.</p> <p>Cement is used in construction as a binder that is added to aggregate, such as sand or stone, to produce mortar or concrete. It is produced by heating limestone and clay minerals in a kiln to form clinker, grinding the clinker and then adding 2 to 3 per cent gypsum. When finished, it is a dense, fine, alkaline powder.</p> <p>Lime has many uses in the environmental, metallurgical, construction, and chemical and industrial sectors. Lime is produced by crushing limestone. This crushed material is then heated to a temperature of about 900 degrees Celsius in the presence of air to obtain lime in a process known as calcination. When this is finished, quicklime is produced. This is unstable so it is either used very quickly or water is added to make slaked or hydrated lime.</p>
Applicability	<p>This category is intended to capture those processes that take place on a cement or lime manufacturing plant that may result in soil (or groundwater) contamination. Only Portland cement is, or has been, manufactured in New Zealand. Other cements (eg, containing fly ash) are imported.</p>
Contamination setting	<p>The manufacture of cement or lime does not generally involve the use of hazardous substances except fuels. The resultant cement or lime is strongly alkaline (pH 12–13) but, if released from storage, will react and convert to an environmentally benign solid as soon as it comes into contact with moisture or atmospheric carbon dioxide. Runoff water that has been exposed to cement or lime is ecotoxic to terrestrial invertebrates and aquatic organisms but is not bioaccumulative or persistent.</p> <p>Fuel and waste storage, including ash, represents the greatest risk of soil contamination.</p> <p>The manufacturing of cement includes such methods as heating, mixing, blending, milling of raw products, or the storage of cement and lime. Ground contamination can occur at any location on site where:</p> <ul style="list-style-type: none"> • fuels, oils and coal or coke, as well as any wastes used as fuel are stored, either in drums or tanks or in coal and coke storage areas. Fuel storage may include solid and liquid waste substances, including treated timber and tyres • waste products and materials, possibly including ash from coal-powered kilns, were produced, handled or disposed of to land. <p>As with many large-scale industries, it is likely that cement manufacturing sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks for liquid chemicals and fuel, electrical transformers, analytical laboratories and engineering workshops may have been present as part of a cement manufacturing site. Asbestos-containing material may be present as part of the building fabric.</p>
Exclusions	<ul style="list-style-type: none"> • Quarries that extract and store limestone rock, gypsum, clay and shale. • Production and storage of agricultural lime, which is ground limestone rock. Sites that store lime for agricultural purposes are covered by HAIL category A4. • Commercial concrete manufacturing. • Storage of packaged cement in the domestic or retail setting, or at construction sites.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage may include:</p> <ul style="list-style-type: none"> • coal or fuel oils • cement additives (principally gypsum) • bulk cement • bulk quicklime • bulk slaked lime. <p>The storage of raw products other than fuel required for the manufacturing of cement is generally considered to be benign. Storage of finished products is usually protected from the elements, because moisture will cause these products to set, and wind may create a cement dust nuisance.</p>	<p>Escape of products or partially processed material from bulk storage or during transfer for transport.</p> <p>Spillage of cement has low soil contamination potential because when in contact with water (eg, soil moisture or rainfall) it will set.</p>	<ul style="list-style-type: none"> • Types and volume of fuels and chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Manufacture	<p>The kiln could be heated by coal, oil or gas to between 1300 and 1450 degrees Celsius. The resulting clinker is then ground down to a fine powder and mixed with a small amount of gypsum, then bagged or shipped in bulk form.</p> <p>Quicklime is made by heating limestone (calcium carbonate) in a coal-fired kiln to produce calcium oxide and carbon dioxide. The resultant quicklime may then be shipped as produced or crushed. When water is added to quicklime, a strong exothermic reaction occurs that creates slaked lime (calcium hydroxide).</p> <p>Slaked lime powder is processed for size (classified) and bagged or shipped in bulk.</p>	<p>Spillage of intermediate or final products during processing.</p> <p>Cement, quicklime and slaked lime all convert to essentially benign solid substances on reacting with soil moisture and/or atmospheric carbon dioxide.</p>	<ul style="list-style-type: none"> • The volume and types of fuels and chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines, from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste disposal	<p>On-site disposal of fly ash and cement kiln dust generated from the burning of coal for the on-site kiln(s), which may contain elevated heavy metal concentrations, including thallium from the raw materials.</p>	<p>Waste disposal from these facilities could result in contamination as a result of direct burial of ash, which could leach into surrounding soils and groundwater.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Activity	Description	Mechanism of contamination	Risk factors
	The contaminant content of the fly ash will be dependent on what, if any, contaminants the fuel used contains.		

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guideline No 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Hydrocarbon fuel, lubricating oils, greases	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	1880s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011).</p>
Cement (calcium silicates, calcium aluminate, calcium aluminoferrite)	Persistence will be dependent on environmental conditions. Mobility is expected to be low because cement rapidly hydrates with water and sets to a benign solid.	1800s to present.	Risk of alkaline runoff, with short-term adverse effects on terrestrial invertebrates and aquatic organisms.
Gypsum (calcium sulfate)	Persistence depends on environmental conditions.	1800s to present.	Low hazard to environmental receptors under normal environmental conditions.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Lime (slaked lime (calcium hydroxide) and quicklime (calcium oxide))	Persistence will be dependent on environmental conditions. But is considered low because lime converts to calcium carbonate by reacting with water and atmospheric carbon dioxide.	1800s to present.	Risk of alkaline runoff, with short-term adverse effects on terrestrial invertebrates and aquatic organisms.
Metals and metalloids (eg, zinc, copper, chromium and thallium)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p> <p>Thallium is concentrated during cement manufacture, especially in the raw meal and kiln tail dust. Thallium may also be present in coal at trace element levels.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>

Back to [Mineral extraction, refining and reprocessing, storage and use](#).

E4

Commercial concrete manufacture or commercial cement storage

HAIL activity intention

Description	<p>A concrete batching plant is an industrial facility that usually has significant storage for raw materials and a mixing and batching plant. Concrete made on these sites is usually used on site, to make concrete products, or discharged to a mix truck for off-site use.</p> <p>There are two main types of concrete plants:</p> <ol style="list-style-type: none"> 1. a wet mix plant that mixes all the ingredients together, including the water, and discharges concrete into trucks for transport 2. a dry mix plant that batches the dry ingredients for bagging for retail or commercial sale, or discharges to mix trucks where water is added and the concrete is mixed in the truck. <p>Concrete products are manufactured by mixing aggregate with cement and water and forming the wet concrete into products in moulds or beds.</p> <p>Sites where concrete and concrete products are manufactured need to store cement, sand, stone, reinforcing, as well as additives, to make the products perform to specification. This includes plasticisers, waterproofing compounds and colouring.</p>
Applicability	<p>This category is intended to capture industries that manufacture concrete on a commercial scale.</p>
Contamination setting	<p>Concrete is made by mixing aggregate (sand and gravel) with Portland cement and water and allowing it to set. Cement is highly alkaline, and a skin and eye irritant as a powder, but will set and become benign when it comes into contact with soil moisture. Concrete will often have admixtures (powders or liquids) added to it in small quantities during the mixing process to improve the workability when placing and the quality of the final product. Common admixtures are accelerators, retarders, water reducers and plasticisers, air entraining agents, pigments, corrosion inhibitors and polymer bonding agents. Products such as fly ash and blast furnace slag are imported as partial replacements for cement.</p> <p>Plants may be mobile or temporary where they are set up for the construction of large structures, such as a power station, building or bridge.</p> <p>A concrete plant will likely consist of the following components:</p> <ul style="list-style-type: none"> • hoppers, tanks or bins for storing various ingredients like cement, aggregates and water • drums or tanks for storing and dispensing admixtures • machinery to accurately weigh, move, dispense and mix ingredients • facilities to dispense the mixed concrete (most likely direct to a concrete truck). <p>The manufacture of concrete does not have a high potential for soil contamination. Potential processes that may warrant further assessment could relate to the storage of hazardous substances perhaps in a workshop, use of fuel storage tanks for fleet vehicles, and waste disposal practices associated with manufacturing. Concrete manufacture has the potential for environmental effects from the discharge of alkaline wash water.</p>
Exclusions	<ul style="list-style-type: none"> • Cement storage and manufacturing (covered by HAIL activity E3). • Those areas at the manufacturing facility used to store finished concrete products (often produced at the same facility). • Use, handling and transportation of batched concrete. • Small-scale concrete making in the domestic, farm or other small-volume setting.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of cement and other raw products (including admixtures) necessary for manufacturing.</p> <p>Storage for waste-wash waters generated from cleaning concrete truck vessels.</p> <p>Possible fuel storage in underground or above-ground containers (and associated refuelling) and various chemicals and fuels associated with on-site workshops and machinery maintenance.</p>	<p>The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on several risk factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> Types and volume of fuels and chemicals, their physical form and properties, including their persistence and toxicity. The condition and weathertightness of buildings, shelters, tanks and containers. The industrial and material handling methods used. The processes and safeguards to prevent discharges. The period and frequency over which storage occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Manufacturing	<p>Generally, the primary raw materials used to make concrete, and the manufacturing processes themselves, are unlikely to represent a risk to human health.</p> <p>The commonly used admixtures are not particularly hazardous in soil. However, with the increase in the reuse of waste products (such as fly ash and blast furnace slag), the use and handling of these components needs to be assessed on a site-by-site basis.</p>	<p>Limited – spills and leaks during manufacturing of raw or processed materials on to or into the ground in such a manner that it can result in overland flow of liquids, chemicals and products to stormwater drains or surface water.</p> <p>Low – most products used in the manufacturing processes do not have a high potential for soil contamination, and production areas will be sealed.</p>	<ul style="list-style-type: none"> The volume and types of fuels and chemicals, their physical form and properties, including their persistence and toxicity. Condition of the equipment, tanks and lines from which any leaks could occur. The period and frequency over which these operations occurred. Standard of facilities and measures to mitigate or control discharges, leaks or spills. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste disposal	<p>Wastes generated at concrete manufacturing facilities may include:</p> <ul style="list-style-type: none"> wastewaters, which could include wash waters and slurry, processing waters or general site stormwater 	<p>Waste disposal from these facilities could result in contamination, as a result of:</p> <ul style="list-style-type: none"> direct burial or application of wastes to ground (excluding concrete) that contain hazardous 	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Activity	Description	Mechanism of contamination	Risk factors
	<ul style="list-style-type: none"> • waste concrete • recovered aggregate from wastewaters • disposal of used containers and other chemicals associated with other ancillary activities. <p>Modern facilities will have wash water and aggregate recycling facilities.</p>	<p>substances, which could leach into surrounding soils, groundwater or surface water</p> <ul style="list-style-type: none"> • direct application of alkaline concrete wastewaters to ground where overland flow can occur and liquids can migrate to stormwater or surface water • seepage from redundant underground structures and pits (including pipes) of fuel tanks, liquid wastes or sludge. <p>Wastewater, especially wash waters from cleaning moulds and forms, tanks, premix trucks and other equipment can be highly alkaline as a result of the cement. Alkaline soil conditions reduce nutrient availability to plants and adversely affect soil biota.</p> <p>Sediment in the waste and wash water can contain silica and other fine particulates that are hazardous in the dust that remains once the water has dried.</p>	

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Cement	Persistence will be dependent on environmental conditions. Mobility is expected to be low because cement rapidly hydrates with water and sets to a benign solid.	1800s to present.	Risk of alkaline runoff, with short-term adverse effects on terrestrial invertebrates and aquatic organisms.
Wastewater	Persistence will be dependent on the operational and environmental conditions. Mobility is expected to be high because wastewater is a liquid.	1800s to present.	Risk of alkaline runoff, with short-term adverse effects on terrestrial invertebrates and aquatic organisms.
Fly ash	Persistence and mobility will be dependent on the contaminants present and the environmental conditions and soil properties.	1800s to present. Commonly used as a partial Portland cement replacement in concrete as well as a hydraulic cement or hydraulic plaster.	Contaminants will be dependent on the source of the fly ash and the fuel it was derived from.
Admixtures Waterproofing agents, microsilica (condensed silica fume), plasticiser, retarders and accelerants, corrosion inhibitors, sealers	Persistence and mobility will be dependent on the admixtures used and the environmental conditions and soil properties.	Related to age of facility and manufacturing timeframe of products.	Varies according to the substance under consideration.

Back to [Mineral extraction, refining and reprocessing, storage and use.](#)

E5

Coal or coke yards

HAIL activity intention

Description	A coal or coke yard is essentially a distribution or wholesale centre where coal and coke are, or were, stockpiled, sorted, mechanically bagged and distributed (bagged for consumers to pick up or prepared for bulk delivery by truck or rail). These operations can take place within buildings or in open space. Machinery at the coal yard is likely to have included screens, conveyors and transportation receiving areas.
Applicability	This category is intended to cover those sites or industries, including coal mines, where coal or coke are, or were, stored and handled.
Contamination setting	<p>Coal is a sedimentary rock that consists mainly of carbon, with varying amounts of other elements, mainly sulfur, hydrogen, oxygen and nitrogen. Coal is extracted from mines both underground and opencast. Metallurgical coke is coal that is processed for a variety of industries by heating coal in the absence of air in retorts. Coke was a by-product of the coal gas manufacturing process.</p> <p>Depending on the size of coal lumps, yards may have included crushers and screens. In some cases, crushing and screening may have been done at another site, such as at the mine, before delivery of the coal.</p> <p>Historically, the materials may not have been covered, and may have been exposed to wind and rain, resulting in movement of coal and coke dust and fragments beyond the stockpile area. Modern yards will have enclosures over the coal and coke to contain coal dust, and the materials will be separated into various grades. Overall, little processing occurs (or did occur) at these sites, with the main activities being storage and handling (as detailed in the activity table below).</p> <p>Processing of coal and coke, other than screening and washing, is beyond the scope of this HAIL activity, and, for the purposes of this HAIL activity, is assumed to have been conducted at the mine site.</p> <p>The risk of significant contamination is greater at sites where crushing or washing of coal is known to have taken place at the yard, and where the yard was unsealed. Drains and flow paths may influence contaminant transport and fate.</p>
Exclusions	<ul style="list-style-type: none"> Coal stored and sold in bags at retail outlets.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Crushing	Breaking coal lumps into smaller fragments. Dust is also produced during this process and can settle below the crusher and travel on the wind and settle a distance away from the plant, depending on particle size and wind conditions.	Crushing creates coal dust, making contamination probable, especially if done where water is present. This includes sprays for dust control. Small particles of coal will have a greater surface area to volume ratio than large pieces, making contaminants contained in the coal more available for leaching.	<ul style="list-style-type: none"> • The volume and types of coal, their physical form and properties, including their persistence and toxicity. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Washing	Washing coal can take many forms, but in the context of coal yards, is mainly to remove the dust from coal in stockpiles, especially after being transported and handled.	Washing removes dust, mixing it with water, where it can leach contaminants. Slurry or runoff from coal or coke dust flow paths and drains can affect contaminant transport and fate. Small particles of coal will have a greater surface area to volume ratio than large pieces, making contaminants contained in the coal available for leaching.	<ul style="list-style-type: none"> • The volume and types of coal, their physical form and properties, including their persistence and toxicity. • Volumes of wash water generated, and water-treatment technologies. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Storage and handling	Various grades of coal and coke are and were stored in yards before being on-sold to the domestic or commercial market. At the yards, the coal or coke may be sorted and graded or it may only be stored. No chemical processing occurs at these sites.	There is a high likelihood that coal or coke dust will be generated at coal yards, and potential exists for widespread dust dispersion if proper handling and suppression methods are not employed. It is also highly likely that coal dust will be deposited and distributed on to the ground and around the area, especially if the site surface is not sealed.	<ul style="list-style-type: none"> • The volume and types of coal, their physical form and properties, including their persistence and toxicity. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills.

Activity	Description	Mechanism of contamination	Risk factors
		Leaching of chemicals from the coal or coke on to the ground as a result of rainfall. Small particles of coal will have a greater surface area to volume ratio than large pieces, making contaminants contained in the coal available for leaching.	<ul style="list-style-type: none"> Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste	<p>Coal and coke dust from handling and/or as a result of coke or coal being crushed at the bottom of stockpiles.</p> <p>Wastes generated at coal or coke yards may include:</p> <ul style="list-style-type: none"> wastewaters – including wash waters and slurry, processing waters or general site stormwater waste coal and coke. 	<p>Leaching of chemicals from the coal or coke on to the ground as a result of rainfall.</p> <p>Dust and slurry from coal or coke. Small particles of coal will have a greater surface area to volume ratio than large pieces, making contaminants contained in the coal more available for leaching.</p> <p>Waste management may have involved sweeping or hosing dust and grit from yards, clearing out drains of coal dust and disposing of the dust and sludge that has accumulated.</p>	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Hydrocarbon fuel, lubricating oils, greases	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p>	1880s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, the hydrocarbon may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	These materials have low solubility and mobility in soil and groundwater.		For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)
Sulfur and sulfur compounds	<p>Persistence and mobility are dependent on the sulfur compound present and environmental conditions and soil properties.</p> <p>Sulfur is very soluble and therefore can be highly mobile in soil.</p>	1800s to present.	<p>Sulfur in soil is not generally considered toxic.</p> <p>Excessive sulfur lowers the soil pH making the soil more acidic, which can:</p> <ul style="list-style-type: none"> • prevent nutrient uptake, limiting or preventing plant growth • increase the mobility of metals and other contaminants • corrode concrete foundations and pipes.
Polycyclic aromatic hydrocarbons (PAHs)	<p>Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	1800s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>
Metals and metalloids in coal dust	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i> .
Coal and coke	Coal and coke will be persistent. Its mobility will be dependent on environmental conditions, especially rain and wind, it is light and can be transported both as dust and in stormwater runoff. While dust is unlikely to leach down into soil, metals leached from the dust may migrate deeper into the soil profile.	1800s to present.	Coal and coke dust can reduce air quality and may contain carcinogenic compounds. Coal and coke dust may also have adverse effects on aquatic ecosystems.

Back to [Mineral extraction, refining and reprocessing, storage and use.](#)

E6

Hydrocarbon exploration or production, including well sites or flare pits

HAIL activity intention

Description	<p>This category is intended to cover onshore hydrocarbon exploration or production. The three main phases of onshore hydrocarbon extraction comprise exploration, testing and production. During any of these phases, a drill rig and flare pits may be present on the site, and more infrastructure will be added as the well moves through to the production phase. A flare pit is a pit that contains a flare, and is used for temporary storage of liquid hydrocarbons that are sent to the flare during equipment malfunction, but that are not burned. A flare pit is also used in conjunction with a gasoline plant, natural gas processing plant, pressure maintenance or repressurising plant, or a well.</p> <ul style="list-style-type: none"> • Exploration – involves undertaking a series of investigations to determine whether the resource is economically viable. During this phase, geological surveys will be completed and an exploration well(s) may be drilled if the survey results are favourable. Hydraulic fracturing (ie, opening or extending existing fractures to increase the flow of hydrocarbons, also known as ‘fracking’) may be undertaken during exploration periods. This will involve the use of hydraulic fracturing fluids. • Testing – during the testing phase, further investigations will be undertaken to confirm early findings and ultimately determine the viability of a hydrocarbon resource. • Production – subject to the exploration and testing results, this may involve the drilling of additional wells (completion of permanent drill pads), development of infrastructure, such as pipelines, processing and waste treatment facilities, and use of temporary storage tanks. Periodic hydraulic fracturing events may take place during the production period. <p>These activities are typically subject to resource consents from regional councils that address the associated environmental discharges.</p>
Applicability	<p>This activity applies to all phases of onshore hydrocarbon extraction, which include exploration, testing and production.</p>
Contamination setting	<p>When applying this category, it is important to note that contamination associated with hydrocarbon exploration and production is likely to be localised to the areas where the activities took place or where storage occurred. The potential for contamination at these sites will occur as a result of storing chemicals, handling drilling fluids and muds used or generated during exploration and production (eg, at the well site), the treatment of waste products, the use of flare pits, and the leaks and spills from storage or pipelines at production drill sites and production facilities. The potential mechanisms for contamination of soils and groundwater will be similar during the exploration and production phases and, for this reason, are grouped below under the heading ‘Drilling and production’.</p> <p>Further information relevant to this industry may be obtained from Ministry for the Environment (2014) <i>Managing Environmental Effects of Onshore Petroleum Development Activities (Including Hydraulic Fracturing): Guidelines for Local Government</i>. https://environment.govt.nz/assets/Publications/Files/managing-environmental-effects-of-onshore-petroleum-development-activities-pdf.pdf</p>

HAIL activity intention

Exclusions	<ul style="list-style-type: none"> • Geophysical survey techniques that do not involve the use of drilling, because they do not have the potential to result in ground contamination. Surveys may include the use of seismic, magnetic, gravity or other methods to look for potential hydrocarbon resources. • Activities associated with offshore oil and gas exploration and production. • Discharge of contaminants to air associated with gas extraction (eg, from controlled flaring or venting). Flaring and venting of gas is controlled (and strictly monitored) and is unlikely to result in the accumulation of hazardous substances in soils. • Exploration and mining of solid material including coal is covered by HAIL activity E7. • Refining of extracted crude oil into hydrocarbon products. • Decommissioning and well abandonment, unless there is the potential for ground contamination to result from this activity. Note: the use of cement to grout the bore is not considered to be a contaminant.
------------	--

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage containers (or excavated pits) will be on site for the:</p> <ul style="list-style-type: none"> • collection of production oil and gas • chemicals used through the drilling and/or hydraulic fracturing processes • collection of waste (cuttings, muds) and wastewaters (fracturing fluids, produced water) generated from the drilling (exploration) and production processes • oils, fuels, lubricants and other liquid materials required for the on-site infrastructure. 	<p>Spills or leaks on to or into the ground potentially resulting in soil contamination.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes.</p> <p>Potential for migration to surface-water receptors, including stormwater.</p>	<ul style="list-style-type: none"> • Types and volume of fuels and chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Drilling and production	<p>During the drilling exploration phases, chemical substances and additives will be injected into the well to improve the drilling. Many of these additives are toxic in their concentrated form; however, if used for fracturing, they will be blended on site with water and sand. These fluids will be pumped into and out of the wellheads and stored</p>	<p>Spills and leaks of liquid chemicals and fuels into and on to the ground from process locations and pipelines.</p> <p>Potential contamination of deeper soils, groundwater and surface water.</p>	<ul style="list-style-type: none"> • The volume and types of fuels and chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines, from which any leaks could occur.

Activity	Description	Mechanism of contamination	Risk factors
	<p>on site before disposal. Chemical additives will make up only a small proportion of the fracturing fluids composition. Historically, diesel-based fracturing fluids have been used.</p> <p>Drilling muds will also be used throughout the exploration phase to aid the drilling process. These muds are commonly water-based, oil-based (now rarely used) or synthetic oil-based and may contain per- and poly-fluoroalkyl substances (PFASs). Barium is used as a heavy additive in drilling mud.</p> <p>Wastewater is produced during the production phase.</p> <p>Production facilities for separating out produced water or gas, storing oil or condensate and transferring products by pipeline or into truck tankers.</p>	<p>Although rare, well failures can occur, at which time there is the potential for drilling muds and contaminants to leak (or blow out) out of the well.</p> <p>Many modern production sites are automated reducing the potential for contamination associated with handling activities.</p> <p>Potential for localised areas of contamination at source points (eg, wells, storage sources).</p>	<ul style="list-style-type: none"> • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste disposal	<p>Wastes will be generated during the exploration and production of hydrocarbons, which will require storage and treatment before disposal. Wastes may include:</p> <ul style="list-style-type: none"> • drilling muds recovered from the drilling and extraction process (will include formation fluids, chemicals introduced during drilling and potentially hydrocarbon residues) • fracturing fluids recovered • solid wastes, including drill cutting separated from muds and waste fluids • disposal of drums and containers used to store hazardous substances • flaring of gas or oil during drilling or before establishment of production facilities. <p>These wastes may be disposed of to land or could be transported to a treatment facility.</p>	<p>Seepage from discharged fluids injected to land (eg, via deep disposal wells) or from lined and unlined pits may result in groundwater contamination.</p> <p>Unburnt hydrocarbons in the base of flare pits.</p> <p>Direct burial and tipping of wastes to ground.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Hydrocarbon fuel, lubricating oils, greases	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	1880s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)</p>
Metals and metalloids (including barium)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
Sulfur and sulfur compounds	Persistence and mobility are dependent on the sulfur compound present and environmental conditions and soil properties.	1800s to present.	<p>Sulfur in soil is not generally considered toxic.</p> <p>Excessive sulfur lowers the soil pH making the soil more acidic, which can:</p> <ul style="list-style-type: none"> • can prevent nutrient uptake limiting or prevent plant growth • increase the mobility of metals and other contaminants

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	Sulfur is very soluble and therefore can be highly mobile in soil.		<ul style="list-style-type: none"> corrode concrete foundations and pipes.
PFAS (drilling muds and aqueous film forming foam (AFFF))	Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.	<p>1950s to present.</p> <p>Use of some compounds within the PFAS grouping (eg, perfluorooctanesulfonic acid (PFOS)) phased out since 2002 but others remain in common use.</p>	<p>Human toxicity not well understood.</p> <p>Some PFAS compounds are highly toxic to environmental receptors.</p> <p>Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>

Back to [Mineral extraction, refining and reprocessing, storage and use.](#)

E7

Mining industries (excluding gravel extraction), including exposure of faces or release of groundwater containing hazardous contaminants, or the storage of hazardous wastes including waste dumps or dam tailings

HAIL activity intention

Description	<p>Mine sites typically cover large areas and are complex, with multiple activities and processes.</p> <p>A mine site could include the following components.</p> <ul style="list-style-type: none"> • Mining area – the area designated for the extraction of minerals or materials via several different techniques, including opencast and underground mines. • Processing area – the area designated for the primary processing of the mineral or material without chemicals or heat. Processing can involve the crushing, screening, grinding, washing, classification, and the separation or concentration of the desired mineral or material from waste material. • Waste rock disposal areas – waste rock may contain elevated concentrations of metals. • Waste coal disposal areas – waste coal may include coal fines and wastewater from washing coal. • Tailings dams – the area designated for the disposal of the unwanted extracted material (including from tunnelling and cuttings) and excess processing wastes, which include either fine waste from primary processing or fine waste from metal extraction from ore, often deposited as a slurry. The tailings disposal location may be remote from the mine and refining locations. Tailings can be extensive in size and are often sited in valleys located near the mine site and engineered into a dammed structure. Tailings frequently have heavy metal contamination and, in some instances, may be (or may have been) used to backfill a mine.
Applicability	<p>This HAIL activity is intended to cover the processes or areas at a terrestrial mine site that could result in ground contamination from the ‘primary processes’, such as rock and ore extraction, crushing and screening. Refining of ore is not within the scope of this HAIL activity, which is mainly concerned with the extraction of material.</p>
Contamination setting	<p>Mining industries are sites where minerals are extracted from the ground. Mines can be opencast, where material is removed from pits, benches or trenches, or below ground, where shafts must be made into the earth. Mining exposes rock to air, resulting in chemical processes that change the physicochemical characteristics of the mine environment. Contaminants can be released as a result of these changes. The mined material usually needs to be processed. Processing of the mined ore can take many forms, specific to the type of mineral extracted, and other factors, although areas where processing of the mined ore occurs should be assessed against HAIL activity D4.</p> <p>The extracted ore can contain compounds and metals that are potentially hazardous if they leach to ground. The tailings dam, if not constructed to a highly engineered level, has the potential to result in widespread contamination. This is primarily because the dam contains a significant amount of extracted and processed sludge that can be highly acidic in nature. If tailings are released from containment within the tailings dam, they have the potential to generate acid mine drainage. Acid mine drainage is toxic to the environment and to humans. Acid mine drainage can occur at any area where rock is exposed to oxygen for the first time, including waste stockpiles and exposed rock faces.</p> <p>As with many large-scale industries, it is likely that mine sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, analytical laboratories, workshops, storage tanks and drums of chemicals and fuel, and electrical transformers may have been present as part of a mine site.</p>
Exclusions	<p>This category does not intend to cover:</p> <ul style="list-style-type: none"> • any ore processing and metal extraction that involves chemical refining, smelting or casting (see HAIL activity D4). • hydrocarbon exploration or processing (of liquids or gases) because this is covered by HAIL activity E6 and refining of petrochemicals, which is covered by HAIL activity A13. • gravel extraction or rock quarrying for aggregate or building stone (no likelihood of soil contamination from the gravel or rock materials but may have ancillary activities covered by other HAIL activities)

HAIL activity intention

- quarries that extract and store limestone rock and clay and shale, because these materials are benign. The storage of lime for agricultural purposes is covered by HAIL activity A4 and lime for cement purposes is covered by HAIL activity E3
- gravel and boulder tailings deposited from sluicing or dredging of alluvial placer deposits (such tailings will not result in soil contamination)
- coal storage at coal mines (see HAIL activity E5).

Activity factors – *Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.* The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Extraction and stockpiling	Storage and stockpiling of unprocessed extracted materials. These materials, once exposed to the atmosphere, could produce potentially hazardous substances if not handled and stored appropriately.	<p>Leaching of chemicals from the extracted raw materials on to the ground as a result of rainfall.</p> <p>Dust from the extracted raw materials (stockpiles and from handling).</p> <p>The potential for contamination of soil or groundwater from the storage of unprocessed stockpiled material will depend on the type of ore and rock (ie, ability to react and breakdown when exposed to the atmosphere) and the storage location.</p>	<ul style="list-style-type: none"> • The volume and types of exposed rock and soil on the site, their physical form and properties, including their persistence and toxicity. • Condition of bunds or dams from which any leaks could occur. • The period and frequency over which the mining operation occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste disposal	<p>Mine sites have the potential to generate a lot of waste products, which may include:</p> <ul style="list-style-type: none"> • disposal of large volumes of unprocessed excess materials usually into a tailings dam. If sulfide bearing minerals are present, and exposed to air and water, these materials can breakdown into sulfuric acid (which can ultimately result in acid mine drainage) • disposal of large amounts of process and mine waters increases the potential for these 	<p>Leaching of chemicals from the extracted raw materials and sludge that is disposed of at a dump site or tailings dam. (Note: an engineered tailing dam, if compromised, may still have the potential to leach contaminants.)</p> <p>Deposition of wastewaters to ground.</p> <p>Spills or leaks from degraded or damaged containers to ground.</p>	The potential for contamination from waste disposal processes at mine sites could be highly variable and will depend on the waste disposal practices and integrity of the waste disposal location (eg, tailings dam construction), both historically and currently.

Activity	Description	Mechanism of contamination	Risk factors
	chemicals to contaminate ground and surface water <ul style="list-style-type: none"> • disposal of chemical containers (eg, associated with chemical processing). 	Potential for widespread soil and groundwater contamination if poor waste handling practices are implemented.	
Chemical and fuel storage	Fuel may be stored in tanks, drums or mobile trailers.	Fuelling practices and housekeeping will affect the likelihood of fuel spills and leaks from containers.	<ul style="list-style-type: none"> • The volume and types of chemicals and fuels stored for use on the site, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (excluding chromium), especially arsenic and mercury	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	1800s to present.	Toxicity is specific to the metal, metalloid or chemical form that the element is in. Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs) .
Sulfides (in soil, can result in sulfuric acid)	Persistence and mobility are dependent on environmental conditions and soil and rock properties. When acid-generating rock is exposed to air and water, the acid generated releases metal and metalloids from the rock and increases the mobility of some metals.	1800s to present.	On exposure to air and water, sulfides in newly exposed rock begin to undergo a series of chemical reactions that produce acid mine drainage. As pH decreases, conditions become favourable for metals and metalloids to become more available.

Back to [Mineral extraction, refining and reprocessing, storage and use](#).

F Vehicle refuelling, service and repair

F1

Airports, including fuel storage, workshops, washdown areas, or fire practice areas

HAIL activity intention

Description	<p>Airports occupy large areas of land and have multiple specific activities that may result in land contamination.</p> <p>Within airport sites are multiple activities that involve hazardous substance storage and use. These activities include fuel and chemical storage, aircraft and vehicle workshops and fire-fighting practice areas. Some larger airports are operationally required to store and practice with fire-fighting chemicals, although now, fire-fighting practice exercises are not commonly undertaken on the airport.</p> <p>There are other activities servicing the aircraft that use the airport, such as refuelling and de-icing, where hazardous substances are used within less-defined areas, typically the airport apron.</p>
Applicability	<p>This activity is intended to capture the specific areas within airports where activities or incidents involving hazardous substances may result in contamination, rather than the entire airport.</p>
Contamination setting	<p>Airports comprise large, grassed and paved areas, such as runways, taxiways and aprons. Where contaminants are discharged to these areas, either accidentally or intentionally, they have the potential to directly or indirectly contaminate land and groundwater through runoff or cracks. These areas should be evaluated on a site-by-site basis based on the activities, water management facilities and maintenance practices.</p> <p>Military airports, or civilian or closed airports with past military activities particularly during World War II, may have had a wider range of activities, including storage or disposal of munitions or other military stores. The historical demolition of airport and accommodation buildings may have resulted in ground contamination. Past activities may have been located in different parts of the site from where current activities are undertaken.</p> <p>It is important to note that the bulk storage of fuel and workshop activities is likely to be limited to discrete areas of a site. Therefore, before assigning a site to this HAIL activity, check whether another HAIL activity best fits the actual site use.</p>
Exclusions	<ul style="list-style-type: none"> Vehicle parking and buildings, such as freight and passenger terminals and parking buildings, unless there is information to show these areas have been used for the storage (including the burial of wastes) of hazardous substances or had activities occurring that involved hazardous substance use in such a way that is likely to result in soil contamination.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Refuelling	<p>Refuelling aircraft with either fixed line installations or tankers.</p> <p>Lead was historically added to aviation fuel between the 1920s to 1980s. Modern aviation fuel may still contain small amounts of lead.</p>	<p>Contamination occurs through:</p> <ul style="list-style-type: none"> • spills or leaks of chemicals to ground (could occur if there were fractures on the flooring or storage took place on unsealed areas) • spills or leaks on to or into the ground (could be associated with damaged containers or from poor handling processes) at the storage location. 	<ul style="list-style-type: none"> • Types and volume of fuels, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The refuelling methods used. • Standard of facilities and measures to mitigate or control leaks or spills. • The period and frequency of refuelling. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Machinery and equipment fabrication and repair	<p>The fabrication and/or repair of machinery, parts and equipment in workshops, hangars and machine shops, involving the use of petroleum hydrocarbons, such as lubricants and solvents, hydraulic fluids and paints, and including the cutting and filing of metal components.</p>	<p>Spills, leaks or drips of liquid, gel or paste chemicals to ground.</p> <p>Machining metals that contain high levels of contaminants, such as tungsten (containing high levels of cobalt), lead and so on.</p> <p>Machining produces flakes, chips, threads or spirals of waste, often referred to as swarf. This is often covered in cutting fluid, which can drip on to ground in bins where it is stored for disposal or recycling.</p> <p>Poor condition of flooring, including slot drains, and cracks or holes in concrete. Old machine mounting holes in concrete pads or floors that have not been filled in.</p> <p>Poor housekeeping, where spills of oils, solvents and cutting fluids are not cleaned promptly.</p> <p>Use of aggressive cleaning fluids and degreasers that can penetrate or degrade concrete flooring.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals and wastes, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.

Activity	Description	Mechanism of contamination	Risk factors
Fire practice areas	<p>Use of aqueous film forming foam (AFFF) chemicals including per- and poly-fluoroalkyl substances (PFASs), specially perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) during emergency firefighting and practice.</p> <p>Hydrocarbon fuel is used in fire pits and practice areas to create the fires that replicate emergency conditions.</p>	<p>Fall-out on to ground of foams sprayed during emergencies or fire-fighting practice.</p> <p>Runoff of foams onto unsealed ground from sealed surfaces where fire-fighting practice is being conducted.</p> <p>Soakage into ground of hydrocarbon fuel applied to objects or the ground to be set alight during fire-fighting practice.</p> <p>The chemicals used in film-forming foams (PFAS) are persistent and highly soluble. Small volumes of PFAS-containing product can cause widespread, low concentration contamination of groundwater and down-gradient plumes, and of surface-water receptors. Similarly, hydrocarbon fuels may cause localised high-concentration contamination with concentrated liquids in and around fire-fighting locations.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. • The period and frequency over which these practice exercises occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of sprays, which can settle on to buildings or land.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
Hydrocarbon fuel (including petrol, aviation kerosene (Jet A1 and military equivalents) and diesel for fuelling airport vehicles) and lubricating oils	<p><i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i></p> <p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on</p>	<p><i>Assists identification of whether, and the length of time, a contaminant may have been in use</i></p> <p>1880s to present.</p>	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	<p>environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>		<p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)</p>
Metals and metalloids (iron, aluminium, copper, lead, cobalt, lead and zinc)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
<p>Per- and poly-fluoroalkyl substances (PFASs)</p> <p>Aqueous film forming foam (AFFF) chemicals, used in firefighting, and in particular PFAS compounds (eg, perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and related compounds)</p>	Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.	<p>1950s to present.</p> <p>Use of some compounds within the PFAS grouping (eg, PFOS) phased out since 2002 but others remain in common use.</p>	<p>Human toxicity is not well understood.</p> <p>Some PFAS compounds are highly toxic to environmental receptors.</p> <p>Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>
Polycyclic aromatic hydrocarbons (PAHs)	PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.	1800s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	<p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>		<p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>
Solvents (including chlorinated) (used for cleaning)	<p>Highly mobile in soils, generally low persistence in soils because volatile.</p> <p>Chlorinated solvent vapours are denser than air and can collect in confined spaces, such as basements or excavations.</p> <p>Some chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater, depending on groundwater conditions. Degradation products may also persist.</p>	1940s to present.	<p>Toxicity is specific to the solvent. Chlorinated solvents are generally toxic, and many are carcinogenic. Exposure pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion.</p> <p>Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water.</p> <p>When in groundwater, DNAPL sinks through the water column and only stops when a limiting layer of rock or clay is encountered, where it can remain for years or decades as it slowly breaks down. The break down products can be more persistent and toxic than the original solvent, for example, perchloroethylene (PCE) degrading to vinyl chloride.</p>

Back to [Vehicle refuelling, service and repair](#).

F2

Brake lining manufacturers, repairers or recyclers

HAIL activity intention

Description	Brake lining manufacture, repair or recycling is a specialist industrial process and will likely be undertaken in an industrial setting. These activities have typically been undertaken by small specialist companies in medium to small industrial premises.
Applicability	This category is intended to capture those industries that manufacture, repair or recycle brake (and clutch) linings and pads for machinery (including motor vehicles). The friction material used in brakes and clutches may contain hazardous substances.
Contamination setting	<p>Brake linings and pads are the consumable components of brakes, which include drum brakes and disc brakes and friction clutches. There is a large variation in friction material composition. Brake linings and clutch parts need to be able to tolerate high temperatures and friction and, because of this, asbestos (chrysotile) was recognised as a good product for use in the friction material. However, due to the risks of working with asbestos, it has been replaced with other fibres such as the synthetic aramids like Kevlar. Asbestos use has been banned and is no longer used in friction material in New Zealand. However, cars made before 1990 with original brake and clutch components are a risk.</p> <p>Most manufacturing or repairs involve machining processes, such as drilling, grinding, milling, bonding and cutting. Storage of hazardous substances will usually also occur at these types of sites. Many older sites will have used friction material incorporating asbestos fibres. Machining, housekeeping and waste disposal can result in asbestos fibres spreading throughout the workshop, as well as the curtilage of the building, and possibly further.</p>
Exclusions	<ul style="list-style-type: none">• The general servicing, bleeding, removal and replacement of vehicle brake pads, disks, drums and clutches.• Facilities that stock and retail brakes and clutches parts, where the friction material was applied by the parts manufacturer.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage and use of hydraulic fluids (including brake fluid)	Storage of fluids in containers. Brake fluids and oils could be leaking on old brake linings and therefore may be encountered during reconditioning.	Spills or leaks on to or into the ground. The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on several factors, such as the condition of containers, volume of material stored, layout and construction of the storage area, and general housekeeping practices.	<ul style="list-style-type: none"> Types and volume of fluids, their physical form and properties, including their persistence and toxicity. The condition and weathertightness of buildings, shelters, tanks and containers Standard of facilities and measures to mitigate or control leaks or spills. The period over which storage has occurred and the frequency with which stocks are replenished. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Machinery and equipment maintenance, fabrication and repair	The maintenance, fabrication and/or repair of machinery, parts, equipment in workshops, machine shops; involving the use of petroleum hydrocarbons, such as lubricants and solvents, hydraulic fluids, paints, and including the cutting and filing of metal components.	Spills, leaks or drips of liquid, gel or paste chemicals to ground. Cutting fluid can drip or spray away from where it is intended, on to the floor beside the machine. Use of aggressive cleaning fluids and degreasers that can penetrate or degrade concrete flooring. Flooring, including slot drains, and cracks or holes in concrete. Old machine mounting holes in concrete pads or floors that have not been filled in. Machining metals that contain high levels of contaminants. Machining produces flakes, chips, threads or spirals of waste, often referred to as swarf. This is often covered in cutting fluid, which can drip on to ground in bins where it is stored for disposal or recycling. Over time, significant contamination can result if there is a complete contaminant pathway.	<ul style="list-style-type: none"> The volume and types of chemicals and wastes, their physical form and properties, including their persistence and toxicity. Condition of the equipment, tanks, lines and nozzles from which any leaks could occur. The period and frequency over which these operations occurred. Standard of facilities and measures to mitigate or control discharges, leaks or spills. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Machining (including milling, grinding and drilling of friction materials)	Removing worn friction material and machining newly installed friction material on brake shoes may liberate fibres or particles, including asbestos.	Poor control of dust generated during machining. Unless carefully controlled, dust liberated by machining has the potential to migrate within the building and outside,	<ul style="list-style-type: none"> The volume and types of friction materials and wastes generated, their physical form and properties, including their persistence and toxicity.

Activity	Description	Mechanism of contamination	Risk factors
	Installing and machining friction material.	through vents, windows and doors, as well as enter ventilation systems.	<ul style="list-style-type: none"> • Condition of the equipment, tanks, lines and nozzles from which any leaks could occur. • The period and frequency over which these operations occurred. • Standard of facilities and measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air, particularly of dust or heavy particles, which can settle on to buildings or land.
Waste disposal and recycling	<p>Temporary storage and disposal of worn brake linings.</p> <p>Collection, temporary storage and disposal of friction material dust from repair or recycling.</p> <p>Collection, temporary storage and disposal of brake fluid residues.</p>	<p>Deliberate tipping of waste liquids to ground.</p> <p>Burial of waste at disposal sites.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p> <p>Note: asbestos-containing waste must be disposed of to a landfill that is consented to accept this type of material.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Asbestos fibres	Asbestos is a mineral and is very persistent. Mobility of fibres is affected by environmental conditions, such as soil characteristics and weather.	<p>1900s to present.</p> <p>Asbestos-containing material is no longer produced but is still present in many buildings and structures.</p>	Asbestos is a proven human carcinogen, and all forms of asbestos can cause cancer. The main way people are exposed to asbestos is by breathing in air that contains asbestos fibres.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			<p>Asbestos causes cancer in a dose-dependent manner. The greater the exposure, and the longer the time of exposure, the greater the risk of developing an asbestos-related disease.</p> <p>No 'safe' lower limit of exposure has been identified with certainty – all exposure is thought to add to the overall risk of disease development – but the risk from a single, low-level exposure is considered to be extremely low.</p> <p>Further information is available in BRANZ (1997) <i>New Zealand Guidelines for Assessing and Managing Asbestos in Soil</i>.</p>
Fibres (including glass and potassium titanate)	Persistent and mobile in air when disturbed.	Unknown.	The risks associated with fibres vary according to the specific substances used. Fibres generally present an inhalation hazard.
Metals and metalloids (eg, zinc, selenium, copper, iron)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Solid lubricants (graphite and metal sulfides)	<p>Persistence and mobility are dependent on components of the lubricant. Graphite lubricants can contain several solvents, including heptane, butanol, propanol, toluene, benzene and ethylbenzene. The metals contained in metal sulfide lubricants include molybdenum and lithium.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	Early 1900s to present.	<p>Toxicity is specific to the lubricants used. The toxicity of the lubricants ranges from high to low human toxicity.</p> <p>These lubricants can be toxic to aquatic life, some with potentially long-lasting effects.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Fillers (vermiculite and barites)	<p>Persistence and mobility are dependent on components of the filler and the environmental conditions and soil properties. But fillers are generally persistent and immobile. Barite fillers may contain barium sulfate and crystalline silica.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	Early 1900s to present.	The toxicity of the fillers is specific to the components. Crystalline silica is known to be a carcinogen.
Hydraulic and brake fluids (mineral oils, polymerised glycols and ethers)	<p>Persistence and mobility are dependent on components of the fluids and the environmental conditions and soil properties.</p> <p>The various grades of hydraulic and brake fluids have different formulations.</p> <p>Brake fluids include:</p> <ul style="list-style-type: none"> • DOT 2: castor oil or alcohol based • DOT 3 fluids: glycol ether based • DOT 4 fluids: mixtures of glycol ether and borate ester • DOT 5 fluids: silicone based • DOT 5.1 fluids: borate ester with glycol ether. 	1900s to present.	Many hydraulic and brake fluids contain constituents that may be toxic and ecotoxic, although the toxicity of individual substances varies.

Back to [Vehicle refuelling, service and repair.](#)

F3

Engine reconditioning workshops

HAIL activity intention

Description	Engine reconditioning workshops are specialist engineering facilities. Engine reconditioning (or remanufacturing) is the practice of removing worn components from internal combustion engines, repairing or replacing them with new or refurbished parts and reassembling the engine, so that the engine meets the original specification and performs as new. They are likely to be small to medium sized enterprises undertaken within an industrial setting.
Applicability	This category is intended to capture those industries that recondition motor engines. Reconditioning includes the replacement or repair (overhauling) and rebuilding of specific parts. Repairs to parts include cutting, machining, grinding, sanding, welding and polishing. Parts may be repaired or rebuilt in the workshop or sent to specialist tradespeople.
Contamination setting	<p>The activities involved in reconditioning engines include machining the cylinder head, honing, boring and sleeving or lining cylinders, replacing worn bearings, piston heads and other worn mechanical components, replacing gaskets, hoses and other perishable fittings. Worn metal surfaces may need to be built up by additive welding and shaped by milling or machining.</p> <p>Common activities include metal working processes (turning, grinding, polishing), use and storage of hazardous substances and waste disposal.</p> <p>The processes are similar to those that may be undertaken in any engineering workshop, but this category specifically addresses engine reconditioning workshops.</p> <p>For detailed information about engine additives, see HAIL activity F7.</p> <p>Note the overlap with HAIL activity A17 and/or activity A2, depending on the substance and volume stored.</p>
Exclusions	<ul style="list-style-type: none">• Workshops that are used to repair, maintain or fabricate machinery other than engines.• Automotive servicing workshops.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage and use of liquid contaminants within a workshop, either held in stock for use or as waste, including:</p> <ul style="list-style-type: none"> lubricating and cutting fluids used with workshop machinery and on parts or equipment being fabricated or repaired fuel for workshop machinery and equipment cleaning substances and solvents, used to clean and degrease machinery and parts metal preparation and finishing chemicals, such as pickling paste, rust remover, primers and paints, and specialist chemicals for a range of purposes. <p>Underground or above-ground storage of fuels, brake fluid (hydraulic fluids), chemical solvents, cleaning fluids, lubricating oils, coolants and other chemicals used in the workshop.</p>	<p>Spills or leaks of liquid, paste or gel chemicals to ground could result from poor storage practices, degradation of chemical containers and associated pipework and valves. Potential for contaminants to reach groundwater or surface water.</p> <p>The accumulation and deposition to ground of solid metal fragments.</p> <p>Contamination from the storage of various chemicals, liquids, oils and metal parts at engineering workshop sites will vary, depending on the storage facility (eg, presence or absence of ground seal), and poor housekeeping will increase the risk of leaks, spills and slops from handling hazardous substances, both present and historic.</p> <p>Corrosion of an underground or above-ground storage tank.</p> <p>The solvents used in processes have the potential to melt transfer and drainage pipework. Surface or subsurface leaks from failed pipework have the potential to discharge contaminants directly to soil. Solvents also pose a risk of vapour intrusion if a plume is close to a building.</p>	<ul style="list-style-type: none"> Types and volume of fluids and chemicals, their physical form and properties, including their persistence and toxicity. The condition and weathertightness of buildings, shelters, tanks and containers. The industrial and material handling processes used and the processes and safeguards to prevent discharges. The period and frequency over which storage occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Machinery or equipment repair	<p>The reconditioning of engines in workshops.</p> <p>Engine reconditioning involves numerous processes that may result in contaminants landing on the ground, such as:</p> <ul style="list-style-type: none"> cutting, grinding, filing or sanding milling, lathing, drilling or honing joining, welding, soldering. <p>General machining practices may include welding, fitting and various machining techniques.</p> <p>Most machining practices require a lubricating or cutting fluid, gel, paste or aerosol to be used. These can be applied in several ways, which might include</p>	<p>Generally, the reconditioning activities will be conducted within built structures with sealed floors. In these situations the potential for contamination of the ground for solid materials is negligible and low for liquids, unless the integrity of the sealed floors is poor allowing soakage through cracks. Spills, leaks or drips of liquid, gel or paste chemicals to ground.</p> <p>Cutting fluid can drip or spray away from where it is intended, on to the floor beside the machine.</p> <p>Machining produces flakes, chips, threads or spirals of waste, often referred to as swarf. This is often covered in cutting fluid, which can drip on to ground in bins where it is stored</p>	<ul style="list-style-type: none"> Types and volume of materials to be machined, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. Condition of buildings, equipment, storage vessels, lines and pipework. The standard of the facilities and measures to mitigate or control leaks, discharges or spills. The industrial and material handling processes used and the processes and safeguards to prevent discharges.

Activity	Description	Mechanism of contamination	Risk factors
	<p>flooding, spraying, dripping, misting or brushing. In modern operations, these fluids are collected and reused many times before being recycled.</p> <p>Processes involving the use of petroleum hydrocarbons, such as lubricants and solvents, including the cleaning, degreasing, cutting, machining and grinding of metal components, and the draining and refilling of motors.</p> <p>Draining and refilling of cooling and hydraulic systems.</p> <p>Modern engine reconditioning facilities are increasingly becoming automated, with many operations also undertaken robotically. However, an engineering workshop may have a long history in one place and may have been upgraded over time. The layout of the site in the past and the workshop housekeeping and engineering practices that have changed over time will have a significant impact on the contamination potential of the site.</p> <p>Modern facilities will be located within specialist buildings and rooms with sealed floors and a high standard of cleanliness.</p>	<p>for disposal or recycling. Over time, significant contamination can result if there is a complete contaminant pathway.</p> <p>Poor condition of flooring, including slot drains, and cracks or holes in concrete. Old machine mounting holes in concrete pads or floors that have not been filled in.</p> <p>Poor housekeeping, where spills of oils, solvents and cutting fluids are not cleaned promptly.</p> <p>Use of aggressive cleaning fluids and degreasers that can penetrate or degrade concrete flooring.</p> <p>Machining metals that contain high levels of contaminants, such as cadmium and lead.</p>	<ul style="list-style-type: none"> • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>Disposal of surplus or used fluids (eg, lubricants, solvents, coolants, fuels, hydraulic fluids).</p> <p>Disposal of metal swarf or unserviceable parts.</p> <p>Disposal of damaged, surplus and obsolete equipment and waste.</p>	<p>Deliberate tipping of waste to ground. Spills or leaks from degraded or damaged containers or bunds. Burial of waste at disposal sites.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guideline 5 – Section 3 Conceptual site Model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids (eg, lead, cadmium, iron)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Chlorinated solvents (including trichloroethene (TCE) and 1,2-dichloroethene or dichloroethylene (DCE)) possibly used to clean parts in workshops or machinery in situ	<p>Highly mobile in soils, generally low persistence in soils because they are volatile.</p> <p>Chlorinated solvent vapours are denser than air and can collect in confined spaces, such as basements or excavations.</p> <p>Some chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater, depending on groundwater conditions. Degradation products may also persist.</p>	<p>Perchloroethylene (PCE): 1930s to present.</p> <p>TCE: 1930s to present.</p> <p>Tetrachloromethane: 1890s to 1950s.</p>	<p>Toxicity is specific to the solvent. Chlorinated solvents are generally toxic, and many are carcinogenic. Exposure pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion.</p> <p>Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water.</p> <p>When in groundwater, DNAPL sinks through the water column and only stops when a limiting layer of rock or clay is encountered, where it can remain for years or decades as it slowly breaks down. The break down products can be more persistent and toxic than the original solvent, for example, PCE, degrading to vinyl chloride.</p>
Petrol, diesel (including benzene, toluene, ethylbenzene, xylene (BTEX) in petrol)	<p>Persistence will be dependent on environmental conditions and soil properties.</p> <p>Liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
			<p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)</p>
<p>Lubricating oils</p> <p>Oils and greases (eg, lubricating oils for machines)</p>	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	<p>Late 1800s to present.</p>	<p>These materials have low human toxicity.</p> <p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Detergents, anti-oxidants, metals and metalloids are among additives in lubricating oils to enhance performance.</p>
<p>Polycyclic aromatic hydrocarbons (PAHs)</p>	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	<p>Late 1800s to present.</p>	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>
<p>Urea (diesel exhaust fluid)</p>	<p>Urea is not persistent, it is taken up by plants or transforms to other nitrogen compounds in soil, including gaseous nitrogen. However, it is highly mobile and readily leaches to groundwater.</p>	<p>1900s to present.</p>	<p>Urea has a low human toxicity.</p> <p>Urea has low toxicity to aquatic organisms but can foster excessive growth of algae.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Ethylene glycol (antifreeze)	Ethylene glycol is not persistent in soil it readily biodegrades. Liquid and therefore highly mobile. However, its mobility will also be dependent on environmental conditions and soil properties.	1920s to present.	Ethylene glycol has moderate human toxicity. The aquatic toxicity of ethylene glycol is low. However, it can decrease dissolved oxygen in waterbodies.

Back to [Vehicle refuelling, service and repair](#).

F4

Motor vehicle workshops

HAIL activity intention

Description	<p>Motor vehicle workshops serve to maintain and repair the mechanical parts of motor vehicles. These workshops are common in New Zealand and usually undertaken in small to medium industrial and commercial buildings.</p> <p>Primary activities include replacing broken or worn parts, carrying out minor repairs and removing and replacing fluids, such as hydraulic fluids, lubricating oils, grease and radiator coolant. Limited engineering takes place, although some drilling, welding and machining may be done.</p> <p>These workshops are often associated with car dealerships and older service stations.</p>
Applicability	<p>This category is intended to capture sites that are or were used historically as motor vehicle workshops. That is, commercial sites where motor vehicles have been serviced and repaired, and ancillary storage of hazardous substances has occurred.</p> <p>It is possible that some motor vehicle workshop sites encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, engineering workshops (where metal fabrication occurs) storage of chemicals, fuel and waste in tanks and drums, and engine reconditioning may have been present or taken place as part of a motor vehicle workshop.</p>
Contamination setting	<p>Motor vehicles include motorcycles, cars, trucks, buses and other heavy motorised vehicles, such as earthmoving and roadmaking plant. The primary concern is contamination of soil by hazardous liquids, including oils, clutch and brake fluids and coolants.</p> <p>Oil and filter changing, and replacing coolant are the most common work done on motor vehicles. Oil can be spilled on the floor, and oily parts may be stored outside the building on the ground. Spilled fluids can flow from concrete pads to drains.</p> <p>There may also have been potential for inappropriate disposal of solid or liquid wastes generated from servicing and repair. The solid wastes include unserviceable parts and brake and clutch dust, which may contain metals (zinc, copper) and historically asbestos.</p> <p>Runoff can wash solid and liquid contaminants to drains or unsealed ground.</p>
Exclusions	<ul style="list-style-type: none"> • Fuel storage and refuelling. • Storage of retail packs of various hazardous substances within shops attached to the workshop. • Residential properties where the land owner maintains their own vehicles.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of vehicles with oil or other fluid leaks.</p> <p>Drummed storage of hydraulic fluids, chemical solvents, cleaning fluids, lubricating oils, coolants, additives and other chemicals used in the workshop.</p> <p>Underground or above-ground storage of waste oil.</p> <p>Outside storage of used lead–acid batteries.</p> <p>Outside storage of used tyres.</p>	<p>Storage of new parts, lubricants, solvents and fluids is usually within buildings with sealed floors.</p> <p>Spills or leaks on to or into the ground.</p> <p>Degradation of an underground or above-ground storage tank.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p>	<ul style="list-style-type: none"> • Types and volume of oils and chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Machinery or equipment repair	<p>The servicing and repair of engines, running gear, suspension and other vehicle parts. Processes may include:</p> <ul style="list-style-type: none"> • washing and cleaning of vehicles, parts, equipment and work areas with steam cleaners, solvents and degreasers • draining and refilling of fuel tanks, lubricating systems, cooling systems and hydraulic systems • removing and replacing friction material in brakes and clutches • cutting, machining, grinding, polishing and welding metal parts. <p>Workshop locations to be aware of may include:</p> <ul style="list-style-type: none"> • parts wash and degreasing baths • inspection pits 	<p>Generally, the main workshop activities are conducted within buildings with sealed floors.</p> <p>The potential for contamination of the ground depends on housekeeping practices, the integrity of sealed floors and the substances present.</p> <p>Motor vehicle maintenance activities may have been performed outdoors on unsealed ground historically, and heavy plant maintenance may still be done outdoors.</p> <p>Spills or leaks of liquid contaminants on to ground.</p> <p>Fall-out of solid contaminants (eg, metal filings, brake dust) on to the ground.</p>	<ul style="list-style-type: none"> • Types and volume of materials to be machined, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which the workshop activities occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
	<ul style="list-style-type: none"> mechanical hoists using hydraulic oils, lines for which could be located underground machine shops. 		
Waste disposal	<p>Disposal of surplus or used chemicals (eg, lubricants, coolant and solvents associated with vehicle servicing).</p> <p>Disposal of damaged, surplus and obsolete equipment, and waste.</p>	<p>Deliberate storage or tipping of waste on the ground (including solids such as used parts).</p> <p>Leaks or overflows from underground or above-ground waste oil storage.</p> <p>Potential burning of waste and generation of ash residues.</p> <p>Spills or leaks from degraded or damaged containers.</p> <p>Burial of waste at disposal sites.</p> <p>Drums of waste oil stored outdoors may leak over time, contaminating soil and surface-water runoff.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p>	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	<i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	
Metals and metalloids	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	Metals and metalloids can be found deeper in the soil profile.		Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs) .
Solvents (including benzene, toluene, ethylbenzene and total xylene (BTEX), acetone, ketones, kerosene)	<p>Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on contaminant.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some solvents can degrade or dissolve drainage pipework. Surface or subsurface leaks from failed pipework have the potential to discharge contaminants directly to soil. Solvents also pose a risk of vapour intrusion if a plume is close to a building.</p>
Chlorinated solvents (including trichloroethene (TCE) and 1,2-dichloroethene or dichloroethylene (DCE)), possibly used to clean parts in workshops or machinery in situ.	<p>Persistence will be dependent on the solvent, environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>The solvents used in the workshops have the potential to melt transfer and drainage pipework. Surface or subsurface leaks from failed pipework have the potential to discharge contaminants directly to soil. Solvents also pose a risk of vapour intrusion if a plume is close to a building.</p>	1800s to present.	<p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on the specific substance.</p> <p>Human health effects and environmental toxicity are specific to the solvent. Their use has declined due to their toxicity.</p> <p>Chlorinated solvents are toxic, and some are considered carcinogenic.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on solvent.</p> <p>Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water.</p> <p>When in groundwater, DNAPL sinks through the water column and only stops when a limiting layer of rock or clay is encountered, where it can remain for years or decades as it slowly breaks down. The break down products can be more persistent and toxic than the original solvent, for example, perchloroethylene (PCE) degrading to vinyl chloride.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Petrol, diesel (including BTEX in petrol)	<p>Persistence will be dependent on environmental conditions and soil properties.</p> <p>Liquid and therefore highly mobile. However, mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011).</p>
Lubricating oil Oils and greases (eg, lubricating oils used for maintenance)	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials have low human toxicity.</p> <p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Detergents, anti-oxidants, metals and metalloids are among additives in lubricating oils to enhance performance.</p>
Polycyclic aromatic hydrocarbons (PAHs)	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	<p>1800s to present.</p> <p>Present as a component of diesel fuel and formed during combustion. May be present in or on engine components.</p>	<p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Urea (diesel exhaust fluid)	Urea is not persistent, it is taken up by plants or transforms to other nitrogen compounds in soil, including gaseous nitrogen. However, it is highly mobile and readily leaches to groundwater.	1900s to present.	Urea has low human toxicity. Urea has low toxicity to aquatic organisms but can foster algae growth.
Ethylene glycol (antifreeze)	Ethylene glycol is not persistent in soil, it readily biodegrades. Liquid and therefore highly mobile. However, its mobility will also be dependent on environmental conditions and soil properties.	1920s to present.	Ethylene glycol has moderate human toxicity. The aquatic toxicity of ethylene glycol is low. However, it can decrease dissolved oxygen in waterbodies.

Back to [Vehicle refuelling, service and repair](#).

F5

Port activities, including dry docks or marine vessel maintenance facilities

HAIL activity intention

Description	<p>Port activities include passenger and cargo ports and/or marine sites, including graving and dry docks, marinas, marine storage terminals and wharf facilities that may result in ground, sediment and/or water contamination that is not expressly covered by other HAIL categories.</p> <p>Ports are sites where ships berth to load or unload goods and passengers, refuel and undergo maintenance. These facilities are usually accompanied by areas where bulk storage of solid and liquid products can be undertaken either within large warehouses or outside.</p> <p>A graving dock, sometimes called a graving dry dock or just dry dock, is normally constructed on land near the coastal waters with a rectangular solid concrete construction with blocks, walls and gates. The vessel is shifted inside the dry dock and rested on the blocks. After the ship is in the required position, the gate is closed, the water removed and maintenance or repairs undertaken.</p> <p>Grids and slipways are where boats are hauled out and maintained or cleaned. Maintenance of vessels includes cleaning, scraping, sanding, blasting, painting or antifouling of the vessel's hull and accessing equipment that cannot be reached under normal conditions This can release organic pesticides and heavy metals in antifoul paints on to land.</p>
Applicability	<p>This category is intended to cover those activities that take place at ports and marine facilities that have the potential to cause soil contamination.</p> <p>Ports where ships can dock and load or offload cargo on to a wharf may discharge contaminants to land and/or water. This could include the contents of shipping containers damaged in transit or during handling.</p> <p>As with many large-scale industries, it is likely that it encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks for chemicals and fuels, electrical transformers and water and waste treatment facilities, reclamation using contaminated materials and dredged materials may have been part of port facility operations.</p>
Contamination setting	<p>Common activities include fuel storage, workshop activities involving hazardous substance storage and use, such as solvents and paints, and storage of bulk products on the ground (eg, stockpiled raw materials, treated timber, coal). At some larger ports, where there is bulk fuel storage and associated pumping and distribution infrastructure, sometimes referred to as 'tank farms', fire-fighting chemicals (including per- and poly-fluoroalkyl substances (PFASs)) may also be stored.</p> <p>Military ports may have had a wider range of activities, which may have included the storage and/or disposal of munitions or other military stores.</p>
Exclusions	<ul style="list-style-type: none"> • Port reclamation and disposal of dredged material. • Sites constructed to treat products using gaseous fumigants, for example, methyl bromide. • Maintenance of ships and boats on slipways.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Fuel storage is covered by either HAIL activity A13 for bulk storage or activity A17 for smaller quantities.</p> <p>Other storage may include:</p> <ul style="list-style-type: none"> • storage of solvents, paints and other chemicals used in marine operations and maintenance and/or in workshops • storage of chemicals used for firefighting at locations where fire-fighting systems may be present • storage of bulk products containing hazardous substances for import or export. 	<p>Spills and leaks of liquid chemicals and fuels into and on to the ground from tanks.</p> <p>Residues leaking from empty drums stored without seals, or improperly sealed full drums.</p> <p>Direct deposition and leaching of contaminants from bulk storage of materials.</p> <p>Potential contamination of deeper soils and groundwater (and surface water).</p> <p>Modern facilities might be fully sealed, with bunds, impermeable liners and remote monitoring systems.</p> <p>The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on several risk factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period and frequency over which storage occurred. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or powder). • Maintenance of facilities and structures.
Cargo handling	<p>Cargo is loaded and offloaded from wharves. This includes hazardous substances and dangerous goods.</p> <p>Liquid cargo may be transferred to shore by specialised terminals, including pressurised pipes and connection points, both on the shore and on jetties or other structures.</p>	<p>If the contents of a container leak on to the wharf, the spill could enter surface drains.</p> <p>Failure of pipework or associated infrastructure may result in spills of significant volumes of whatever substance is being transferred. This is usually associated with liquid hydrocarbon products, including fuels and oils.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period and frequency over which handling occurred. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or powder).
Refuelling	<p>Refuelling for ships or at marine stops is covered by category F7. Note, only refuelling activities that can contaminate soil are relevant, such as fuel transfer</p>	<p>Spills and leaks during transfer of product as a result of faulty valve handling, not properly connecting hoses and overfilling.</p>	<ul style="list-style-type: none"> • The volume and types of fuels, their physical form and properties, including their persistence and toxicity. • The period and frequency over which refuelling occurred.

Activity	Description	Mechanism of contamination	Risk factors
	<p>operation over land (valve and pump stations, pipelines, road tankers).</p> <p>Spillage into water from refuelling operations that contaminates soil elsewhere, for example, a beach above the high tide mark, is covered by category H.</p>	<p>Damage to above-ground (or below-ground) pipelines due to deterioration or accident.</p> <p>Potential for leaks in pipework to result in soil contamination if located in or above ground, which may result in groundwater contamination. Spills or leaks could directly reach the receiving body (eg, harbours).</p> <p>Modern safer refuelling practices are generally now implemented but accidents still occur.</p>	<ul style="list-style-type: none"> • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Maintenance repairs	<p>Maintenance and repairs of marine vessels and port infrastructure may also take place. There could be engineering workshops at the port for, or to support, this purpose. These sites should be assessed, to see whether they meet the threshold for being recorded under other HAIL activities.</p>	<p>Deposition of hull cleaning residues on to or into the ground or surface water creating potential for marine sediments and surface-water contamination.</p> <p>Spills or leaks of hazardous liquids on to or into the ground or surface water potentially resulting in soil and/or water contamination.</p> <p>Potential for migration to groundwater (and nearby surface water) and formation of down-gradient plumes, if enough product is released.</p> <p>Historically, maintenance repair works would have been undertaken outside at locations that were generally unsealed.</p> <p>Modern facilities are more likely to have sealed ground and will have protocols to capture spills or leaks of hazardous substances.</p>	<ul style="list-style-type: none"> • Types and volume of materials to be used for maintenance or repairs, for example, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. • Condition of buildings and port equipment. • The standard of facilities and measures to mitigate or control leaks, discharges or spills.
Waste disposal	<p>Disposal of residues, including paint residues, from hull scraping, water blasting and abrasive blast cleaning.</p> <p>Disposal of used containers of oils and paints and other chemicals used in the workshop.</p> <p>Disposal of old or damaged machinery and parts.</p> <p>Disposal of used oils and fuels during maintenance and repair works.</p>	<p>Waste disposal from these facilities could result in widespread contamination, as a result of:</p> <ul style="list-style-type: none"> • direct burial of wastes and sludge, which could leach into surrounding soils and groundwater • direct application of liquid and solid wastes to ground could result in surface soil contamination and migration to deeper soils and groundwater, as well as sediment and surface-water contamination. 	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Activity	Description	Mechanism of contamination	Risk factors
		<ul style="list-style-type: none"> seepage from redundant underground structures and pits (including pipes) and damaged and degraded above-ground storage containers of liquid wastes or sludge. 	
Fire practice areas	<p>Use of aqueous film forming foam (AFFF) chemicals including per- and poly-fluoroalkyl substances (PFASs) specially perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) during emergency firefighting and practice.</p> <p>Hydrocarbon fuel is used in fire pits and practice areas to create the fires that replicate emergency conditions.</p>	<p>Fall-out on to ground of foams sprayed during emergencies or fire-fighting practice.</p> <p>Runoff of foams on to unsealed ground from sealed surfaces where fire-fighting practice is being conducted.</p> <p>Soakage into ground of hydrocarbon fuel applied to objects or the ground to be set alight during fire-fighting practice.</p> <p>The chemicals used in film-forming foams (PFASs) are persistent and highly soluble. Small volumes of PFAS-containing product can cause widespread, low concentration contamination of groundwater and down-gradient plumes, and of surface-water receptors.</p> <p>Similarly, hydrocarbon fuels may cause localised high-concentration contamination with concentrated liquids in and around fire-fighting locations.</p>	<ul style="list-style-type: none"> The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. Condition of the equipment, tanks, lines and nozzles, from which any leaks could occur. The period and frequency over which these practice exercises occurred. Standard of facilities and measures to mitigate or control discharges, leaks or spills. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Discharges to air, particularly of sprays, which can settle on to buildings or land.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Persistent?	Period of use	General Comments
<p>Polycyclic aromatic hydrocarbons (PAHs)</p> <p>Component of crude oil, heavy fuel oils (bunker oil) and distillates, such as diesel and fuel oils</p>	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p>	<p>Throughout life of gasworks, potentially from the 1860s to 1970s.</p>	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p>

Key contaminant of concern	Persistent?	Period of use	General Comments
	<p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>		<p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
<p>Hydrocarbon fuel (including petrol, aviation kerosene (Jet A1 and military equivalents), diesel for fuelling airport vehicles and lubricating oils)</p>	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	<p>1880s to present.</p>	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand</i> (revised 2011)</p>
<p>Metals and metalloids (iron, lead, tin, nickel, copper, magnesium, zinc, aluminium, chromium, including chromium VI, cadmium, silver, manganese and so on)</p>	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	<p>1800s to present.</p>	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>

Key contaminant of concern	Persistent?	Period of use	General Comments
Tributyltin (TBT) (used in antifouling paint)	<p>TBT is persistent in soils and sediments. TBT has a low water solubility and lipophilic character, it adsorbs readily onto particles.</p> <p>Persistence and mobility are dependent on environmental conditions and media properties.</p> <p>TBT bioaccumulates in organisms because of its solubility in fat.</p>	<p>1960s to 1989 (used in antifouling paint on all vessels).</p> <p>1989 to 2008 (restricted use to large vessels over 25 metres).</p>	<p>Organotins are used in antifouling paint for ship hulls, as a stabiliser in the manufacturing of plastic products, as a catalyst in poly(vinyl chloride) products, a biocide (fungicide, bactericide, insecticide) and as a preservative for wood, textiles, paper, leather and electrical equipment.</p> <p>Organotins are known to be toxic at relatively low levels of exposure not only to marine invertebrates but also in mammalian systems. Organotins have been demonstrated to have immunotoxic, teratogenic, neurotoxic and carcinogenic effects in mammals.</p> <p>Historical formulation of paints containing tributyltin in New Zealand is possible.</p>
Organochlorine compounds historically used in antifouling paints	<p>Organochlorines are characteristically described as persistent and bioaccumulating substances prone to long-range transportation.</p> <p>Organochlorines are also very persistent in the environment, often remaining in soil or sediment for years or even decades.</p>	1950s to 1980s.	<p>Human health effects and environmental toxicity are specific to the compound and chemical form that the compound is in.</p> <p>Organochlorines accumulate in the body fat of animals and can be very persistent. As a result, these chemicals can accumulate in the food chain, allowing higher concentrations to occur higher up the food chain.</p> <p>Organochlorine pesticides (OCPs) are toxic to vertebrates (including humans) and invertebrates in both terrestrial and aquatic habitats.</p>

Key contaminant of concern	Persistent?	Period of use	General Comments
<p>Per- and poly-fluoroalkyl substances (PFASs)</p> <p>Aqueous film forming foam (AFFF) chemicals, used in firefighting, and in particular PFAS compounds (eg, perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA) and related compounds)</p>	<p>Highly persistent and mobile. Persistence and mobility are dependent on the PFAS compound present, environmental conditions and soil properties. Specific substances should be assessed individually.</p>	<p>1950s to present.</p> <p>Use of some compounds within the PFAS grouping (eg, PFOS) phased out since 2002 but others remain in common use.</p>	<p>Human toxicity is not well understood.</p> <p>Some PFAS compounds are highly toxic to environmental receptors.</p> <p>Discharges on to or into the ground have the potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Information on human and environmental toxicity is available in the Heads of EPAs Australia and New Zealand, PFAS National Environmental Management Plan (draft version 3.0 is currently under consultation).</p>

Back to [Vehicle refuelling, service and repair](#).

F6

Railway yards, including goods-handling yards, workshops, refuelling facilities or maintenance areas

HAIL activity intention

Description	<p>Railways yard are sites where goods are loaded and/or unloaded and trains are manufactured, repaired, maintained and refuelled. In recent times, these sites are likely to cover a large area and, depending on the goods and the repair and maintenance requirements, may include some large industrial buildings.</p> <p>Historically smaller rail yards and sidings existed in many small towns where goods were stored, loaded and unloaded. However, the goods may not have been hazardous, and determination of the material stored, loaded and unloaded at these stations should be undertaken before assigning land to this activity.</p>
Applicability	<p>This category is intended to cover activities that take place on railway sites that may result in ground contamination that are not expressly covered by other HAIL categories.</p> <p>The purpose of this category is not to record the entire railway network as potentially contaminated land but to ensure those areas where potentially contaminating activities and credible sources of contamination are (or were) located are identified.</p>
Contamination setting	<p>The parts of railway yards most likely to result in contamination commonly include railway sidings and yards where goods are (and were) loaded and unloaded, and at refuelling or maintenance and workshop facilities. Historically, the railway network was used extensively to transport goods, with many railway sidings being present alongside industrial sites (goods are now predominantly transported via roads). It is important to note that goods handling itself does not constitute a contamination risk; it is more important to determine where potentially hazardous goods were loaded and unloaded (eg, at railway sidings or yards) and by what means they were handled.</p> <p>Common activities include fuel storage, workshop activities involving hazardous substance storage and use (such as oils, solvents, and paints), and the handling and transportation of potentially hazardous goods at railway yards and sidings.</p> <p>Rail locomotives (or engines) have changed with time from steam-powered to diesel-powered to electric-powered. During the steam era, railway stations or yards commonly had coal storage (see HAIL activity E5) and locations where the engine fireboxes and ash pans, which could contain partially burnt coal, were emptied into pits under the engines. Steam-engine use stopped in 1971 in the South Island and in the late 1960s in the North Island, except for steam heritage and preservation and restoration locations. Main trunk line steam engines were converted to oil burning in the late 1940s and early 1950s. Diesel and petrol shunting locomotives and passenger railcars were introduced in the 1920s and 1930s, but large diesel locomotives were not introduced until the early 1950s. The different contaminant sources from each type of system (primarily steam and diesel) needs to be considered when assessing land under this category.</p> <p>Asbestos was commonly used in locomotives, especially in steam-powered models, as insulation around the boiler and pipework, in brake gaskets and friction material and anti-drum coatings in passenger carriages, among other uses.</p> <p>An understanding of the operational periods is important to pinpoint contaminants and activities likely to be associated with a site.</p> <p>Major railway workshops were located in Hillside in Dunedin, Addington in Christchurch, Petone and later Gracefield in Lower Hutt, Newmarket and later Otahuhu in Auckland, East Town in Wanganui with smaller workshops in New Plymouth, Napier, Nelson, Greymouth, Westport and Invercargill.</p> <p>Routine maintenance was carried out within engine sheds located at stations and within railway yards at many other locations.</p> <p>As with many large-scale industries it is likely that railway yards encompassed other HAIL activities. Such activities should be recorded as specifically as possible, where they can be identified. For example, workshops, storage tanks for fuels, wastes and other hazardous substances, and electrical transformers and substations may have been present as part of a railway yard.</p>

HAIL activity intention

	Many maintenance activities that take place in a railway engineering workshop, such as the removal and application of paints, reconditioning of brake linings, metal treatment and finishing, foundry activities and metal fabrication, should be assessed under the most relevant HAIL activity.
Exclusions	The entire railway network is not intended to be captured by this category. Discrete locations where a credible source of contamination has been determined to be present should be assessed using the applicable HAIL activity.

Activity factors – *Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.* The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>May include:</p> <ul style="list-style-type: none"> storage and handling of packaged or containerised (liquids or solids) hazardous goods at storage yards and rail sidings materials being loaded and unloaded manually or mechanically using forklifts or cranes storage of coal for steam engines in bunkers or stockpiles storage of chemicals, including oils, paints and degreasers used in the workshop fuel oil (steam era) and diesel storage in above- or below-ground tanks storage of used chemicals associated with repairs and maintenance. 	<p>Leaching or deposition of hazardous substances from stockpiles and temporarily stored goods on to or into the ground.</p> <p>Spills and leaks of liquid chemicals and fuels into and on to the ground from tanks.</p> <p>Residues leaking from empty drums stored without seals, or improperly sealed full drums.</p> <p>Storage of potential contaminants on unsealed land historically.</p> <p>Potential contamination of deeper soils and groundwater (and surface water).</p> <p>Note: storage of potentially hazardous substances could have occurred at multiple locations at a depot, railyard or rail siding.</p>	<ul style="list-style-type: none"> Types and volume of goods, fuels, oils and chemicals, their physical form and properties, including their persistence and toxicity. The condition and weathertightness of buildings, shelters, tanks and containers. The industrial and material handling processes used and the processes and safeguards to prevent discharges. The time and frequency over which goods were stored. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Manufacturing and heavy maintenance	<p>Maintenance of locomotives and engines in workshops will have varied, depending on the type of engine and works required.</p> <p>Historically, manufacture of steam locomotives, wagons and carriages and assembly of imported locomotives and wagons were carried out in the</p>	<p>Mainly spills and discharges to land, as a result of working on unsealed land or where discharges could be washed to on to unsealed land or into waterways.</p> <p>Due to the size of the machinery captured by this category, many maintenance activities</p>	<ul style="list-style-type: none"> Types and volume of materials to be machined, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. Condition of buildings, equipment, storage vessels, lines and pipework.

Activity	Description	Mechanism of contamination	Risk factors
	<p>major workshops, with operations such as foundries, metal hardening, forging, iron and steel fabrication, cutting, machining, welding, degreasing and metal finishing, including abrasive blast cleaning, pickling, plating and painting.</p> <p>Heavy maintenance was also carried out, which included complete rebuilding of both steam and diesel locomotives, rebuilding of wagons and refurbishment of carriages.</p> <p>Generally, the processes carried out in the Railway workshop are covered by other HAIL activities and these should be referred to in order to assess the mechanism of contamination.</p>	<p>involving machining works may have been undertaken outside, potentially over unsealed ground. If this was the case, then there could be high potential for ground contamination. However, modern machining works may be undertaken in specialist facilities with limited potential for ground contamination to occur.</p>	<ul style="list-style-type: none"> • The standard of facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or vapours).
Maintenance – servicing	<p>General servicing would be similar to that carried out in a motor vehicle workshop (though on a much larger scale) and would involve replacement of oils, engine fluids and lubrication of parts and, in the steam era, maintenance of boilers.</p> <p>General washing and cleaning would occur.</p>	<p>Due to the size of the machinery captured by this category, many maintenance activities may have been undertaken outside, potentially over unsealed ground. The potential for ground contamination from servicing activities increases if appropriate handling controls were not followed.</p> <p>Leaks, spills and slops of oils, fluids and other contaminants.</p> <p>Electrified trains require less servicing but could have contained polychlorinated biphenyls (PCBs) in heavy electrical equipment.</p>	<ul style="list-style-type: none"> • Types and volume of materials to be used for maintenance or repairs, for example, lubricants and other chemicals, their physical form and properties, including their persistence and toxicity. • Condition of buildings and equipment. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • Discharges to air and deposition of airborne contaminants (mainly dust or vapours).
Refuelling	<p>Refuelling is relevant for the operation of steam- and diesel-powered locomotives and engines.</p> <ul style="list-style-type: none"> • Steam – coal was provided to locomotive tenders or bunkers via a chute or conveyor-type system. Later, fuel oil was dispensed via a piped network from bulk storage tank(s), which could have been located above or below ground. • Diesel – fuels were dispensed via a piped network from bulk storage tank(s), which could have been located above or below ground. 	<p>Spills or leaks from delivery lines and during refuelling with tankers.</p> <p>Direct deposition of solid products (eg, coal stockpiles) into and on to the ground.</p> <p>Potential for localised high-concentration contamination with fuels in and around tanks and refuelling locations, particularly if bare soil.</p>	<ul style="list-style-type: none"> • The volume and types of fuels, their physical form and properties, including their persistence and toxicity. • The period and frequency over which refuelling occurred. • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
		<p>Contamination potential is lower where refuelling is undertaken on sealed ground, particularly within specialist refuelling areas.</p> <p>Potential contamination of deeper soils and groundwater (and surface water).</p> <p>Modern safer refuelling practices are generally now implemented but accidents still occur.</p>	
Waste disposal	<p>Steam engines produced partially burnt coal, ash and clinker from burning coal.</p> <p>Disposal of used containers of oils and solvents and other chemicals used in the workshop.</p> <p>Disposal of old or damaged machinery and parts.</p> <p>Disposal of used oils and fuels during maintenance and repair works.</p>	<p>Waste disposal from these facilities could result in widespread contamination, as a result of:</p> <ul style="list-style-type: none"> • spillage and misdirected emptying of fireboxes and ash pans on to the ground • direct burial of wastes and sludge (including ash and clinker), which could leach into surrounding soils and groundwater • direct application of liquid and solid wastes to ground could result in surface soil contamination and migration to deeper soils and groundwater, as well as sediment and surface-water contamination • seepage from redundant underground structures (including pipes) and damaged and degraded above-ground storage containers of liquid wastes or sludge. 	The potential for contamination from waste disposal processes could be highly variable depending upon the waste disposal practises and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Persistent?	Period of use	General Comments
Polychlorinated biphenyls (PCBs)	Persistent. Relatively insoluble and immobile.	Imported between 1940s and 1970s but could be used in small quantities after	Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> .

Key contaminant of concern	Persistent?	Period of use	General Comments
		this period. Phased out from 1980s, banned from storage and use from 2016.	
Asbestos	Asbestos is a mineral and is very persistent. Mobility of fibres is affected by environmental conditions, such as soil characteristics and weather.	1900s to present. Asbestos-containing material is no longer produced but is still present in many buildings and structures.	Asbestos is a proven human carcinogen, and all forms of asbestos can cause cancer. The main way people are exposed to asbestos is by breathing in air that contains asbestos fibres. Asbestos causes cancer in a dose-dependent manner. The greater the exposure, and the longer the time of exposure, the greater the risk of developing an asbestos-related disease. No 'safe' lower limit of exposure has been identified with certainty – all exposure is thought to add to the overall risk of disease development – but the risk from a single, low-level exposure is considered to be extremely low. Further information is available in the BRANZ (1997) <i>New Zealand Guidelines for Assessing and Managing Asbestos in Soil</i> . https://www.baybuildinginspections.co.nz/wp-content/uploads/2020/01/Asbestos-In-Soil-.pdf
Solvents (including chlorinated) used for cleaning	Highly mobile in soils, generally low persistence in soils because volatile. Chlorinated solvent vapours are denser than air and can collect in confined spaces, such as basements or excavations. Some chlorinated solvents will biodegrade in aerobic conditions. They persist in groundwater, depending on groundwater conditions. Degradation products may also persist.	1930s to present.	Toxicity is specific to the solvent. Chlorinated solvents are generally toxic and many are carcinogenic. Exposure pathways for chlorinated solvents include inhalation, dermal exposure and soil ingestion. Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water. Chlorinated solvents can permeate through concrete over time and contaminate underlying soil. Chlorinated solvents sink through groundwater, due to their density, and present a risk of vapour intrusion if a plume is close to a building.
Coal	Coal dust will be persistent. Its mobility will be dependent on environmental conditions, especially rain and wind, it is light and can be transported both as dust and in stormwater runoff. While the coal dust is unlikely to leach down into soil, metals leached from the dust may migrate deeper into the soil profile.	1800s to present.	Coal dust can reduce air quality and may contain carcinogenic compounds. Coal dust may also have adverse effects on aquatic ecosystems.

Key contaminant of concern	Persistent?	Period of use	General Comments
<p>Hydrocarbon fuels (including petrol, diesel for fuelling railway vehicles and lubricating oils and greases)</p>	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	<p>1800s to present.</p>	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011).</p>
<p>Metals and metalloids (iron, lead, tin, nickel, copper, magnesium, zinc, aluminium, chromium, including chromium VI, cadmium, silver, manganese and so on)</p>	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals and metalloids are generally more mobile and available in acidic soils.</p> <p>Metals and metalloids can be found deeper in the soil profile.</p>	<p>1800s to present.</p>	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>

Back to [Vehicle refuelling, service and repair](#).

F7

Service stations, including retail or commercial refuelling facilities

HAIL activity intention

Description	<p>Service stations are where motor vehicles fill up with fuel. Service stations receive bulk fuel deliveries into underground and above-ground storage tanks, usually from road tank wagons, for resale to customers. Commercial refuelling facilities operate in a similar manner but are mainly operated by a company for their own use, for example, dairy factories, large transport companies and so on.</p> <p>Historically, storage tanks on service stations and commercial refuelling facilities were small in size (5000 litres to 20,000 litres) and it wasn't uncommon for multiple tanks to be present across a site. The tanks often contained several products including petrol, diesel, kerosene and lubricating oil. Oil bars were once present in forecourts, which allowed for members of the public to dispose of used oils directly into storage tanks.</p>
Applicability	<p>This HAIL activity is intended to capture sites that are or were used as a service station for motor vehicle refuelling or commercial refuelling facilities. Commercial refuelling includes current or past fixed storage and refuelling facilities at farms and horticultural sites, truck stops, marine stops, transport yards and vehicle fleet bases (including taxi and rental car depots) with refuelling facilities, and port, airport and railway refuelling locations.</p>
Contamination setting	<p>Modern tanks are usually of composite construction, have integral secondary containment and leak detection, and are larger in size (20,000 litres to more than 100,000 litres). They are often located in one part of a site, often within a 'swimming pool' containment structure, surrounded by bedding material rather than soil. Bulk tanks may be located above ground or below ground.</p> <p>Above-ground tanks are prone to physical damage (impacts by vehicles and so on) and deterioration as a result of exposure to the elements.</p> <p>Below-ground steel tanks often develop holes as a result of corrosion, especially galvanic corrosion when partially submerged in groundwater.</p> <p>Leaks can also occur at joints in the pipework and fittings where pipes join the tanks.</p> <p>Petroleum-based fuels can contain various additives that are added to the fuel to improve vehicle performance. Historically, lead compounds were the main additive.</p> <p>Modern-day trucks may use additives (urea solutions) to control diesel exhaust emissions. Many service stations and truck stops are now equipped with separate storage tanks and dispensers for these additives.</p> <p>Additionally, modern tanks can now contain several different fuel types within split compartments. When undertaking an assessment against this activity, consider the current and historical storage locations. When undertaking an assessment against this HAIL activity, consider the current and historical storage locations.</p> <p>This HAIL activity is also not intended to cover bulk storage terminals (including aviation, marine or railway sites) where the primary HAIL activity is storage and transfer of fuel to bulk tank wagons.</p> <p>The storage of chemicals, fuel and liquid waste in tanks and drums, other than the bulk underground and above-ground tanks intended to store hydrocarbon fuels before resale, does not apply to this activity.</p> <p>Motor vehicle workshops are often located adjacent to service stations.</p>
Exclusions	<ul style="list-style-type: none"> • Storage of retail packs of various hazardous substances, such as fuel and oil additives, lubricants and motor oils and cleaning products. • Bulk storage of fuels (more than 100,000 litres to millions of litres) for distribution, for example, bulk storage terminals and storage facilities at ports, airports or railways.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Above- or below-ground storage of petroleum-based fuels or chemical additives. Note: storage locations could change with time.	<p>Spills or leaks on to or into the ground and corroded or faulty underground tanks that leak have potential for fuel migration to groundwater and formation of down-gradient plumes.</p> <p>Most service stations have sealed concrete forecourts. Spills, leaks and contaminated overland flow will be directed to the surface drainage giving potential for migration to surface-water receptors including stormwater. However, service stations may be equipped with an interceptor, that, if maintained, will prevent hydrocarbons discharging to surface water.</p> <p>The potential for contamination will be dependent on several risk factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals, their physical form and properties, including their persistence and toxicity. • The period over which substances were stored and frequency of restocking. • Condition of any storage tanks, containers, pipework or fuel-delivery equipment. • The fuel handling methods used. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Maintenance and monitoring of facilities and structures.
Refuelling or dispensing	Refuelling vehicles from a fixed dispenser location and refuelling tanks directly from a tanker where this is consistently in one location.	<p>Spills or leaks from delivery lines or dispensers (could be above or below ground).</p> <p>Spills or leaks during refuelling with tankers.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Potential for localised high-concentration contamination with fuels and chemical additives in and around refuelling locations, particularly if bare soil is present.</p> <p>Potential for lower-concentration contamination of wider area, depending on extent of contamination migration.</p>	<ul style="list-style-type: none"> • The volume and types of fuels, their physical form and properties, including their persistence and toxicity. • The period and frequency over which refuelling operations occurred. • The fuel handling methods used. • Condition of any storage tanks, containers, pipework or fuel-delivery equipment. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
		Contamination potential from a spill is lower where refuelling is undertaken on sealed ground.	
Waste disposal	<p>Waste disposal at a retail service station or a commercial refuelling facility is generally minimal.</p> <p>Modern facilities will capture all stormwater runoff from the refuelling area, which will be treated before discharge via an interceptor (or similar).</p> <p>Deliberate dumping and discharge of fuels.</p>	Deliberate spills and discharge of fuels and chemicals to ground.	The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Persistent?	Period of use	General comments
Polycyclic aromatic hydrocarbons (PAHs) in coal	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	1920s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air, but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Lubricating oil	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Lubricating oils commonly include metals such as zinc and molybdenum in additives to improve performance.</p>

Key contaminant of concern	Persistent?	Period of use	General comments
Hydrocarbon fuels (including petrol, diesel for fuelling railway vehicles and lubricating oils and greases)	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)</i>.</p>
Benzene, toluene, ethylbenzene and total xylene (BTEX)	<p>Persistence will be dependent on the compound, environmental conditions and soil properties. BTEX are stable but can undergo microbial degradation.</p> <p>BTEX are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	From the 1860s to present.	<p>Toxicity is specific to the compound. BTEX are considered toxic, and some are known carcinogens.</p> <p>Exposure pathways for BTEX include inhalation, dermal exposure and soil ingestion.</p> <p>Vapours are flammable and, at specific concentrations, potentially explosive.</p>

Back to [Vehicle refuelling, service and repair](#).

F8

Transport depots or yards, including areas used for refuelling or the bulk storage of hazardous substances

HAIL activity intention

Description	Transport depots or yards are sites where heavy vehicles (trucks, trailers or vans) are loaded and/or unloaded with hazardous goods and/or they are refuelled. These sites are likely to cover a large area to provide for parking and manoeuvring of the vehicles and to include large industrial buildings in which the hazardous materials are stored.
Applicability	<p>This activity is intended to cover areas within a transport depot that are (or were) used for refuelling and/or the bulk storage of hazardous substances.</p> <p>Common activities include fuel storage from above- or below-ground storage tanks (note: additives, including diesel exhaust fluid, may also be stored and used), workshop activities involving bulk hazardous substance storage, such as hydrocarbons, per- and poly-fluoroalkyl substances (PFASs) and solvents.</p>
Contamination setting	<p>This HAIL activity is not intended to capture the whole site but those areas where refuelling or bulk storage of hazardous substances take place.</p> <p>This HAIL activity is not intended to capture the use of the hazardous substances in a workshop, because this is expressly covered by another HAIL activity. It is likely that a large proportion of the site will be covered in hardstanding or compacted stone to allow the vehicles to use the site in all weather.</p> <p>Note that the activities of fuel storage and refuelling are also addressed by, and will have considerable overlap with, HAIL activities A2, A13, A17, F6 (and possibly other HAIL activities). These activities provide information to help determine if refuelling or bulk storage has occurred within a transport depot.</p> <p>A wide range of hazardous substances may be, or have been, stored at transport depots or yards, therefore, when evaluating this HAIL activity, it is important to establish the site history.</p>
Exclusions	<ul style="list-style-type: none"> • Transport depot workshops. • Refuelling or the storage of hazardous substances at an airport, marine depot or railway depot.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	Above- or below-ground storage of petroleum-based fuels (expected to be dominated by diesel), diesel exhaust fluid, solvents, additives and other chemicals (hazardous substances) associated with operations and maintenance, fuel installations and delivery, and/or in workshops in bulk quantities.	<p>Leaching or deposition of hazardous substances from stockpiles and temporarily stored goods on to or into the ground.</p> <p>Spills and leaks of liquid chemicals and fuels into and on to the ground from tanks.</p>	<ul style="list-style-type: none"> • The volume and types of fuels and hazardous substances, their physical form and properties, including their persistence and toxicity. • The period and frequency over which refuelling occurred.

Activity	Description	Mechanism of contamination	Risk factors
	<p>Bulk storage of hazardous substances in transit or for distribution. A wide variety of substances are possible.</p> <p>Note: storage locations could change with time or there could be multiple locations.</p>	<p>Residues leaking from empty drums stored without seals or improperly sealed full drums.</p> <p>Storage of potential contaminants on unsealed land historically.</p> <p>Potential contamination of deeper soils and groundwater (and surface water).</p>	<ul style="list-style-type: none"> • The period and frequency over which hazardous substance storage occurred. • The industrial and material handling methods used. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Refuelling	<p>Refuelling vehicles from a fixed dispenser location and refuelling tanks directly from an above-ground tank.</p> <p>Note: refuelling locations could change with time or there could be multiple locations.</p>	<p>Spills or leaks from delivery lines or dispensers (could be above or below ground).</p> <p>Spills or leaks during refuelling with tankers.</p> <p>Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.</p> <p>Potential for localised high-concentration contamination with fuels and chemical additives in and around refuelling locations, particularly if bare soil is present.</p>	<ul style="list-style-type: none"> • The volume and types of fuels, their physical form and properties. including their persistence and toxicity. • The period and frequency over which refuelling operations occurred. • The fuel handling methods used. • Condition of any storage tanks, containers, pipework or fuel delivery equipment. • The processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>Disposal of surplus chemicals (eg, lubricants, solvents).</p> <p>Disposal of damaged, surplus and obsolete equipment, and waste.</p>	<p>Deliberate tipping of waste to ground.</p> <p>Spills or leaks from degraded or damaged containers.</p> <p>Burial of waste at disposal sites.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminant of concern	Persistent?	Period of use	General comments
Polycyclic aromatic hydrocarbons (PAHs) in coal	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	1920s to present.	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air, but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p>
Lubricating oil	<p>These materials are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>Lubrication oils and greases have low solubility and mobility in soil and groundwater.</p>	Late 1800s to present.	<p>These materials may cause long-term adverse effects in the aquatic environment.</p> <p>Lubricating oils commonly include metals such as zinc and molybdenum in additives to improve performance.</p>

Key contaminant of concern	Persistent?	Period of use	General comments
Hydrocarbon fuels (including petrol, diesel for fuelling railway vehicles and lubricating oils and greases)	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011)</i>.</p>
Benzene, toluene, ethylbenzene and total xylene (BTEX)	<p>Persistence will be dependent on the compound, environmental conditions and soil properties. BTEX are stable but can undergo microbial degradation.</p> <p>BTEX are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	From the 1860s to present.	<p>Toxicity is specific to the compound. BTEX are considered toxic, and some are known carcinogens.</p> <p>Exposure pathways for BTEX include inhalation, dermal exposure and soil ingestion.</p> <p>Vapours are flammable and, at specific concentrations, potentially explosive.</p>

Back to [Vehicle refuelling, service and repair](#).

G Cemeteries and waste recycling, treatment and disposal

G1

Cemeteries

HAIL activity intention

Description	Cemeteries are areas of land where human bodies are buried. Cemeteries are usually designated areas in local plans. While many modern cemeteries are discrete large open spaces, historically they were frequently associated with churches or other religious sites.
Applicability	This activity is intended to capture areas of land where the burial of human bodies (public and private cemeteries) has taken place.
Contamination setting	<p>Contamination from cemeteries can include breakdown products from the embalming process as well as several compounds that result from the breakdown of a corpse. Depending on the use, layout and size of the cemetery property, areas of the larger property may not have been affected by breakdown contaminants, and therefore do not form part of the HAIL site. For example:</p> <ul style="list-style-type: none"> • larger areas of land that have not yet been developed and are not part of the current burial area • areas of the site that do not contain complete bodies (ie, designated areas for cremated remains) • areas of the site that are designated for administration purposes, such as office spaces or buildings used for memorial services and large carpark areas. <p>Given the sensitivity of these sites and strict planning controls that would restrict development on cemeteries, the associated risk to human health from soil contamination is very low. The reason for this is that the depth at which bodies are buried means the potential for exposure to potentially contaminated soil will be limited. The main contamination pathway for cemeteries is groundwater and the potential for contaminants to migrate to a drinking water well or surface water.</p> <ul style="list-style-type: none"> • Ancillary HAIL activities or facilities may be undertaken, or be present, which will also require assessment.
Exclusions	<ul style="list-style-type: none"> • Natural burial sites where the bodies are not embalmed, and coffins are designed to be biodegradable. • Funeral homes where embalming products are stored or used or those facilities where embalming products are manufactured. These may be covered by other HAIL activities. • Biological hazards (from the breakdown of corpses) are not considered under this category because they are not considered to be a hazardous substance as referenced within this document. • Crematoriums.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Sub-activity and process	Description	Mechanism of contamination	Contamination potential
Breakdown of corpse	Embalming involves the injection of chemicals, many of which are toxic or ecotoxic, into a corpse to delay the process of decomposition. Other by-products can breakdown from the corpse. A human corpse normally decays within 10 to 12 years.	Adsorption into soils immediately surrounding corpses. Potentially leaching into groundwater.	Low: potentially localised contamination below ground surface, subject to hydrogeology conditions (and ability for attenuation to take place). Potential for migration to groundwater and formation of down-gradient plumes. Potential for migration to surface-water receptors.
Breakdown of coffins	The chemicals used in coffins may degrade into the surrounding soils over time.	Adsorption into soils immediately surrounding corpses. Potentially leaching into groundwater.	Low: potentially localised contamination below ground surface, subject to hydrogeology conditions (and ability for attenuation to take place).

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Metals and metalloids associated with historic embalming and the decay of the coffin (arsenic, lead, copper and mercury)	Persistence and mobility are dependent on environmental conditions and soil properties. Metals are generally more mobile and available in acidic soils. Metals can be found deeper in the soil profile.	1800s to present.	Toxicity is specific to the metal and metalloid or chemical form that the element is in. Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil . Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs) .

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Organic compounds associated with embalming (formaldehyde, glutaraldehyde, phenol and methanol)	<p>Persistence will be dependent on environmental conditions and soil properties.</p> <p>Most compounds are stable but can undergo microbial degradation.</p> <p>These compounds are liquid and water soluble and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Note: studies completed have estimated that over half of the pollutant load leaches within the first year or less (depending on rainfall and infiltration rates)</p>	Mid 1900s to present.	Toxicity is specific to the compound and its breakdown compounds. However, if discharges from this activity occur to soil and water, they will likely be dilute, and the toxicity of these compounds is therefore considered low.

[Back to Cemeteries and waste recycling, treatment and disposal.](#)

HAIL activity intention

Description	<p>Drum and tank cleaning is an industrial activity that involves the use of liquid cleaners and heat treatments. The site is likely to be in an industrial setting with open space for the storage of drums needing cleaning, an area for cleaning processes (this could be in the open or within a building) and buildings for the storage of clean drums and cleaning chemicals. Containers often contain residues of the substances that they held, which need to be removed prior to cleaning and refurbishing the container. These residues can include hazardous substances.</p> <p>The facility may also include a workshop to repair metal tanks and to remove corrosion and recoat the interior and exterior of the drums.</p>
Applicability	<p>This category is intended to cover those industries that undertake the reconditioning or recycling of storage containers (eg, drums or tanks).</p>
Contamination setting	<p>Integral to this category is the processes of cleaning, generation and storage of wastewaters and sludge, and potential treatment and disposal of wastewaters. It is during these processes that the greatest volume of hazardous substances will be handled, as opposed to the final stages of recycling and reconditioning of the containers.</p> <p>Cleaning of containers will be undertaken using heat treatment (from a furnace) or chemical treatment or a combination of both methods. Generally, the cleaning procedures will involve the use of water (cold and hot), detergents, chemical treatments typically using a caustic solution (sodium hydroxide), sterilisation and resin or epoxy residue treatment. Solvents may be used in the cleaning process and a kerosene treatment may also take place. Wastewaters generated during the cleaning process will be treated using interceptors, filtering processes and chemical treatment within balance tanks using chemicals such as sulfuric acid, sodium hydroxide and ferrous sulfate. Sludge will be produced from this process that will need to be disposed of. The processes of cleaning and associated wastewater treatment have the potential to result in ground contamination from the same mechanism. For this reason, they have been grouped together in the table below under the category of 'cleaning and treatment'.</p> <p>It is important to determine the nature of the chemicals or substances that were stored in the drums or tanks being reconditioned or recycled, so an accurate determination of the main contaminants of concern for the site can be made. The substances listed below are intended to represent a sample of the most common contaminants that may be present but are not intended to represent an exhaustive list.</p>
Exclusions	<p>No exclusion</p>

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of and fuel, chemicals or liquid waste could occur on almost any part of a site and may not be in an area that is dedicated to storage.</p> <p>Storage may include:</p> <ul style="list-style-type: none"> • residues from recycled and reconditioned containers that are or were temporarily stored within holding drums and tanks (may be treated on site or at another facility) • emulsion tanks for treating waste residues • treated wastewater sludge requiring offsite disposal • paint and solvent storage • diesel storage for furnaces. <p>Note: hazardous substances could be stored at different locations at a facility and could comprise underground and above-ground infrastructure.</p>	<p>Spills or leaks on to or into the ground potentially resulting in soil contamination.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p> <p>The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on a several factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> • Types and volume of residual and cleaning chemicals, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Cleaning and treatment	<p>The level of cleaning required and use of hazardous substances during the cleaning process will depend on the previous uses of the containers.</p> <p>Containers can be either cleaned using heat (furnace heated by diesel) or chemicals or a combination of both (refer to descriptions in introduction section). Note: only steel containers can be heat treated.</p> <p>Drums may be handled using conveyor systems.</p> <p>Wastewaters produced from the cleaning process will be treated on site (refer above); however,</p>	<p>Spills or leaks of hazardous substances direct to ground in treatment and cleaning areas.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p> <p>Historical infrastructure and practices may not have been up to current industry standards. Therefore, it is important that the practitioner must consider both the current and historic setting.</p> <p>The potential for contamination of the ground to occur from any spills or leaks would be minimised by this seal.</p>	<ul style="list-style-type: none"> • The volume and types of the residual chemicals in the drums, and effluent generated, and the chemicals used to treat the effluent, their physical form and properties, including their persistence and toxicity. • Condition of the equipment, tanks and lines from which leaks could occur. • The period and frequency over which these operations occurred. • Standard of measures to mitigate or control discharges, leaks or spills. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.

Activity	Description	Mechanism of contamination	Risk factors
	sludge material may need to be disposed of to a landfill.		
Reconditioning	Metal container reconditioning or repairs may be necessary. This may involve metal reworking processes such as gas welding, shot blasting and dent removal works.	Deposition of metallic compounds on to the ground.	<ul style="list-style-type: none"> • Types and volume of materials and chemicals used to clean and repair drums, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which reconditioning occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or vapours).
Recycling	<p>Once the containers have been cleaned and reconditioned, they will be prepped for recycling, which will involve:</p> <ul style="list-style-type: none"> • seal tests using water or air • possible application of a de-rusting coating using acids • possible application of epoxy lining (or similar) • possible application of paints. 	<p>Spills and leaks of application chemicals (eg, de-rusting chemicals, painting and lining chemicals) to ground in recycling area of facility.</p> <p>Modern recycling processes are expected to take place inside specialist facilities. The ground is likely to be sealed and ideally maintained to a high standard. The potential for contamination of the ground to occur from any spills or leaks would be minimised by this seal.</p> <p>However, historical facilities and practices may have differed such that the risk of contamination of the ground was greater.</p>	<ul style="list-style-type: none"> • Types and volume of chemicals used as anti-corrosives and to line drums, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which recycling occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • Discharges to air and deposition of airborne contaminants (mainly dust or vapours).

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	<p>Waste disposal (not already covered by the above sections) may include:</p> <ul style="list-style-type: none"> disposal of damaged containers or metal parts removed from containers disposal of paint and solvent residues used during recycling and reconditioning disposal of ash produced from the heat-treatment process disposal of shot blasting residues. 	<p>Spills or leaks from degraded and damaged containers to ground.</p> <p>Deliberate tipping or burial of waste or residues (including sludge or ash) to ground.</p> <p>Current facilities will likely have strict wastewater controls and will recycle products and chemicals where possible. The ground is likely to be sealed and ideally maintained to a high standard.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
	<p><i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i></p>	<p><i>Assists identification of whether, and the length of time, a contaminant may have been in use</i></p>	
Solvents (used for cleaning – white spirits, ketones, methyl ethyl ketone (MEK), xylene, acetone)	<p>Persistence will be dependent on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<p>Human health effects and environmental toxicity are specific to the solvent.</p> <p>Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on contaminant.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered. Solvents pose a risk of vapour intrusion if a plume is close to a building.</p>
Hydrocarbons (used for cleaning – kerosene)	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Many hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be</p>	1880s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, they may also contaminate groundwater. Many are toxic to aquatic organisms and may cause long-term adverse effects.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
	dependent on environmental conditions and soil properties.		<p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (revised 2011).</p>
Polycyclic aromatic hydrocarbons (PAHs) (from diesel for furnaces)	<p>PAHs derived from human activities are considered persistent organic pollutants (POPs) and can accumulate in food webs. Depending on their size, individual PAHs vary significantly in toxicity and mobility and in their behaviour in the environment.</p> <p>PAHs become more insoluble in water as their molecular weights increase. This limits their mobility in soil and groundwater. However, PAHs can bind to small particles leading to migration in surface water and air.</p>	1800s to present	<p>Toxicity is specific to the PAH.</p> <p>PAHs are environmental pollutants that represent a risk not only to humans but to most living organisms. PAHs generally have a low degree of acute toxicity to humans but are carcinogenic and can bioaccumulate.</p> <p>PAHs become less soluble in water as their molecular weights increase. High-molecular weight PAHs are generally more toxic than the lighter molecular weight PAHs.</p> <p>PAHs can bind to small particles leading to migration in surface water and air but generally have limited mobility in soil and groundwater.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>
Acids	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to its water solubility.</p>	1800s to present.	<p>A range of acids are frequently used in analytical laboratories.</p> <p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Alkalis (and detergents)	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to its water solubility.</p>	1800s to present.	<p>Alkalis are not generally toxic but can cause severe burns by all exposure routes.</p> <p>Alkalis can be toxic to aquatic organisms; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>
Metals (from sand blasting and welding)	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile.</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) Toxicological intake values for priority contaminants in soil.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) Updating the Ecological Soil Guideline Values (Eco-SGVs).</p>

Back to [Cemeteries and waste recycling, treatment and disposal](#).

HAIL activity intention

Description	A landfill is a site where waste materials have or are being deposited. The waste may be sourced from multiple locations, such as a municipal landfill, or be from just one waste generator, for example, a wood waste dump. This activity is typically undertaken in excavations, for example, quarries and pits for gravel extraction, however, on some sites, the dumping has occurred on the surface, causing the land profile to change, for example, gullies and coastal margins.
Applicability	This activity applies the disposal of solid waste or sludge amounting to more than a thin layer, with a resultant change in the level or contour of the land at the time of filling. This includes but is not limited to the deposition in a pit or a quarry, in a valley, on the side of a slope, or as a mound above the existing ground surface, or any combination.
Contamination setting	<p>Landfills without effective containment increase the likelihood of the discharge of hazardous contaminants to the environment. There are many inconsistencies in the design and management of landfills throughout New Zealand, and many operate with vague, subjective or ineffective controls on hazardous waste disposal.</p> <p>Landfill sites is included as a distinct HAIL activity because a wide variety of waste types, which may include hazardous substances, are disposed in a single location and their potential to impact both human health and the environment.</p> <p>A landfill may be considered as a waste disposal site used for the controlled deposit of soil waste on to or into land, in accordance with the WasteMINZ (2022) <i>Technical guidelines for disposal to land</i>, (WasteMINZ, 2022). This activity would include:</p> <ul style="list-style-type: none"> • municipal landfills (classes 1–4, WasteMINZ, 2022), including hazardous waste landfills, construction and demolition waste landfills and industry landfills • farm dumps • wood waste dumps • any other location where non-natural waste has been deposited in sufficient quantity that the level of the land at the time of filling has been altered and/or raised • sites where a significant volume of fly-tipped waste has resulted in a change to the ground contour • any other fill of unknown origin or uncharacterised fill. <p>Several types of landfill exist that can produce landfill gas as a by-product of the breakdown of organic material in the waste body. Landfill gas is not a soil contaminant in the conventional sense of hazardous substances within the soil, but it is a hazardous substance that arises through natural processes acting on the body of waste within a landfill. Landfill gases can migrate and build up within confined spaces in buildings where they may pose an explosive risk.</p>
Exclusions	<ul style="list-style-type: none"> • Disposal to land, which is restricted to liquid or thin layers of solids or sludges deposited on the surface of the land such that no significant change occurs to the contour or level of the ground and where the generation of landfill gas is unlikely, in a manner that the generated gas can migrate and cause a hazard adjacent to the disposal facility itself. • Farm offal pits used only for offal. • Class 5 landfills (cleanfills), if they comply with the requirements of the Technical Guidelines for Disposal to Land WasteMINZ, 2022.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guideline No 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	Waste disposal	<p>Discharges of leachate from the landfill to vulnerable receptors, groundwater and surface water.</p> <p>Discharge of waste from the site due to high winds or overland flow.</p> <p>Migration of landfill gases from the landfill, especially if landfill gas capture is not required.</p>	<ul style="list-style-type: none"> • Types and volume of wastes disposed of, their physical form and properties, including their persistence and toxicity. • The condition and integrity of any landfill lining system, • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which waste disposal occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. <p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence <i>Persistence and mobility are key factors in determining the likelihood of contaminant longevity and migration</i>	Period of use <i>Assists identification of whether, and the length of time, a contaminant may have been in use</i>	General comments
Waste materials	Persistence will be dependent on environmental conditions and landfill properties. Some wastes are stable but others can undergo microbial degradation generating leachate and landfill gases.		Human health effects and environmental toxicity are specific to the waste deposited.
Leachate	Persistence will be dependent on environmental conditions and soil properties. However, leachate is a mixture of chemicals, some that will not degrade and others that may degrade in soils or water.		Human health effects and environmental toxicity are specific to the leachate. When discharged to land, leachate may also contaminate groundwater and, subsequently, surface water. Leachates are generally toxic in the environment and may cause long-term adverse effects.
Landfill gases (methane, carbon dioxide)	Persistence will be dependent on environmental conditions and soil properties. However, landfill gas is a mixture of gases that may interact with soils and groundwater. Methane and carbon dioxide are soluble in water.		Landfill gases can migrate and accumulate in confined spaces. When this occurs, it poses an asphyxiation and explosive risk.

Back to [Cemeteries and waste recycling, treatment and disposal](#).

G4

Scrap yards including automotive dismantling, wrecking or scrap metal yards

HAIL activity intention

Description	Scrap yards, including automotive dismantling, wrecking or scrap metal yards, are usually located in an industrial or rural setting. These activities can take place on open land, sealed sites or within industrial buildings. At these sites, disused vehicles and scrap metal are collected and stored so that used parts can be removed and reused, or the metal and plastics processed and sent to be recycled or disposed of.
Applicability	<p>This activity is intended to cover facilities referred to collectively as scrap yards, metal yards, junk yards or wrecking yards. These facilities are used to store metal and non-metallic items for the purpose of dismantling them for parts and resale purposes, recycling back to manufacturers or, ultimately, waste disposal. The category may also apply to rural or peri-urban properties where scrap vehicles or items are stored outside on unsealed ground.</p> <p>Note the potential for overlap with other HAIL categories that refer to recycling and smelting facilities.</p>
Contamination setting	<p>Many products that reach the end of their useful life contain parts or materials that still have value, either as second-hand parts or for their recyclable materials. Scrap yards and automotive dismantlers capitalise on this by collecting and processing a wide variety of items. Commonly stored materials or items include vehicles and machinery, (including whole car bodies and tyres), electrical appliances and equipment (such as transformer housings, metallic building and construction waste, printed circuit boards, batteries and e-waste, and the waste products from these goods).</p> <p>Hazardous substances are present in many of the component parts of the items stored and dismantled on these sites. Unsealed surfaces and the absence of controlled drainage systems are of great significance at these sites.</p> <p>In the context of automotive dismantling, wrecking or scrap metal yards, processing may include:</p> <ul style="list-style-type: none"> • breaking down the objects they have collected to recover reusable parts or components • breaking the objects down into similar types of materials to increase the value of the material • compressing the scrap into more compact and easily manageable cubes. <p>Many opportunities exist for contaminants to escape and result in contaminated land. Many scrapyards historically operated on unsealed ground and accepted a wide variety of materials.</p>
Exclusions	<ul style="list-style-type: none"> • Waste transfer stations where household electrical appliances are stored for collection and off-site recycling.

Several activities will be carried out at these sites to extract recyclable materials. This will often involve dismantling, shearing or cutting, shredding, fragmentising, compaction and crushing. When managed poorly, these activities and associated processes all have the potential to result in ground contamination.

Contamination can vary widely and depends on the history and management of the site, facility factors and environmental controls at individual sites.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of non-processed and processed metallic and non-metallic components.</p> <p>Storage of hazardous substances removed during processing.</p> <p>Storage of cleaning and degreasing agents in containers (underground or above ground).</p>	<p>Storage of damaged objects that contain hazardous substances that could leak, for example, vehicles, which could leak oil, petrol, diesel, battery acid, hydraulic fluid, transmission fluid and oil, and transformers that contain dielectric fluid, possibly including polychlorinated biphenyls (PCBs).</p> <p>Spills, leaks and deposition of hazardous substances from storage areas into or on to the ground.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p>	<ul style="list-style-type: none"> • Types and volume of waste materials, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Shredding	<p>Shredding, shearing, fragmentising and crushing are usually done by machine.</p> <p>These processes are done to reduce the volume of the waste, making transportation more efficient.</p>	<p>Shredding is a non-selective method that relies on the removal of all hazardous substances from the material to be shredded. This is often time consuming and laborious and is sometimes omitted. As a result, the shredded material can be contaminated with a wide range of contaminants or can leak if in liquid form. Shredder floc or floc mud are generic terms for the non-metallic waste that is a by-product of the shredding process.</p>	<ul style="list-style-type: none"> • Types and volume of materials to be shredded, lubricants and other chemicals that may be present, their physical form and properties, including their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of the facilities and measures to mitigate or control leaks, discharges or spills. • The industrial and material handling processes used and the processes and safeguards to prevent discharges • The period and frequency over which shredding has occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Dismantling	<p>Dismantling may be done by hand or machinery.</p> <p>These processes may include the draining of oil, fuel and hydraulic fluid. In some</p>	<p>Spills, leaks and deposition of hazardous substances from dismantling and crushing processes into or on to the ground.</p>	<ul style="list-style-type: none"> • The volume and types of chemicals within the object to be dismantled and used to clean parts, their physical form and properties, including their persistence and toxicity.

Activity	Description	Mechanism of contamination	Risk factors
	<p>instances, hazardous substances may still be present when products are crushed. For example, brake pads containing asbestos, transformers containing PCB residues, batteries containing lead and acid, vehicles containing fuels, hydraulic and transmission fluids, air conditioning gases, as well as engine and transmission oils and radiator coolant.</p> <p>Liquid solvents, including chlorinated solvents, may be used for the cleaning of parts. The recycled parts and materials may have been dipped into cleaning tanks or sprayed with the cleaners and degreasers. Spills from degreasing units can result in contaminated soil, even when done indoors, due to the permeability of concrete, if done often over a period of years.</p>	<p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p> <p>The historic practices of 'dismantling' has resulted in the contamination of the ground at many scrap yards because many hazardous substances were still present and not managed appropriately during these processes.</p> <p>These facilities often had large areas of unsealed ground, often outdoors, with inadequate controls to intercept contaminants. Rainfall leaches contaminants from scrap piles and tracks contaminants along drainage paths and into surface water and groundwater.</p>	<ul style="list-style-type: none"> • Condition of the equipment. Older equipment may contain chemicals that are now banned or not used due to safety concerns. • Processes and safeguards to prevent discharges. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period and frequency over which the dismantling and cleaning of the equipment took place.
Waste disposal	<p>Excess waste generated from these types of facilities may include:</p> <ul style="list-style-type: none"> • containers of hazardous substances drained from machinery and vehicles • hazardous substances stored for disposal to landfill, treatment or recycling • excess and used cleaning products used for degreasing metallic components. <p>Some sites may have had designated areas for burning of non-metal components that could not be readily recycled.</p> <p>Modern sites should have designated wash-down bays with trade waste facilities.</p>	<p>Deliberate burial (including ash residues) and/or tipping of sludge and hazardous substances to ground.</p> <p>Spills or leaks from degraded and damaged containers to ground.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
Metals and metalloids	<p>Persistence and mobility are dependent on environmental conditions and soil properties.</p> <p>Metals are generally more mobile and available in acidic soils.</p> <p>Metals can be found deeper in the soil profile</p>	1800s to present.	<p>Toxicity is specific to the metal, metalloid or chemical form that the element is in.</p> <p>Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i>.</p> <p>Information on environmental toxicity is available in Manaaki Whenua – Landcare Research (2019) <i>Updating the Ecological Soil Guideline Values (Eco-SGVs)</i>.</p>
Hydrocarbons fuel, lubricating oils, greases	<p>Persistence will be dependent on environmental conditions and soil properties. Most hydrocarbons are stable but can undergo microbial degradation.</p> <p>Some hydrocarbons are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p> <p>Lubrication oils and greases are not expected to be readily biodegradable and therefore may be persistent in soil and sediments.</p> <p>These materials have low solubility and mobility in soil and groundwater.</p>	1880s to present.	<p>Human health effects and environmental toxicity are specific to the hydrocarbon. When discharged to land, they may also contaminate groundwater.</p> <p>Many are toxic to aquatic organisms and may cause long-term adverse effects.</p> <p>Light non-aqueous petroleum liquids are less dense than water and not very soluble. Large spills will move vertically down into soil, before spreading laterally when groundwater is encountered.</p> <p>Some hydrocarbons pose a vapour intrusion risk.</p> <p>For specific information, consult Ministry for the Environment (1999) <i>Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand</i> (revised 2011).</p>
Polychlorinated biphenyls (PCBs) used in dielectric transformer oils	Very persistent. Limited mobility in soil.	Imported between the 1940s to 1970s, but may have been used in small quantities after this period, and could be a contaminant of non-PCB oil in older transformers.	Information on human toxicity is available in Ministry for the Environment (2011) <i>Toxicological intake values for priority contaminants in soil</i> .

Key contaminants of concern	Chemical persistence	Period of use	General comments
		Programme of phasing out in 1980s, banned from use and storage from 2016.	
Solvents – chlorinated (dichloromethane, tetrachloromethane, tetrachloroethane)	<p>Persistence will be dependent the solvent, on environmental conditions and soil properties. Most solvents are stable but can undergo microbial degradation.</p> <p>Solvents are liquid and therefore highly mobile. However, their mobility will also be dependent on environmental conditions and soil properties.</p>	1800s to present.	<ul style="list-style-type: none"> • Human health effects and environmental toxicity are specific to the solvent. Different chlorinated solvents can and have been used in laboratories. Their use has declined due to their toxicity. • Chlorinated solvents are toxic, and some are considered carcinogenic. • Chlorinated solvents are also referred to as dense non-aqueous phase liquid (DNAPL) because they are denser than water. • Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Moderate to high ecotoxicity, depending on solvent. • They are used to extract contaminants and constituents from other matrices and as a solution in which samples are analysed.
Asbestos fibres	Asbestos is a mineral and is very persistent. Mobility of fibres is affected by environmental conditions, such as soil characteristics and weather.	<p>1900s to present.</p> <p>Asbestos-containing material is no longer produced but is still present in many buildings and structures.</p>	<p>Asbestos is a proven human carcinogen, and all forms of asbestos can cause cancer. The main way people are exposed to asbestos is by breathing in air that contains asbestos fibres.</p> <p>Asbestos causes cancer in a dose-dependent manner. The greater the exposure, and the longer the time of exposure, the greater the risk of developing an asbestos-related disease.</p> <p>No 'safe' lower limit of exposure has been identified with certainty – all exposure is thought to add to the overall risk of disease development – but the risk from a single, low-level exposure is considered to be extremely low.</p> <p>Further information is available in BRANZ (1997) <i>New Zealand Guidelines for Assessing and Managing Asbestos in Soil</i>.</p>
Acids	<p>Low persistence and mobility if in small quantities, because soil will tend to neutralise and degrade.</p> <p>Will likely be mobile in the environment due to its water solubility.</p>	1800s to present.	<p>A range of acids are frequently used in analytical laboratories.</p> <p>Acids are not generally toxic but can cause severe burns by all exposure routes. The lower the pH of the acid the more corrosive it is.</p> <p>Acids can be highly toxic to aquatic organisms and terrestrial plant life; however, are not considered to bioaccumulate or bioconcentrate through the food chain.</p>

[Back to Cemeteries and waste recycling, treatment and disposal.](#)

G5

Waste disposal to land (excluding where biosolids have been used as soil conditioners)

HAIL activity intention

Description	<p>Practices that are captured under this activity include land farming or bio-piling of contaminated soils, disposal to land of untreated municipal wastewater and disposal to land of wastewater from industrial processes that contain hazardous organic or inorganic contaminants. These activities are likely to be undertaken on unsealed land in a rural or industrial area. It is likely that these activities will require a resource consent for the discharge to land.</p> <p>Waste may in the form of a liquid, sludge or solid and must, when deposited, have the potential to result in contamination of soils. It must therefore be from a source that is considered to contain, or contains, a hazardous substance or could break down into a hazardous substance.</p>
Applicability	<p>This category is intended to capture those sites or areas at a site where waste disposal to land has been deliberate and has occurred as a thin layer on or in the ground such that there is no significant change to the contour or level of the ground, and includes disposal of wastewater to land that constitutes a potential contaminant source.</p>
Contamination setting	<p>The waste may be deliberately incorporated into the underlying soil by cultivation (land farming). When assessing disposal of wastewater to land, consider the likelihood of toxic contaminants. For example, effluents from dairy sheds and some primary produce industries have a large biological load but no or insignificant contaminant load, but piggery and chicken effluents may contain elevated metal concentrations. Similarly, many treated municipal wastewaters will have lost most of the contaminant load during filtering, clarifying and settling processes (including treatment ponds) with the sludges produced containing most of the contaminants. It is therefore essential to understand the nature of the waste that has been disposed of and the main contaminants of concern that such waste may contain or produce, to accurately assess the risk from the practice.</p>
Exclusions	<ul style="list-style-type: none"> • Landfilling, where the pre-existing ground level has been altered by waste deposition. • Accidental or incidental spills or leaks to ground (eg, as a result of accidental releases or fly tipping of containers where liquid residues are present). • Agricultural spreading of animal effluents (eg, dairy shed effluent) or manure where normal animal husbandry practices are not expected to result in contamination of effluent or manure. Note: piggery effluents may contain elevated concentrations of copper and zinc, and historically chicken manure could contain arsenic compounds. • Domestic septic tanks. While these systems may discharge wastewater to ground containing biological hazards, the amount of organic chemicals or inorganic contaminants, such as metals and metalloids, that could persist in soil will generally be low. • Municipal biosolids (or other types of biosolids) processed in accordance with the New Zealand Water and Wastes Association (NZWWA) (2003) <i>Guidelines for the safe application of biosolids to land in New Zealand</i> or updates of these guidelines. • Wastewater to land from industrial food processing that contains only plant or animal-based material. • Sites where it was common practice to dispose of large amounts of waste within the operating facility. Rather than capture that waste disposal under this category, it should be captured under activity that applies to the principal HAIL activity. Examples include the assessment of solid waste disposal at gasworks, leaded sludge disposal at bulk storage terminals and refineries, and the disposal of treatment tank and dip sludges at timber treatment facilities.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Waste disposal	Application to land by irrigation or spreading of solid hazardous substances, or wastewater or sludges that contain hazardous substances, which results in a thin layer of waste on the ground and no significant change to the contour or level of the ground (the pre-existing ground level will not change significantly).	<p>Direct deposition of waste on to the ground.</p> <p>Incorporation of the waste into the ground surface by cultivation.</p> <p>Infiltration of liquid wastes and liquids from sludges into the ground.</p> <p>Potential leaching from solid wastes that may cause contamination of underlying soils and possibly groundwater and surface water.</p>	<ul style="list-style-type: none"> Types and volume of wastes disposed of, their physical form and properties, including their persistence and toxicity. The industrial and material handling processes used and the processes and safeguards to manage discharges. The period and frequency over which waste disposal occurred. Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. Discharges to air and deposition of airborne contaminants (mainly litter, dust or vapours). <p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
Widespread, depending on the type of waste deposited or to be deposited to land	Persistence will be dependent on environmental conditions and landfill properties. Some wastes are stable but others can undergo degradation.	Dependent on the waste disposal period.	Human health effects and environmental toxicity are specific to the waste deposited.

[Back to Cemeteries and waste recycling, treatment and disposal.](#)

G6

Waste recycling or waste or wastewater treatment

HAIL activity intention

Description	<p>This HAIL activity covers three broad ranges of activities.</p> <ul style="list-style-type: none"> Waste recycling – is where materials in a waste stream are segregated, collated and recycled, an example would be metal recycling from the municipal waste stream. This activity can be undertaken on range of scales from a small transfer station to a large industrial building where the metal is stockpiled before being recycled. Waste treatment – this activity occurs when a toxic or difficult waste to dispose of is treated either physically or chemically to make the waste acceptable for disposal. Waste treatment is a specialist industry and would usually be undertaken in an industrial setting that could comprise both open areas and buildings. Wastewater treatment – the treatment of wastewater includes municipal, industrial and community wastewater treatment plants. The size of these wastewater treatment plants varies significantly, depending on the size of the catchment. The treatment usually comprises multiple phases, including screening equipment, settling tanks, filter beds and ultraviolet treatment.
Applicability	<p>This category is intended to identify those sites handling, processing and recycling waste(s) that are not covered by another more specific HAIL activity. Wastes can be solid or liquid and have the potential to cause contamination to soil, surface water or groundwater.</p>
Contamination setting	<p>Due to the variety of waste products that may be captured by this broad activity, it is important to understand the nature of the wastes handled, treated and recycled, and the main contaminants of concern that such waste may contain or produce, to accurately assess whether this HAIL activity applies.</p> <p>Waste recycling may involve specific processes to achieve a product suitable for recycling and these will vary for each waste type. An understanding of what these processes are and what hazardous substances may be present in that waste type is necessary. The waste may be in various forms ranging from liquids or sludge to solids.</p> <p>Examples of facilities that may be captured under this category include:</p> <ul style="list-style-type: none"> waste transfer stations where refuse and recyclable materials are temporarily stored for further disposal or recycling. May include plant for sorting, segregation, compaction and baling of waste facilities that specialise in the recycling of chemicals, paints, lubricating oil and plastics. <p>Waste treatment occurs at facilities where liquid or solid wastes, including industrial wastes, contaminated soils, slurry and sludges are stored and treated before disposal. Treatment processes may include biotransformation, distillation, rendering and other heat treatments, chemical neutralisation, chemical transformation, concentration reduction, stabilisation, and land-based treatment of solid waste and sludges, such as drilling muds and contaminated soils.</p> <p>Wastewater treatment plants treat wastewater from residential and industrial properties. The wastewater received at these plants contains a wide range of contaminants from multiple sources that include metals, pharmaceuticals, sewage, organic waste and per- and poly-fluoroalkyl substances (PFASs).</p> <p>Some activities can generate leachate that may impact on groundwater and water ways. These discharges could potentially result in loss of a resource and ecological issues. Groundwater impacts should be considered in the wider scope and whether they could impact on human health or surface water.</p>
Exclusions	<ul style="list-style-type: none"> Battery recycling. Electronics disassembly and recycling. Scrap yards. Treatment or spreading of agricultural organic wastes (faeces and urine).

HAIL activity intention

- Biological treatment of waste from industrial food processing that contains only plant- or animal-based waste.
- Septic tank(s), wastewater and grey water treatment systems that serve a residential dwelling. While these systems may discharge wastewater to ground containing biological hazards, the amount of organic chemicals or inorganic contaminants, such as metals and metalloids that could persist in soil, will generally be low.
- Ancillary treatment processes as part of larger industrial sites that are otherwise captured in another category, for example, the locations of oil–water separators and interceptors on service station sites.

Activity factors – *Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.* The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in the Contaminated Land Management Guidelines and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Storage	<p>Storage of untreated and treated waste at a treatment facility. Waste could be in liquid, sludge, slurry or solid form.</p> <p>Waste could be stored in above- or below-ground containers or could be placed directly on the ground if it is in a solid form.</p> <p>Waste may go on to be further processed (see 'Processing' below) at the facility or it may be stored for disposal elsewhere (including export).</p>	<p>Spills, leaks and deposition of hazardous substances from storage areas into or on to the ground.</p> <p>Spills and leaks into the ground from damaged pipelines, faulty pipeline connections or faulty valves.</p> <p>Potential for migration to groundwater (and surface water) and formation of down-gradient plumes, if enough product is released to ground.</p> <p>The potential for contamination of soil or groundwater from the storage of hazardous substances will be dependent on several risk factors and complete hazard-pathway-receptor linkages.</p>	<ul style="list-style-type: none"> • Types and volume of waste materials, their physical form and properties, including their persistence and toxicity. • The condition and weathertightness of buildings, shelters, tanks and containers. • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • The period and frequency over which storage occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Processing	<p>Processing of waste will vary, depending on the type of waste and hazardous substances that might be present. Processing or treatment of waste will be undertaken for the purpose of recovering or producing a product that can be reused, recycled or disposed of safely.</p> <p>Processing for hazardous wastes and liquids, including wastewater, may include:</p>	<p>Spills and leaks of liquid chemicals and fuels into and on to the ground from process locations, containers, vessels and pipelines.</p> <p>Leaching or deposition of hazardous substances from stockpiles on to or into the ground.</p> <p>Potential contamination of deeper soils, groundwater and surface water.</p>	<ul style="list-style-type: none"> • Types and volume of waste materials to be processed, and other contaminants that may be present, their physical form and properties including, their persistence and toxicity. • Condition of buildings, equipment, storage vessels, lines and pipework. • The standard of facilities and measures to mitigate or control leaks, discharges or spills.

Activity	Description	Mechanism of contamination	Risk factors
	<ul style="list-style-type: none"> • pre-treatment processes, such as decanting, filtration, removal of sediments • dewatering of sludges • use of biological treatments, such as trickling filters, bioreactors, sludge digesters and anaerobic and aerobic ponds • use of physical treatments, such as heating, to separate or distil chemical mixes and aeration to increase chemical breakdown processes • use of additives or blends to neutralise or stabilise waste, could apply to soil or liquids • use of chemicals to change the chemical form of wastes • physical separation of one waste stream from another via picking, sorting, screening or grading mechanisms. <p>Processes for materials and products beyond their useful life may include: dismantling, sorting, screening, shredding, crushing and baling and, in the past, incineration.</p>	<p>The potential for contamination to be present at the sites captured by this category could be highly variable and will depend on the history of the construction, operations, site facility features and handling factors.</p>	<ul style="list-style-type: none"> • The industrial and material handling processes used and the processes and safeguards to prevent discharges. • Discharges to air and deposition of airborne contaminants (mainly litter, dust or vapours). • The period and frequency over which processing has occurred. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments.
Waste disposal	<p>Waste treatment facilities will also generate their own waste stream that needs to be managed. Wastes may include:</p> <ul style="list-style-type: none"> • liquid chemicals or sludge that cannot be processed • by-products produced from the processing, including contaminated water • containers or other solid waste materials that require disposal or destruction at another facility. 	<p>Spills or leaks from degraded or damaged containers and treatment systems to ground, which could result in soil, groundwater or surface-water contamination.</p> <p>Deliberate burial and/or tipping of sludge and hazardous substances to ground.</p>	<p>The potential for contamination from waste disposal processes could be highly variable, depending on the waste disposal practices and locations, both historically and currently.</p>

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site Model.

Key contaminants of concern	Chemical persistence	Period of use	General comments
The contaminants of concern will be dependent on the specific activity, the waste they recycle and/or treat.	Persistence and mobility will be specific to the contaminant and the physical or chemical form that the contaminant is in.	Dependent on the waste treatment period and/or the date the contaminant was first produced.	Human and environmental toxicity will be specific to the contaminant and the physical or chemical form that the contaminant is in.

H Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

H

Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment

HAIL activity intention

Description	<p>Land that is not a HAIL site but is adjacent to, or within influencing distance of, sites that use hazardous substances can be affected by the activities undertaken at the site, given the contaminants of concern.</p> <p>The land has been subject to migration of hazardous substances from an adjacent site on which there is a confirmed unconfined source of contamination that is, or has been, at or above applicable environmental guideline values.</p> <p>Migration of contaminants can occur through multiple pathways including groundwater, airborne particulates, vapour intrusion or overland flow.</p>
Applicability	<p>This activity covers land where contaminants from adjacent sites poses a risk to human health or the environment to the land.</p> <p>This includes:</p> <ul style="list-style-type: none"> land with no history of HAIL activities having taken place, but where contaminants from a HAIL activity on an adjacent site have migrated to the land, in concentrations that could result in adverse effects on human health or the environment land where one or more HAIL activities have occurred, but where the land has additionally been affected by contaminants from a HAIL activity on an adjacent site to the extent that the contaminants pose a risk to human health or the environment. <p>A contaminant or contaminants must be present on an adjacent site at concentrations that exceed applicable environmental guideline values, indicating that a risk to human health or the environment exists.</p> <p>A pathway must exist that enables the contaminants to migrate from the source site to the land.</p> <p>Land impacted by contaminants from an adjacent site would be classified under HAIL activity H only once the migration of contaminants at levels that could pose a risk to human health and/or the environment is confirmed. Documentation or evidence should be available that confirms the presence and level of contamination, such as a detailed site investigation report.</p> <p>Land where a HAIL activity has taken place that is also subject to HAIL activity H should be recorded under the relevant HAIL activity and additionally under HAIL activity H.</p>
Contamination setting	<p>At first glance, there may be no obvious reason for identifying this land as a HAIL site, because it does not have a history a hazardous activity or industry taking place there. However, there is a contaminated HAIL site close to the land. The contaminants have been shown to be, or have been, at high concentrations above acceptable standards and guidelines. Contaminants are also mobile, and there are no barriers or mitigation measures to prevent them crossing property boundaries. These contaminants can migrate using one or more pathways and are likely within the land’s soil and groundwater.</p>

HAIL activity intention

	<p>The factors that may influence whether the land will be impacted by the contaminated site include:</p> <ul style="list-style-type: none"> • the concentration, mass, volume and mobility of contaminants that have been identified on the contaminated site • the soil type on the contaminated site and the land, for example, impermeable or porous • the depth and direction of groundwater and whether it flows toward the land • the topography supports the likelihood of migration, for example, direction of overland storm flow • preferential migration pathways that should be considered (eg, underground service trenches). <p>Other than the migration of liquids over or through the ground, there are other pathways by which contaminants can migrate from a contaminated site. These include aerial deposition of particulates or aerosols and migration of ground gas and vapours through soils.</p>
Exclusions	Not applicable.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination.

The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Groundwater migration	The movement of contaminants either dissolved in, or floating on, groundwater forming a plume.	<p>The contaminants move with the groundwater. They can adsorb on to soil particles contaminating the soil.</p> <p>The abstraction of contaminated groundwater for drinking water, stock water or irrigation.</p> <p>Discharge of contaminated groundwater to surface water.</p>	<ul style="list-style-type: none"> • The physical and chemical properties, permeability and topography of soils and proximity to sensitive receiving environments • The groundwater flow direction and velocity. • Types, volume and properties of contaminants in the groundwater, including their solubility, density, persistence and toxicity. • The contaminant source. What was spilled, how much was spilled and when was it spilled? • Have any remedial or mitigation actions been taken, for example, sealed surfaces, permeable reactive barriers, containment walls?
Gas and vapour migration	The migration of gases and vapours through soil or the desorption of gases or vapours from contaminated groundwater, for example, from landfills or solvent plumes.	The gases and vapours migrate into buildings and confined spaces where they may pose an asphyxiation, explosive or exposure risk.	<ul style="list-style-type: none"> • The contaminant source. How much gas and vapour may be generated? • Types, volume and properties of the gases and vapours, including their volatility, density, persistence and toxicity. • The physical and chemical properties, permeability and topography of soils and proximity to sensitive receiving environments. • Preferential pathways, services, cracks in building structure. • Atmospheric conditions – air pressure and temperature.

Activity	Description	Mechanism of contamination	Risk factors
			<ul style="list-style-type: none"> • Have any remedial or mitigation actions been taken, for example, gas and vapour barriers?
Surface migration	The transport of contaminated material by water flowing over the land. This is likely when heavy rainfall occurs.	Contaminated particulates or dissolved contaminants deposited on to soil or into waterbodies following heavy rainfall or the cleaning or water blasting of surfaces.	<ul style="list-style-type: none"> • The contaminant source – the concentration of contamination that is or was present on the source site. • Types, volume and properties of the gases and vapours, including their volatility, density, persistence and toxicity. • The physical and chemical properties, permeability and topography of soils and proximity to sensitive receiving environments. • Preferential pathways, services and cracks in building structure. • Atmospheric conditions – rain frequency and intensity. • Have any remedial or mitigation actions been taken, for example, bunds and interceptors?
Particulate migration	The transport of small or light contaminated particles and aerosols by the wind. For example, long term stack discharges or a large fire.	<p>Contaminated particles and aerosols are deposited on land or waterbodies and accumulate to concentrations that pose a risk to health and/or the environment.</p> <p>Contamination of land or waterbodies via this pathway is considered to unlikely, unless prolonged particulate discharges have occurred.</p>	<ul style="list-style-type: none"> • The contaminant source – the concentration of contamination that is or was present on, or released from, the source site. • The duration and frequency of releases from the source site. • Types, volume and properties of the particulates and aerosols, including their persistence and toxicity. • The physical and chemical properties, permeability and topography of soils and proximity to sensitive receiving environments. • Atmospheric conditions – wind direction and strength. • Any remedial and mitigation actions that have been taken, for example, air control systems, fencing.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

This is not associated with any specific HAIL activity and therefore potential for a wide range of contaminants exists. The characteristics or properties of contaminants or hazardous substances will be dependent on the contamination that has been identified on the contaminated site that is adjacent to, or within influencing distance of, the land.

I Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment

HAIL activity intention

Description	<p>Land that is not a HAIL site but where the release of contamination could pose a risk to human health or the environment.</p> <p>The intentional or accidental release of a hazardous substance does not necessarily refer only to consented discharges. It can cover many types of situations, including accidental discharges of fuel or chemicals from mobile operations.</p>
Applicability	<p>This activity applies when:</p> <ol style="list-style-type: none"> 1) the land is not HAIL, and 2) it has been subject to a confirmed on-site release of hazardous substances or contaminants, and 3) the contamination is likely to be, or have been, at or above the applicable soil contaminant standard and environmental guideline value for the land.
Contamination setting	<p>At first glance there may be no obvious reason for identifying this land as a HAIL site if it doesn't have a history of having undertaken a hazardous activity or industry. However, there has been a release of contaminants on to the land and soil and/or groundwater concentrations are likely to be at or above the applicable soil contaminant standard and environmental guideline values for the land.</p> <p>Examples of intentional or accidental release of hazardous substances include:</p> <ul style="list-style-type: none"> • transport accidents and spills of hazardous substances or dangerous goods, where a release has occurred, and • fires and burn pits.
Exclusions	<ul style="list-style-type: none"> • A HAIL site.

Activity factors – Aspects or characteristics of a HAIL activity that relate to the potential of the activity to cause contamination and/or affect the extent, severity or nature of the contamination. The potential for contamination of soil or groundwater from the use, storage and disposal of hazardous substances will be dependent on many risk factors and complete hazard-pathway-receptor linkages. This is dealt with in more detail in Contaminated Land Management Guidelines No. 5 and as part of a preliminary site investigation.

Activity	Description	Mechanism of contamination	Risk factors
Release of hazardous substances	The intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.	Discharges of solid and/or liquid hazardous substances or contaminants on to land that pose a risk to vulnerable receptors, groundwater, and surface water.	<ul style="list-style-type: none"> • Types and volume of chemicals or wastes released, their physical form and properties, including their persistence and toxicity. • Permeability and topography of soils and surfaces and proximity to sensitive receiving environments. • The period and frequency over which releases occurred.

Substance factors – characteristics or properties of contaminants or hazardous substances that affect the exposure risk, such as mobility, persistence and duration of use and changes over time. For specific information about individual substances, always refer to the safety data sheet, where available. For specific information about the links between the contaminants of concern and the exposure risk, refer to Contaminated Land Management Guidelines No. 5 – Section 3: Conceptual site model.

This is not associated with any specific HAIL activity and therefore potential for a wide range of contaminants exists. The characteristics or properties of contaminants or hazardous substances will be dependent on the contamination that has been identified on the contaminated site that is adjacent to, or within influencing distance of, the land.

Part C: Supplementary information and additional considerations

The information provided in part C is intended to clarify some of the concepts, terms and definitions most inconsistently applied.

Emerging contaminants

Emerging contaminants (current or future) are substances that exhibit unidentified, unquantified or poorly understood adverse effects on human health or the environment.

While many will not be identified in the current activity profiles, they will need to be considered as part of the HAIL identification and risk assessment.

Due to the developing situation in respect of per- and poly-fluoroalkyl substance (PFAS) contamination, PFAS has been incorporated into the HAIL activity profiles.

Hazardous substances and contaminants

It is important to note that this guidance is concerned with chemical contamination to which exposure would pose a risk to human health and the environment. It is not concerned with the storage of hazardous substances and chemicals that result in above-ground physical impacts (eg, explosion risk from LPG storage) or biological impacts (eg, potential for illness and disease from water or airborne pathogens).

Persistence

The term 'persistence' refers to the resistance of a substance to break down through natural processes in soil, sediment or groundwater. It is an important characteristic of contaminants that relates to how long one can expect the contaminant to pose a risk to human health or the environment once it has been discharged to land.

The persistence of a substance is indicated by the term half-life, which is the time it takes for the concentration of the substance to reduce by 50 per cent.

In this guidance, substances have been broadly classified as either persistent or non-persistent. A substance with a degradation half-life in soil of six months or greater is considered persistent under Annex D (1)(b) of the Stockholm Convention on Persistent Organic Pollutants.

When assessing land, the persistence of contaminants may determine whether the land is covered by a HAIL activity or not. To determine persistence, it may be necessary to review international literature, or safety data sheets may include information about the half-life of the particular compound.

Bulk storage

The risk to human health and the environment has the potential to increase as the volume of chemicals stored increases. However, the risk is also dependent on other factors, such as toxicity. When considering whether a substance meets the threshold of bulk storage, you must consider the toxicity, volume and potential scale of the effects on health and the environment.

In this guidance, bulk storage refers to:

- substances that trigger a regulatory control due to a combination of hazardous properties and volumes
- larger quantities or volumes of chemicals than would be expected to be stored by an average person.

Bulk is a relative term and for some substances could be less than 2 litres and for others more than a tonne. In general, hazardous substances stored for commercial use or purposes can be considered to be bulk storage as an initial starting point, although this should always be evaluated on a site-by-site basis.

Bibliography

ANZECC. 1992. *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. Canberra, Australia: Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council.

ANZECC. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Volume 1: The guidelines*. Canberra, Australia: Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. Retrieved from www.agriculture.gov.au/SiteCollectionDocuments/water/nwqms-guidelines-4-vol1.pdf (15 June 2018).

BRANZ. 2017. *New Zealand Guidelines for Assessing and Managing Asbestos in Soil*. Porirua: BRANZ Limited.

Canterbury Regional Council. 2013. *Sports turf scoping study Canterbury – Report No. R12/115*. Christchurch: Environment Canterbury.

Cavanagh J, Munir K. 2016. *Development of soil guideline values for the protection of ecological receptors (Eco-SGVs): Technical document*. Envirolink Tools Grant: C09X1402 – updated June 2019. Manaaki Whenua – Landcare Research.

Cavanagh, J. 2019. *Updating the Ecological Soil Guideline Values (Eco-SGVs)*. Envirolink Grant: 1935-GSDC156. Manaaki Whenua – Landcare Research

CL:AIRE. 2018. *Department of the Environment Industry Profiles* (Published in 1995). Contaminated Land: Applications in Real Environments, United Kingdom.

Gaw S, et al. 2014. University of Canterbury. *Envirolink Report 1473 – Guidance for assessment of sites in accordance with category A10 of the Hazardous and Activities Industry List (HAIL)*. Christchurch: University of Canterbury.

Gaw S, James T. 2015. University of Canterbury. *Review of potential soil contamination issues from pesticide use in productive land and sports fields – Envirolink Report 545*. Richmond: Tasman District Council.

James T, Gaw S. 2015. *Review of Potential Soil Contamination Issues from Pesticide Use in Productive Land and Sports Fields*. Report to Tasman District Council, Client Report 545. Hamilton: AgResearch Limited.

Ministry for the Environment. 1997. *Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand*. Wellington: Ministry for the Environment.

Ministry for the Environment. 1999. *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (Revised 2011). Wellington: Ministry for the Environment.

Ministry for the Environment. 2001. *A Guide for the Management of Closing and Closed Landfills in New Zealand*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2004. *Contaminated Land Management Guidelines No. 3: Risk Screening System*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2006. *Contaminated Land Management Guidelines No. 4: Classification and Information Management Protocols* (Revised 2011). Wellington: Ministry for the Environment.

Ministry for the Environment. 2006. *Identifying, investigating and managing risks associated with former sheep-dip sites: A guide for local authorities*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2011. *Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values* (Revised 2011). Wellington: Ministry for the Environment.

Ministry for the Environment. 2011. *Hazardous Activities and Industries List (HAIL)*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2011. *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2011. *Toxicological Intake Values for Priority Contaminants in Soil*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2014. *Managing Environmental Effects of Onshore Petroleum Development Activities (Including Hydraulic Fracturing): Guidelines for Local Government*. Wellington: Ministry for the Environment.

Ministry for the Environment. 2021. *Contaminated Land Management Guidelines No. 1: Reporting on Contaminated Sites in New Zealand* (Revised 2021). Wellington: Ministry for the Environment.

Ministry for the Environment. 2021. *Contaminated Land Management Guidelines No. 5: Site Investigation and Analysis of Soils* (Revised 2021). Wellington: Ministry for the Environment.

Ministry for the Environment. 2022. *New Zealand's updated National Implementation Plan under the Stockholm Convention on Persistent Organic Pollutants*. Wellington: Ministry for the Environment.

National Chemicals Working Group of the Heads of EPAs Australia and New Zealand. 2020. *PFAS National Environmental Management Plan*. Version 2.0. NEMP 3.0 is in draft, to be finalised.

New Zealand Institute of Chemistry. 1998. *Chemical Processes in New Zealand*. Second Edition. Auckland: New Zealand Institute of Chemistry.

NZWWA. 2003. *Guidelines for the safe application of Biosolids to Land in New Zealand*. Wellington: New Zealand Water and Wastes Association.

Robinson BH, Yalamanjali R, Reiser R, Dickinson NM. 2018. *Lithium as an emerging environmental contaminant: Mobility in the soil-plant system*. *Chemosphere*. Christchurch: University of Canterbury.

The Secretariat of the Stockholm Convention. 2009. *Annex D of the Stockholm Convention on persistent organic pollutants (POPS)*. United Nations Environment Programme, Nairobi.

United States Environmental Protection Agency. 2022. [Regional Screening Levels \(RSLs\) – Generic Tables](#) (November 2022). Washington DC, United States of America: USEPA.

WasteMINZ. 2022. [Technical Guidelines for Disposal to Land](#) (Revision 3). Waste Management Institute New Zealand (WasteMINZ) Auckland.

Wolf DC, Cryder Z, Khoury R, Carlan C., Gan J. 2020. [Bioremediation of PAH-contaminated shooting range soil using integrated approaches](#). Riverside, United States of America: Department of Environmental Sciences, University of California.

World Health Organization. 1998. [The impact of cemeteries on the environment and public health – An introductory briefing](#). Geneva, Switzerland: World Health Organization.