Chapter 3

Assessment of asbestos contaminated sites

3.1 Overview

The WHS and health regulations described in Chapter 2 allow for immediate asbestos removal and soil clean-up of asbestos soil contamination associated with contemporaneous demolition of structures, recent illegal surface dumping and/or limited residual surface or low scale impacts. Where immediate removal is not possible due to the nature, extent or spread of contamination and there is a need for further assessment, a decision may be made to report the affected property as a contaminated site (Section 2.1). Once a site is reported, the investigation, assessment and management process is set out in the Contaminated Sites Guidelines (external site) and National Environmental Protection (Assessment of Site Contamination) Measure (ASC NEPM).

The key objective of an asbestos contaminated site investigation is to characterise the nature, quantity and extent of the asbestos in the soil in sufficient detail to inform remediation and/or management of the site for the protection of public health. As such, the scope of site investigations and the sampling and analysis plan must be aimed at:

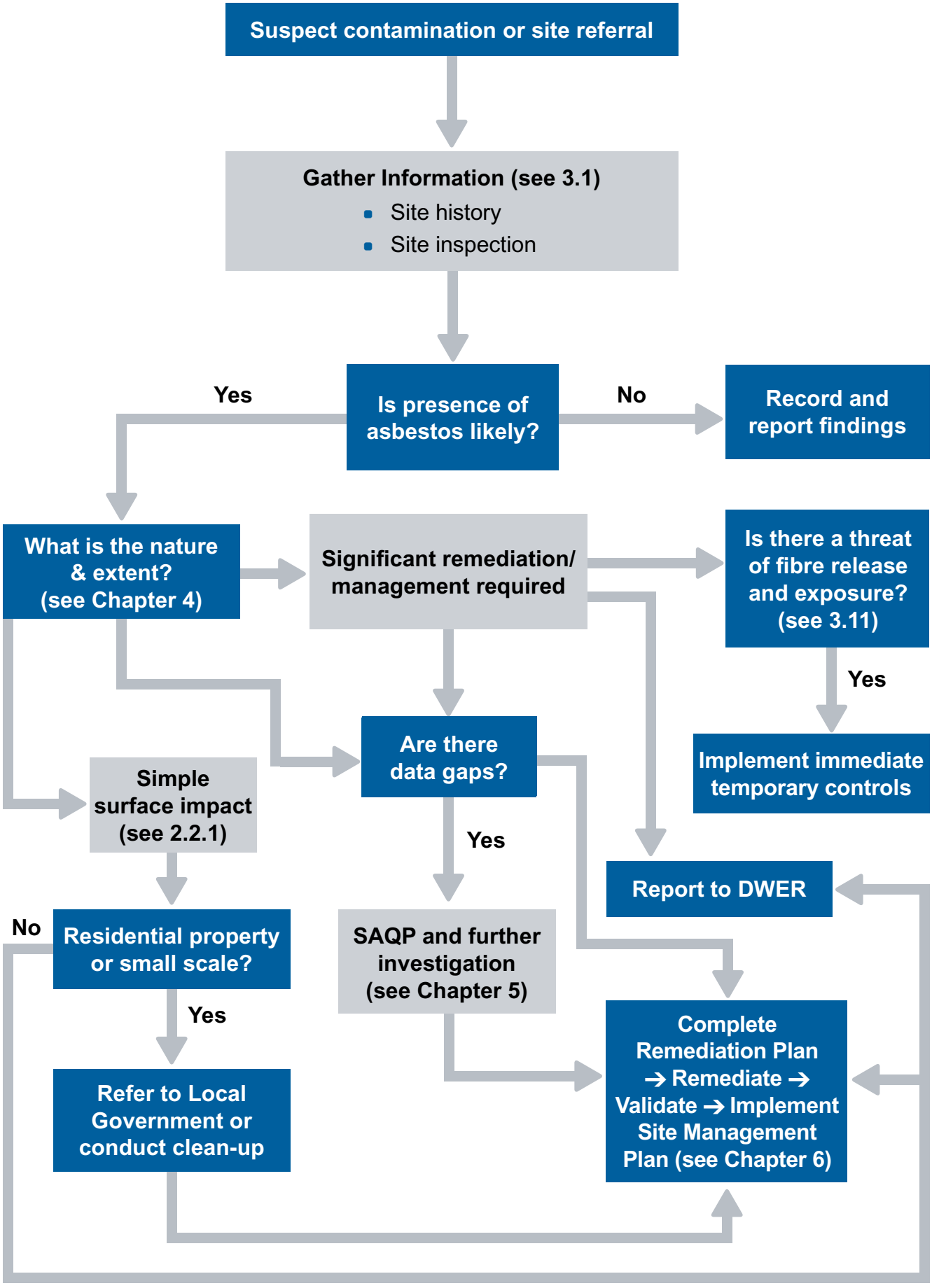
- addressing the data gaps regarding the nature, quantity, location and dispersion of asbestos contamination
- proposing feasible remedial options and developing a remediation plan/procedure for the preferred option
- establishing validation criteria for the removal or containment of sources of asbestos contamination.

Asbestos is a nationally controlled and regulated hazardous substance with restrictions on use, sale/supply, transport and disposal. As such, the decision for remedial action is often taken where contamination is found above screening levels (Tier 1 assessment) without undertaking further risk assessment.

The processes for further assessment (Tier 2 and 3) assessment and health risk assessment are described in the ASC NEPM Schedule B4 (external site). A health risk assessment may be completed and occur as part of a more detailed site investigation or as a separate activity/report. A health risk assessment may be undertaken to address real or perceived health risks associated with the site and can aid stakeholder communication and consultation.

Remediation options are preferred, which minimise the potential for release of airborne asbestos fibres and also minimise the volume of asbestos contaminated material handled, transported and disposed to landfill. Where feasible, containment and management in situ is supported.

Figure 5 Site investigation and management process



3.2 Site investigation process

Site investigations must be undertaken in accordance with the Contaminated sites guidelines: Assessment and management of contaminated sites, (DWER 2021) (external site).

The initial steps of an investigation undertaken for assessment and management of contaminated sites include:

- checking the site history
- systemic visual site inspection/walkover
- preliminary soil sampling.

These steps are important in determining the likely presence, type, condition, quantity, and distribution of suspect asbestos contamination, developing a conceptual site model, and directing any subsequent investigation and management actions.

Given the physical nature of asbestos contamination, particularly bonded ACM, much more information can be gathered at the early stage of an investigation than for other contaminants. Visual indicators and field sampling provide immediate results, and data gaps may be addressed as they arise. Results from sampling and field analysis can be used to implement pre-considered remediation and validation actions. For example, for an investigation area with simple surface bonded ACM impacts, it may be possible to concomitantly:

- complete the site investigation
- delineate the impacted area through successive surface sampling
- undertake multiple passes to record and remove the surface impact
- validate the impacted area as clear of visible bonded ACM on the final pass.

Early confirmation of the presence or potential for asbestos contamination has three main advantages:

1. Early consideration of possible remediation/management options.
2. Protection of site workers before more extensive site investigation works being undertaken.
3. Prevent the spread of contamination.

If asbestos contamination is missed and is then accidentally dispersed across the site through earth disturbance, a much larger area may require investigation and remediation. This would prove to be a protracted and costly exercise.

Asbestos contamination needs to be identified early and properly handled to ensure subsequent disturbance and dissemination does not occur across the site and result in costly delays and extra investigative and remediation effort.

The need for a more extensive investigation will depend on the conceptual site model (CSM) data gaps. (See Section 3.7). Further investigations may provide:

- greater accuracy in delineating the lateral and vertical extent of impacts to inform site remediation plan/procedures
- a better understanding of future land uses and activities that may lead to the release of airborne fibre and possible receptors, e.g. maintenance workers for underground services, trespassers, recreational activities, construction/site works.

Additional investigations may also be necessary where new evidence of contamination arises, such as:

- vandalism or degradation of structures containing asbestos on a reported site
- identifying new contaminated areas, e.g. following site excavations
- wind or storm damage
- cross-contamination by earthworks and movement of materials and stockpiles

Information from additional investigation may be used to update conceptual site models to include any changes in site conditions, surrounding environment and possible receptor exposures.

3.3 Site history

A site history or desktop investigation consists of compiling and assessing information from relevant records and interviews. This investigation should include:

- historical site use, including site buildings, structures and associated utilities which have the potential to contain asbestos
- an evaluation of records to determine the presence of asbestos in any remaining or demolished structures, including any:
  - asbestos register
  - demolition permits, asbestos removal plans and/or clearance certificates
  - site or building plans
  - previous environmental or geotechnical investigations identifying building or commercial/industrial waste
  - local authority records/permits
- Landgate (external site) records
- anecdotal information regarding the site history and use (sources include site owner/family members, neighbours, local government, historians)
- analysis of historical aerial photographs to identify past structures and possible disposal, burial and dumping activities
- information relating to the character and extent of any fill material, especially that which was derived from building waste
- the likelihood of unexpected discovery of building(s) and/or structure(s) that main contain asbestos that may be in the pathway of planned soil disturbance.

The above information should be reviewed to identify situations where asbestos contamination may be expected or suspected to be present, such as:

- industrial land, e.g., asbestos-cement manufacturing facilities, former power stations, and rail and ship yards, especially workshops and depots
- waste disposal or dumping sites, e.g. building waste
- pre-1990 buildings or structures damaged by fire or storm
- land with fill or foundation material of unknown composition
- commercial and residential sites where buildings or structures have been constructed using bonded ACM or where asbestos may have been used as insulation material, e.g., asbestos roofing, sheds, garages, reservoir roofs, water tanks, boilers

- sites where pre-1990s buildings or structures have been improperly demolished or renovated, or where the relevant documentation is lacking
- disused services made from asbestos cement – e.g., water pipes, telecommunication trenches or pits.

Where a clearance certificate/report has been provided for site demolition and removal activities, it must be reviewed together with any available asbestos removal plans to ensure that soil contamination was addressed at the demolition/removal stage. A comprehensive clearance report and asbestos removal plan that addresses soil contamination issues may be relied upon if there is no further evidence of asbestos contamination from recent or past land uses.

3.4 Site inspection

More intensive initial site inspection/walkover is expected for asbestos contaminated sites, given the physical nature of the contaminant. Surface inspection methodology can include the early sampling of bonded ACM and other suspect materials (see Chapter 5 for sampling methodologies).

When reporting the site inspection/walkover results, it is critical that the report comments specifically on the presence or absence of asbestos material and the inspection methodology.

The inspection methodology should be based on set objectives developed from a conceptual site model (see Section 3.7). The site inspection methodology must be scoped and designed to adequately inform decision making for subsequent stages of investigation or management.

The focus should be on judgmental investigation of areas that have (or are suspected of having) asbestos contaminated soils, e.g. waste deposits, former building footprints. Consider the following:

- site history (Section 3.3)
- areas that could reasonably be expected to be contaminated (e.g. building footprints)
- visible evidence of contamination
- the likely distribution and scale
- the likely depth of contamination
- hidden contamination (e.g. dense vegetation, buildings and structures, hardstand areas)
- soil type and physical properties.

The site inspection/walkover should include a description of:

- any remaining asbestos-containing structures, especially if in poor repair
- footprints of demolished structures (including fences, drains and soakwells)
- waste and debris on the surface of the site
- any uncontrolled fill (particularly if it contains building or industrial waste).

Site walkovers for finding surface asbestos occurrence and distribution should be grid-based to facilitate good coverage of the site and facilitate the logging of visible evidence of possible contamination. Areas with suspect or known asbestos contamination should then be surveyed and assessed in more detail (see Chapter 5).

Visual inspection reports need to include comments on the presence or absence of any suspect asbestos or other indicative findings and the inspection methodology. The decision-making parameters and methodology used for inspection, including any variations from these guidelines, should be justified and reported

EXAMPLE – SITE INVESTIGATIONS AND FINDING EVIDENCE OF ASBESTOS CONTAMINATION

All field technicians and contract workers working with AAA Enviro Consultancy Pty Ltd have completed in-house asbestos in soil training course and on the job mentoring program. Company procedures state that suspect asbestos contamination sources need to be recorded at every stage of any site investigation.

During the initial walkover at a commercial/industrial site, a field technician notes the location of suspect waste building waste materials on a map of the site. The site is divided into large grids, and a field notation is made of the densities of different type of debris as they walk over a grid area. Broken bricks, concrete, fibre-cement fragments and tiles are noted in particular grids. A number of test pits are made in the grid areas of observed contamination to consider the vertical extent of observed surface impacts. All test pits show that debris is found no deeper than 15 cm from the surface.

An investigation area is defined by the lead investigator based on the findings of the site walkover and site history. An SAQP is developed that includes dividing the investigation area in smaller 2 m x 2 m grids, collecting suspect debris for bulk identification to confirm the presence of asbestos, and soil cross raking and sampling to 15 cm. All suspect asbestos materials are separated, weighed and described. Several fragments of suspect asbestos contamination representing the variety of visual materials observed are sent for laboratory confirmation for the presence of asbestos.

The bore logs for ground water monitoring wells include a detailed description of the soil layers and the presence/absence of introduced fill. The logs specifically state that no fibre containing waste (insulation, textiles, fibre-cement) or building waste debris is observed. The lead investigator confirms there is no site history evidence of uncontrolled fill at the site and considers all the information from the walkover, more detailed surface investigations, bore logs and site history before finalising the CSM.

3.4.1 Visual indicators of contamination

If contamination is from broken asbestos cement sheeting or other bonded ACM, where the material retains its integrity, any co-located AF (smaller size fraction material) may be considered ‘trivial’ in proportion to the bulk bonded ACM source. In these circumstances, the investigation and remediation areas can be assessed and validated using bonded ACM as the primary measure of contamination.

The presence of other building or industrial waste material may suggest/provide evidence for the presence of asbestos contamination.

It may also be possible to visibly distinguish bulk FA in soil. However, FA mixed in soil may not be visible and may be best sampled as AF (see Chapter 5).

3.4.2 Laboratory confirmation of contamination

3.4.2.1 Suspect materials

Laboratory confirmation for suspect materials is important as the appearance of bonded ACM or FA in the ground is disguised through destruction and discolouration such that it may become difficult to identify.

It is possible to assume the presence of asbestos within a material based on knowledge of asbestos-containing products and the age and appearance of materials. The alternate assumption must not be made (that a suspect material does not contain asbestos). However, it is recommended that a NATA accredited laboratory always confirms the presence of asbestos in suspect materials.

Figure 6 Examples of known asbestos-containing materials – fibre rope seal, textile materials and weathered low density fibre board.

3.4.2.2 Asbestos Fines in soil

Laboratory confirmation for AF in soil would be indicated where asbestos contamination has been severely degraded or broken down, leading to a likely increased proportion of AF in soil.

For example, observation of unusually high numbers of very small sized debris that suggest the destruction of original source material or site history suggesting the destruction of material, including:

- evidence of pulverising, crushing, cutting, sawing, sanding, or other means of the breakdown of bonded ACM into fine material
- use of high-pressure cleaning of asbestos cement sheeting.
- damage by fire or other natural disasters
- severe weathering/deterioration (Figure 7).

Where FA is suspected to be present, it may be more readily broken down into fine material and mixed with soil, which will make it difficult to identify and quantify visually. As such, the delineation of contamination is likely to require soil sampling and laboratory analysis for FA as AF in soil (See Chapter 5).

Figure 7 Fire damaged asbestos cement flue.

Figure 8 FA in soil (photo courtesy of Aurora Environmental).

3.5 Sampling

Chapter 5 – Sampling, Monitoring and Analytical Methods, provides detailed information on sampling methodology and common analytical methods for assessing asbestos contamination.

3.6 Delineating extent of contamination

Delineating the extent of asbestos contamination is required to inform remedial options where asbestos is present at or above screening levels. Information to be considered for delineating the impact is provided below.

- Where there is good information on the origin of the asbestos contamination, the lateral investigation area can be considered to include the entire area likely to have been impacted, with confirmatory sampling extending slightly beyond the suspect area in all directions.
- The depth of contamination may be either be inferred from the desktop investigation or informed by targeted sampling.
- In both the above cases, the need to confirm the extent of contamination will depend on site-specific data requirements for possible remedial options and data gaps/uncertainty associated with the suspected area of impact.

3.7 Conceptual site model

A conceptual site model with illustrated source-pathway-receptors must be derived that includes all activities associated with the site, including existing and future uses. Possible receptors include:

- site remediation personnel
- earth moving and construction workers
- site visitors and trespassers
- future owners/occupiers
- adjacent residents or workers
- underground service maintenance workers.

Consideration should be given to any asbestos remaining in structures that will be subject to demolition or disturbance so that they can be handled in compliance with the WHS legislation and in such a way, they do not result in asbestos soil contamination.

The only exposure pathway of concern is inhalation of airborne respirable fibres. As such, consideration must be given to the potential for activities at the site to generate or release respirable fibres. While natural erosion forces may be considered, in most circumstances, these are unlikely to significantly contribute to an amount of exposure to respirable particulates within a recipient's breathing zone to a level or duration that increases disease risk.

For a simple assessment (Tier 1), a precautionary approach is taken that assumes an exposure pathway is complete where there are people at the site, and a recipient could interact with the asbestos contaminated material (e.g. recipients have access to the asbestos in soil either at the surface or from excavations). Tier 2 assessment may include a more comprehensive site-specific exposure assessment that includes the factors outlined in Section 3.11.

3.8 Screening levels for asbestos in soil

In establishing screening criteria, consideration has been given to the following principles and assumptions used for regulating and controlling asbestos at a National level:

- screening criteria do not distinguish between commercial asbestos mineral fibre types
- the reporting, assessment and management of asbestos contamination under the CS Act provides a mechanism to inform and protect persons from potential future exposure to asbestos-contamination
- fibres are more likely to be released from both FA and AF than from bonded ACM
- bonded ACM in soil is assumed to eventually (over a long period) degrade to asbestos fines as a result of damage or destruction over time
- exposure to asbestos, which has no evidence of a threshold level for mesothelioma risk, should be kept as low as reasonably practicable.

The criteria are summarised in Table 2 and remain the same as in previous Department of Health guidance. A background in establishing screening criteria is provided in Appendix One.

Table 3 Asbestos in soil screening levels

Site uses[4]	Soil asbestos screening criteria
All site uses – FA	10 mg/kg (0.001 %) w/w asbestos
All site uses – AF	10 mg/kg (0.001%) w/w asbestos
Residential A – bonded ACM	100 mg/kg (0.01 %) w/w asbestos
Residential B – bonded ACM	400 mg/kg (0.04 %) w/w asbestos
Recreational C – bonded ACM	200 mg/kg (0.02%) w/w asbestos
Commercial/Industrial D – bonded ACM	500 mg/kg (0.05%) w/w asbestos

3.8.1 Application of investigation and screening levels

The criteria for FA and AF remain fixed for all site uses as there is high uncertainty associated with quantifying asbestos concentrations below 0.01% w/w asbestos. As such, the sampling error and lack of analytical sensitivity in establishing concentration differences between 0.001% w/w and 0.01% w/w would make any adjustment at this order of magnitude meaningless. Example calculations for estimating asbestos in soil concentrations are provided in Appendix Two.

Inadequate sampling strategies rather than lack of accuracy in the adopted analytical methods characteristically limit the effective evaluation of sites contaminated by asbestos.

As for other contaminants, the results from soil analysis must be interpreted in the context of the information obtained from the broader site investigation and applying professional judgement on whether the criteria have been exceeded. More information is provided in Appendix B1 (external site), Section 3 of the ASC NEPM.

[4] Classification of site uses as per the ASC NEPM.

The use of statistics may be appropriate in some circumstances. However, justification for the use of statistics, along with a description of any limitations and assumptions and compliance with DWER Contaminated Sites Guidelines and ASC NEPM, must be provided.

The final decision regarding assessment against criteria should include multiple lines of evidence for which statistics may contribute but not be the sole decision-making parameter. If using statistical analysis, the following must be considered:

- where more than one distinct fill or soil stratum is impacted, separate determinations should be made for each section
- sampling strategy, including sample locations, sampling methods, and sampling density, is designed to find localised hot spots
- sampling strategy considers future subdivision plans with a sample distribution that includes each proposed lot
- where an individual sample result is equal to or greater than 0.1 % w/w asbestos soils, for any form of asbestos, the surrounding soils are subject to higher density sampling to confirm/delineate a hot spot and the impacted soils remediated.

For mixed waste materials (e.g. coarse aggregate material vs soil), a judgemental and semi-quantitative approach may be necessary to estimate the contamination concentration. The extent of the investigation and the sampling plan should consider the remediation options for the mixed waste materials present at a site. Where it is necessary to provide advice against criteria, professional judgement will be required. It is expected that sufficient justification is provided within reports to support any decisions made.

3.8.2. Surface contamination

In addition to meeting the criteria in Table 2, the accessible ground surface (as designated by site investigations or the 10 cm default) should be free of visible bonded ACM and FA at the end of the remedial site works (expected site clean-up criteria). There are two main objectives for remediating the soil surface to be visibly free of asbestos:

1. Minimises the potential for ready access to any contamination (such as isolated fragments), resulting in further deterioration or misuse.
2. Addresses aesthetic, public perception and other regulatory expectations specific to asbestos.

3.8.2.1 Accessible ground surface determined by site investigation

The accessible, readily disturbed surface layer should be differentiated from the underlying soils when describing the site's soil profile. The factors in defining the surface soil layer and the depth to which superficial asbestos contamination is observed or can be reasonably expected to be found are:

- activities undertaken at their site and their frequency (e.g. walking, driving, sports activities)
- the likely depth of soil disturbance from site activities
- any mitigating factors (e.g. ground cover, compaction, soil type and condition).

For example, shifting and sandy soils with no ground cover may have surface bonded ACM contamination extending beyond 10 cm depth that can be encountered when walking or playing in the sand.

Test pits or other sampling methods may be used to verify/justify the inspection/remediation depth of the surface impacted soils.

3.9 Derivation of site-specific clean up criteria

The screening criteria are often used as default soil clean up goals. Site-specific clean up goals can be developed if any of a range of mitigating factors apply, such as the depth or form of contamination, binding or stabilising soil characteristics, or the nature of surface coverings.

The derivation of site-specific clean-up criteria should be limited to those parameters that will not change character with time. For instance, surface cover is less useful as its extent and integrity can change, whereas contamination depth is less likely to change. In applying this approach, the adjustment of each parameter must be justified and supported by evidence.

The parameters that best lend themselves to the derivation of site-specific criteria are:

- soil character
- contamination depth
- contamination lateral spread
- analytical method.

If any of these parameters are demonstrated to be mitigating for a particular site, they can apply to any of the asbestos types present, i.e. bonded ACM, AF and FA. The only exception is the analytical method parameter, as it relates only to AF.

Soil character would be an addition to current investigation requirements, and additional sampling will have to be undertaken to confirm parameters and provide confidence in any proposed site-specific clean-up goals.

Additional information on how the above parameters can be considered in the derivation of clean-up goals is available in Appendix Three. These parameters are also important in exposure assessment (Section 3.11).

As asbestos is a banned and controlled hazardous substance/waste, the second objective of remediating asbestos contamination must be considered, which is to inform site owners, occupiers and users regarding the presence of asbestos and enable compliance with all legislation. If all mitigating factors are considered, the amount of bonded ACM, AF and FA that can remain in the soil at levels that do not increase public health risk may still be subject to control by other legislation. **As such, the derived site-specific screening clean up goals may not exceed the maximum level of 0.1% w/w asbestos in soil**. That is, for deriving site-specific criteria, even where all the mitigating factors apply, and the conceptual site model demonstrates that there is no unacceptable health risk, the maximum amount of material that can remain at a site without any form of remediation, control, or management is 0.1% w/w asbestos.

The derivation of site-specific clean-up goals will most likely be applicable in supporting sustainable, in situ remediation and management options.

Any adjusted site-specific goals must still be below 0.1% w/w asbestos content (Globally Harmonised System of Classification and Labelling of Chemicals (GHS)).

When considering regulatory requirements (and potential requirements for analytical testing) of soil being removed from a site, practitioners should first address whether the soil meets the definition of waste. (see Factsheet – Assessing whether material is waste (external site)). Material removed from site for disposal or re-use that meets the definition of waste will need to comply with the *Environmental Protection (Controlled Waste) Regulations 2004* and *Landfill Waste Classification and Waste Definitions 1996* (as amended 2019).

3.10 Air guidelines

A practical air quality control limit of 0.01 fibres per millilitre (f/mL) asbestos applies to all **removal work**, including around contaminated sites, as described by the Membrane Filter Method. [NOHSC:3003(2005) (MFM). (See Section 5.9.1)

It is important to note that the control limit **should not be used to evaluate recipient exposure risks**.

Exposure should always be minimised to as low as can be achieved by implementing effective dust control measures.

Personal sampling results for any site personnel should be below the occupational exposure standards (0.1 fibres/mL) or the site-specific action level adopted as part of the workplace risk assessment.

No ambient air guidelines have been set for asbestos. A cumulative exposure of 0.01 f/mL.yr is estimated to increase risk above 1 x 10^{-5} for mesothelioma for crocidolite and amosite fibres (Hodgson and Darnton, 2000). Exposure assessment would need to consider the duration of exposure and, potentially, the use of air monitoring reference methods that allow for a lower limit of detection.

Dust (particulate) monitoring may accompany other asbestos specific sampling during remediation activities for more immediate responses to any failures in dust management measures. The Air NEPM 24-hour guidance goal of 50 µg/m^3 for PM_{10} (particulate matter with an equivalent aerodynamic diameter of 10 µm or less) is often applied as an action level for total dust control.

3.11 Exposure assessment for public health

A quantitative or qualitative exposure assessment that assumes reasonable and probable worst-case exposure scenarios can be undertaken for asbestos contamination. Such an assessment can provide additional confidence in conclusions and recommendations, aid in health risk communication and/or provide support and justification for site-specific clean-up goals.

The magnitude of the asbestos contamination hazard depends on the potential for respirable fibres to be released from soil which is influenced by among other things:

- the type and condition of asbestos present
- the quantity/concentration of asbestos present in soil
- the depth and extent of contamination
- soil type and physical properties
- nature of surface coverings, including presence of vegetative cover
- soil moisture content.

Exposure assessment should consider reasonable worst-case seasonal variations for each of the above factors at each site. Also, the measurement of various parameters, e.g. soil moisture, can be included in the sampling plan.

It is also important to note that while the above factors are suitable for understanding the magnitude of the asbestos in soil hazard, the most significant contributing exposure factor will be the human activities/tasks that directly create and/or release dust and airborne fibres.

Exposure assessment should consider:

- future site uses
- the duration and frequency of dust-generating activities and likely levels of airborne (respirable fraction) particulates
- quantification or estimation of fibre in air concentrations during current and future site activities
- mitigation through proposed remediation and management measures.

Methods for completing an exposure assessment include:

- qualitative exposure assessment based on investigation and assessment of the site, activities undertaken, the potential for particulate/fibre release and expected air concentrations
- task/activity-based sampling for activities being undertaken at the site
- simulation of past or future tasks/activities likely to be undertaken at the site (may require additional approval from WorkSafe Division or the WorkSafe Commissioner).

It is not easy to estimate exposure for all uses of a site confidently. The feasibility of undertaking monitoring during exposure assessment should be carefully considered (See Section 5.9.2). However, in some circumstances, such as to demonstrate support for sustainable options for in situ remediation or to provide health risk information on possible past exposures, it may be justified.

If the elements of the risk determination change during the subsequent site operations, such as by uncovering unexpected additional asbestos material or as indicated by air monitoring results, the exposure assessment should be reviewed, and the CSM updated.