Appendix C: Measures for the Asbestos Contaminated Sites

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1.1 ASBESTOS SOIL CONTAMINATION

The risk of asbestos is mainly associated with inhalation of fibres which is a severe risk to human health compared with other commonly occurring exposure routes. Asbestos fibres are considered to be carcinogenic and therefore even low levels of exposure to dust or fibres can pose an unacceptable level of risk. There is no definitive 'safe' level of exposure to asbestos.

Asbestos is not a chemical toxin in the sense applied within the overall Framework for the Management of Contaminated Land in South Africa and thus a slightly different approach has to be adopted when assessing sites which may be potentially contaminated with asbestos.

Recently various administrations have attempted to develop asbestos soil guidelines based on a reduction of risk approach supported by cancer risk assessments based on 'weight of evidence', however the uncertainty in target risk levels may deviate by several orders of magnitude from actual relevant values and thus numerical screening values are not sufficiently underpinned by scientific data to have a wide practical application in assessing contaminated soils.

It should be noted than the application of asbestos regulations and advisories intended for the protection of workers in an occupational scenario have limited application in assessing asbestos risk associated with contaminated soils and that monitoring techniques applied in the occupational environment may need to be modified for monitoring environmental health concerns. Furthermore although asbestos is a hazardous air pollutant no Air Quality Standards for ambient air quality have been published in South Africa.

The South African Occupational Health and Safety Asbestos Regulations (2001) define 'Regulated Asbestos Fibre' as follows:

> *Regulated Asbestos Fibre means a particle of asbestos with a length to diameter ratio of greater than 3 to 1, a length greater tha 5 micometers and diameter of less than 3 micrometers.*

Asbestos is a terms that includes naturally occurring silicate minerals. In South Africa asbestos is defined as:

> *amosite, chrysotile, crocidolite, fibrous actinolite, fibrous anthophyllite, and fibrous tremolite, or any mixture containing any of these minerals.*

As the ingestion of asbestos fibres from contaminated water is an unusual pathway to develop under normal circumstances and the exposure route is not particularly sensitive in terms of human health risk the soil screening values for protection of water resources is several orders of magnitude greater than the those determined for the inhalation pathway and thus only gross levels of asbestos contamination far in excess of human health limits for inhalation exposure would be trigger the need for remedial action. In this case remediation criteria will always be governed by the risk of asbestos inhalation and other pathways are not generally worth detailed consideration.

The 1996 Department of Water Affairs guideline for Drinking Water Quality is 1 million fibres/litre

In the overall context of the 'Framework' the Section on Asbestos Soil Contamination is included as an initial guidance based on a risk management approach. No soil screening values are proposed for asbestos in soil. For detailed discussion of asbestos soil contamination, sampling and analytical methods and the assessment of risk and remediation and management of asbestos contaminated sites, as best international practice, the reader is referred to the following reference:

Western Australia Department of Health (2009) 'Guidelines for the Assessment of Asbestos-Contaminated Sites in Western Australia.

1.2 CHARACTERISTICS OF ASBESTOS CONTAMINATION

Asbestos is a priority contaminant of concern in South Africa due to a long history of mining, manufacturing and use as construction and building materials. There are thus a wide variety of potentially contaminated sites from primary and secondary contamination associated with mining waste dumps, manufacturing dumps and residues and demolition wastes and activities.

Asbestos soil contamination can take the form of either bulk material in a primary setting as waste dumps or as residual demolition rubble and aggregate, or can be more widely distributed as Secondary Asbestos Contamination in the form of scattered fragments of asbestos aggregate or as fibres in soil.

In terms of physical properties that influence the risk release of asbestos to air four forms can be recognised.

Asbestos Containing Material (ACM)

Asbestos which is cemented and physically bound in a matrix commonly used as building materials. The ACM is defined as fragments that cannot pass through a 7mm diameter sieve (i.e. the typical thickness of asbestos cement sheeting), The smaller fragments of ACM are crushed and therefore have a higher likelihood for fibre release. ACM is generally a highly stable form of asbestos with a low risk of fibre release unless severely weathered or crushed by construction traffic. ACM is defined as containing at least 1% asbestos by weight. Normally the concentration of asbestos in building materials does not exceed 15% by weight.

Fibrous Asbestos (FA)

Fibrous poorly bound asbestos, typical of asbestos insulation materials. Includes degraded and weathered ACM which crumbles under hand pressure.

Asbestos Fines (AF)

Described as free-fibres, or as asbestos dust, consisting of single fibres and small fibre bundles. A high risk category of asbestos that can pose a significant health risk if fibres are made airborne.

Naturally Occurring Asbestos (NOA)

Consideration of natural background values is important in the derivation of site specific remediation criteria for asbestos. As a natural occurring mineral in rocks it can be expected that widespread background levels of asbestos contamination will be a feature of most asbestos mining areas and can also occur in non-mining areas where the soils are derived from greenstone rocks with a high proportion of chrysotile or asbestiform amphiboles.

1.3 ASBESTOS CONTAMINATION OCCURRENCE

Asbestos contamination can occur in a wide variety of situations the most common sites which are associated with widespread asbestos use are as follows:

Known and likely asbestos contamination is associated with the following activities:

- Asbestos mines and associated stockpiles and dumps, including adjoining land.
- Asbestos manufacturing facilities
- Power Stations,
- Rail-yards and ship-yards, especially workshops and depots
- Waste disposal or dumping sites, particularly where building waste has been disposed of.

Suspect or possible asbestos contamination is associated with following situations:

- Derelict building sites, particularly where structures have been damaged by fire or storm and complete demolition or removal has not been undertaken
- Disused sites where asbestos was used as a building material and where redundant underground services are likely to consist of ACM piping.
- Land with fill of unknown composition.

The widespread use of asbestos building material in South Africa has also lead to the contamination of various natural soil and gravel aggregates used in the construction of roads and even in some building concrete aggregates. This may be particularly prevalent in former mining areas.

Areas that are covered by hardstanding and are likely to remain undisturbed do not require investigation.

1.4 ASBESTOS CONTAMINATION SITE ASSESSMENT

Phase 1 Site Assessment should identify the risk posed by possible asbestos contamination as detailed below.. Asbestos concentrations need to be determined for specific locations and specific soil strata and thus the weight of ACM should not be averaged across the total mass of soil at a site to determine a bulk site contaminant loading. Determination of asbestos concentrations from bulk soil samples is only valid where there is no visible evidence of asbestos contamination and the bulk soil material can be regarded as being homogeneous and representative of the uppermost 100mm of soil on site.

For ACM

$$\text{Soil Asbestos } \% = \frac{\% \text{ Asbestos Content } \times \text{ ACM (kg)}}{\text{soil volume (L)} \times \text{soil density (kg/L)}}$$

% Asbestos content for ACM is normally a maximum of 15%

Soil density can be assumed to vary from 1.65 kg/L for uncompacted sands and sandy fill to 1.8 kg/L for compacted soils.

1.4.1 Site assessment process

The assessment of asbestos soil contamination is highly dependant on field sampling and analytical detection. Interpretation of the results of sampling programmes need to evaluated with care and their limitations understood before arriving at a risk assessment or remediation objective.

A simple stepwise criteria for qualitative site assessment is as follows :

- Visually determine existence of asbestos contamination of soil by type and condition.
- Determine existence of asbestos fibres in soil by laboratory testing.
- Determine type of land use and anticipated activity patterns of human receptors and relate this to be likelihood of fibre release from soil to airborne exposure routes.

Judgemental sampling which targets a particular area of a site that is known or likely to be contaminated by asbestos is the preferred approach to site characterisation. If visible asbestos is recognised it can be assumed that the soil surrounding the visible asbestos is also contaminated within a 1m radius of the asbestos to account for uncertainty in sampling.

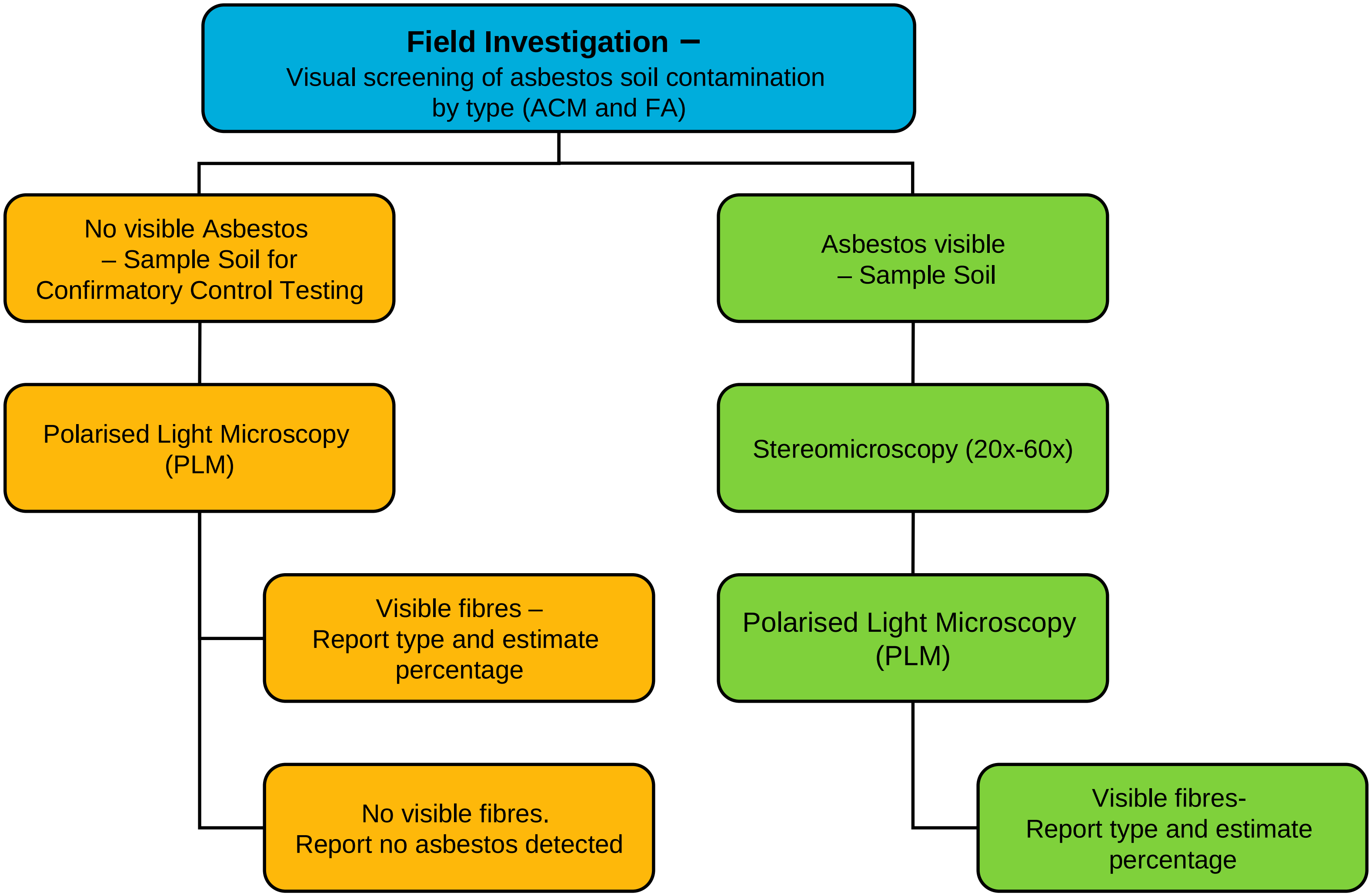
Surface soil sampling is by visual inspection and manual collection of soil samples and ACM where possible using a rake (teeth spacing must be <7mm). Care should be taken not to damage or bury asbestos during sampling.

Deeper soils should be investigated by trial pitting or trenching. Precautions to protect samplers, workers and the general public from excavation hazards and potential fibre release must be implemented. Boreholes are less suitable means of investigation as the opportunity for visual assay is very limited. Borehole sampling may be acceptable if the site has restricted access or obstructions that make trial pitting difficult or if the risk of asbestos dust release during excavation is unacceptable.

Sampling patterns should allow for secondary distribution of asbestos;

- due to vandalism or degradation of structures containing asbestos
- removal and demolition of structures containing asbestos
- cross contamination by construction earthworks, transport of asbestos wastes, crushing and fibre release by vehicle activity, storm damage to structures containing asbestos.
- dispersion and deposition of asbestos contamination by wind erosion and erosion and deposition of asbestos by stormwater flow

Figure 1. Testing methodology for assessing asbestos contamination in soils



Although the approach to sampling and testing of asbestos in soils is based on a tiered system of visual assay it is important to include a number of samples of soil for microscopic analysis that do not appear to have any visible asbestos. These control samples can be used to validate the visual assessment of the site and to provide detection screening for asbestos fibres that may not be apparent to the naked eye. The number of control samples is site dependant but at least 1 sample in 10 should be used for quality control purposes.

1.4.2 Analytical Methods for Asbestos in Soils

It is important to note that the accuracy and precision of all forms of asbestos determination is not comparable to chemical laboratory techniques. Most techniques require visual estimation of asbestos fibres in sub-samples derived from larger bulk samples of soil. As the distribution of asbestos in soil is highly variable the choice of a more precise (and expensive) high magnification technique may not provide more confidence in the bulk concentration of asbestos in soil than a similar semi-quantitative technique applied to a large number of samples.

The preferred method above includes visual screening using stereomicroscopy followed by more detailed visual estimation using Polarised Light Microscopy (PLM). It should be noted that a number of samples that have no visible asbestos should be subjected to examination by PLM in order to validate the results of the less precise screening step.

Asbestos dust in soil is very difficult to analyse for and requires the use of advanced microscopic techniques including Scanning Electron Microscopy (SEM) Or Transmission Electron Microscopy. In general this step is unlikely to be required for assessing asbestos soil contamination. The presence of abundant asbestos fibres in a soil sample can be taken as an indication of a substantial amount of asbestos fines and the high risk status of the site will not be influenced by the results of the more precise testing which can be regarded as a confirmatory measurement.

The limitations of microscopic methods of asbestos detection are not related to the sensitivity of the technique. Asbestos fibres are optically distinctive and even very low numbers of fibres can be detected with time and patience. It is however difficult to achieve consistent reproducible quantitative analyses and this problem tends to be most critical at the levels that may best define an acceptable risk. For instance an asbestos level in soil of 0.01% weight/weight asbestos may find general acceptance as a criteria for defining an acceptable risk. It is however unlikely that the available analytical techniques can provide a level of certainty at levels much below 0.025%. The limitations of laboratory determination must be considered when setting practical target levels for asbestos remediation. Reduction of risk by taking all reasonable measures to reduce exposure to asbestos by elimination of the exposure pathways is thus the favoured and precautionary approach to remediation and is not over-reliant on analytical certainty