PRACTICAL CONSIDERATIONS IN ASSESSING ASBESTOS IN SOIL

John Howell, Senior Toxicologist, Environmental Health
Presentation Scope

- Asbestos soil contamination and risk
- Asbestos soil assessment case study
- Asbestos fire contamination
Asbestos Context

- Australia was one of the greatest past asbestos users
- Asbestos fully banned 2003, no new use or reuse
- Still huge presence of asbestos in pre-1987 buildings
- Mainly asbestos cement sheeting: walls, roofs, fences
- 30-70 yrs old & subject to deterioration & disturbance: removals, demolition, refurbishments

- Background levels of fibre in air – urban 0.0001 f/ml
- Everyone has asbestos fibres in their lungs
- Australia (esp WA) has highest mesothelioma rate in world
Determining Asbestos Risk

- Best based on real measured health effects – ARDs
- Complicated by time lag, exposure uncertainty & confounding causes e.g. smoking
- For lower levels of exposure mesothelioma incidence is best basis – sensitive, specific, lethal
- Background level of mesothelioma risk is 1 per million person years ie \(70 \times 10^{-6}\) for a lifetime
- Incidence trending from past asbestos industries tradies, DIYers, asbestos professionals? Public?
Trends of Mesothelioma from 1960-2013

- Will numbers keep increasing or has it peaked?
Public Health Risk

- In absence of detailed ARDs incidence info, general qualitative risk estimates possible based on:
  - Population size
  - Potential exposure level
  - Potential duration

- Also need to account for perception & regulations

- For specific situations semi-quantitative estimates possible also using dose/response curves, asbestos type & fibre features, air measurements/estimates, population knowledge & activity info
## Scenario-based Public Health Risk Matrix

<table>
<thead>
<tr>
<th>Exposure Scenario</th>
<th>Population Size</th>
<th>Exposure Level</th>
<th>Exposure Duration</th>
<th>Individual Risk</th>
<th>Population Risk</th>
<th>Risk Perception</th>
<th>Management Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIY Renovations</td>
<td>Medium</td>
<td>High</td>
<td>Low-medium</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Education efforts</td>
</tr>
<tr>
<td>Contaminated Land</td>
<td>Medium-high</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Well regulated</td>
</tr>
<tr>
<td>Weathered/Worn/Broken</td>
<td>Medium-high</td>
<td>Low – very low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Poor regulation</td>
</tr>
<tr>
<td>Pressure Cleaning</td>
<td>Low</td>
<td>Medium - high</td>
<td>Low-medium</td>
<td>Medium</td>
<td>Low-medium</td>
<td>High</td>
<td>Rare but managed</td>
</tr>
<tr>
<td>Fire damage</td>
<td>Low-medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low-medium</td>
<td>Low-medium</td>
<td>High</td>
<td>Varied regulation</td>
</tr>
<tr>
<td>Dodgy Removals</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>?? regulated</td>
</tr>
<tr>
<td>Dodgy Demolitions</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>?? regulated</td>
</tr>
<tr>
<td>C&amp;D Recycling</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td>New regulations</td>
</tr>
<tr>
<td>Mining Activities</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>New regulations</td>
</tr>
<tr>
<td>Dumping</td>
<td>Medium</td>
<td>Very low</td>
<td>Low</td>
<td>Very low</td>
<td>Low</td>
<td>Medium</td>
<td>Managed</td>
</tr>
</tbody>
</table>
Sources of Asbestos in Soil

- On site building waste
- Dodgy demolitions and removals
- Dumping
- Uncontrolled fill
- Roof runoff to soil, soak wells, water bodies
- Use of contaminated C&D recycle material
- Asbestos material shedding & dispersal e.g. fires
- Asbestos material disposal/internment
Is soil risk management adequate?

- NEPM/WA Guidelines comprehensive
- But generic & conservative, especially the HILs:
  - Aim of $10^{-6}$ (> background?)
  - Extrapolation to bonded material (only $\uparrow 10x$)
  - Likely presence of amphibole basis
  - Assumption of dry conditions (\downarrow 10x)
  - Life time exposure
- How widely & effectively implemented? In WA well!
- Would work better with regulator engagement & site specific cleanup criteria methodology
WA Risk Management Activity

- Scenario specific guidance i.e. dwelling demolition, mining activities, regional parks, fire/disasters, C&D
- Site Specific Criteria Methodology?
- Revision of *Health (Asbestos) Regulations 1992*:
  - Public health evidence based e.g. DIY
  - Alignment with OHS legislation, interagency synergy
  - Education and empowerment of LG EHOs
  - Multi-scenario guidance
Asbestos Soil Assessment*
NEPM/WA Management Principles

Both pieces of guidance state:

- Undertake detailed site investigations only when really necessary
- Treat asbestos contamination primarily in terms of Bonded ACM where appropriate i.e. minimise soil lab analysis
- Manage asbestos contamination *in situ* wherever possible
- Place emphasis on a weight-of-evidence approach

Also actions are expressed in terms of “should”, “recommend”, but allow for justified alternatives.
The Differences

- Technically NEPM varies by <5% from WA Guidelines
- NEPM written differently & divided between S1 & S2
- NEPM has more OHS emphasis
- NEPM has significantly less investigative detail
- NEPM lacks remediation, validation & reporting info
- NEPM lacks the supporting guidance documents & advisory system

Differences in usability? WA still uses own!
INTEGRATED SUMMARY OF THE NEPM (CONTAMINATED SITES ASSESSMENT) AND WESTERN AUSTRALIAN GUIDELINES RELATING TO ASSESSMENT AND MANAGEMENT OF ASBESTOS IN SOIL

Purpose

This document identifies in general terms and references key recommended practices contained in the asbestos provisions (Schedules B1 and B2) of National Environmental Protection Measure (Contaminated Site Assessment) (Amended 2013) (NEPM) and the Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009 (Guidelines). In doing so the NEPM takes precedence, with the Guidelines providing additional guidance as necessary, especially on site remediation and management.

NEPM Schedule B1 – Guideline on Investigation Levels, Section 4

Context and Screening Levels

- Applies to assessment of all types of asbestos site contamination but not asbestos in surface wastes, buildings, structures or operational pipelines. (S4.1)
- Site assessors should comply as necessary with national and jurisdictional work health and safety legislation and guidance related to asbestos. (S4.3)
- Work involving asbestos-contaminated soil is permitted if a competent person has determined that the soil contains no visible asbestos material or non-visible material if suspected. Visible asbestos should be removed with documentation prior to work commencing. (S4.3)
- A competent person is one who has acquired through training, qualification or experience, the knowledge and skills to identify, investigate and assess asbestos in the context of an environmental site assessment. (S4.3)
- Categories of asbestos contaminants include: bonded asbestos-containing material (B-ACM – non-friable, sound matrix material, above 7x7mm in size), fibrous asbestos (FA – friable and fibrous material), and asbestos fines (AF – sub-7mm material including free fibre). (S4.4)
- Assessment and management of asbestos contamination should take into account the asbestos condition and potential for damage and fibre release. (S4.6)
- The screening levels of asbestos (pure equivalent weight-for-weight (w/w)) in soils which trigger further investigation and/or management are as follows (S4.8):

<table>
<thead>
<tr>
<th>Form of asbestos</th>
<th>Residential A</th>
<th>Residential B</th>
<th>Recreational C</th>
<th>Commercial/industrial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonded ACM</td>
<td>0.01%</td>
<td>0.04%</td>
<td>0.02%</td>
<td>0.05%</td>
</tr>
<tr>
<td>FA and AF* (friable asbestos)</td>
<td></td>
<td></td>
<td>0.001%</td>
<td></td>
</tr>
<tr>
<td>All forms of asbestos</td>
<td>No visible asbestos for surface soil</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 0.001% w/w applies for FA and AF only when gravimetric determinations are possible, and is not applicable to free fibres. (S4.8)
Western Australian Guidelines

Additional Assessment Information
- Greater detail and more issues covered in regard to a PSI (Chapter 2) and DSI (Chapter 3).
- The recommended density for judgmental and grid sampling will depend on the likelihood of asbestos contamination and be some multiple of the minimum density outlined Appendix A as applied based on Section 3.2.4.
- For the residential criteria of 0.01% w/w asbestos, this % corresponds to about one 3 x 3 cm ACM (i.e. B-ACM) fragment (10gm) per m² on the surface or in a 10L bucket of soil. (WA Health advice)
- Guidance is provided on stockpile sampling. (Section 4.1.6)
- A worked example is recommended for asbestos contamination calculations. (Section 4.1.7)
- Asbestos and dust air monitoring may be necessary during any DSI, remediation and site development, and should meet the Guidelines (0.01fl/ml) and NEPM criteria (FM10P of 50 µg/m³ over 24 hours), respectively. (Sections 4.2 and 4.2.4)
- For naturally occurring asbestos in situ, sampling should concentrate on delineating and characterising specific areas where human exposure is likely. (Chapter 4 Preamble)
- The Guidelines include the following relevant Appendices:
  - B - Management of small-scale low-risk asbestos contamination
  - C - Immediate response actions
  - D - Contingency plans

Risk Assessment and Remediation
- Any risk assessment should use a tiered approach including preparing a conceptual site model. (Section 5.1)
- Qualitative human health risk assessment is acceptable and should take account of any risks associated with the remediation options as well as proposed future land-uses. (Section 5.1.3).
- Risk mitigating factors can include asbestos mineral type, impact depth, and soil type and moisture content. (WA Health advice)
- Investigation criteria can be used as generic clean-up goals, or alternatively site-specific clean up goals can be developed. (Section 5.1.3)
- Important considerations in deciding upon remediation methods include minimisation of: public health risk; soil disturbance; and removal of contaminated material to landfill (Section 5.2).
- The remediation approach should be justified in terms of advantages/disadvantages in comparison with other remediation options. (Section 5.2)
Case Study

- Owner wishes to develop 10 ha site for low/med housing with gardens and POS areas.
- State Planning Commission requires environmental assessment.
- Owner wants to avoid any residential title encumbrances.
- What should owner do based on the NEPM guidance?
  - Hire “competent”* consultant to undertake a PSI.
PSI Process

What was found from the desktop study:

- Block open to road in N & drains to SE corner, some fly tipping.
- Plantation & organic market farm from 1968 to 1993.
- Brick/tile house & 3 cement sheeting sheds built in NE corner 1969.
- 20m diameter dam built in SE 1969 with corrugated cement sheet walls.
- 2003 - buildings demolished (little documentation) & debris moved to centre of block, dam buried with fill from southern development & new cement fence erected around W, S & E boundaries. No previous fence.
- 2004 – timber elements of debris stockpile burnt by vandals.
Where might asbestos contamination occur?

- Possible dumping along main road or access tracks.
- As debris at original building site, stockpile & on the route between them.
- As fine material near stockpile resulting from fire.
- Possibly along fence line.
- Debris associated with dam or covering fill.
How should site inspection (walkover) be undertaken?

- Develop plan, including contingencies and protective measures.
- On a judgmental grid basis, tighter for high probability areas.
- Look for visual indicators & take representative**B-ACM/FA or surface soil lab samples as necessary.
- Document and photograph.
# Grid-Based Site Inspection

<table>
<thead>
<tr>
<th>Zone</th>
<th>Area</th>
<th>Insp. Grid*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Fence-line</td>
<td>900 x 2m (1800m²)</td>
<td>Linear x 2m</td>
</tr>
<tr>
<td>B “Fly-Tip”</td>
<td>10 x10m (100m²)</td>
<td>2m x 2m</td>
</tr>
<tr>
<td>C Building Footprints</td>
<td>80m x 50m (4000m²)</td>
<td>4m x 4m</td>
</tr>
<tr>
<td>D Dam</td>
<td>25m rad. (2000m²)</td>
<td>4m x 4m</td>
</tr>
<tr>
<td>E Stockpile (black)</td>
<td>60 x 50m (3000m²)</td>
<td>4m x 4m</td>
</tr>
<tr>
<td>E Area (yellow)</td>
<td>120 x 80m minus stockpile (6600m²)</td>
<td>5m x 5m</td>
</tr>
<tr>
<td>Rest of site</td>
<td>5.5ha</td>
<td>10m x 10m</td>
</tr>
</tbody>
</table>
Surface visibility adequate for selected grid dimensions.

Corrugated fence (A) not asbestos based on age & features. Good condition & no adjacent debris.

Fly tipping (B) included 7m$^3$ building debris & big sound cement sheet pieces sitting on surface. Lab tested asbestos positive.

Building site (C) had numerous small sound cement sheet fragments. Positive for asbestos. Possibly >0.01% ie > 3x3cm fragment m$^2$. Brick/tile fragments. Soil disturbance.

Stockpile (Eb) - likely B-ACM both sound & burnt. Representative & lab soil samples positive, also for fibre/chips nearby (Ey). Nil for haulage track.

Dam site (D) showed no surface building debris. Surface appearance & old vehicle tracks agree with likely fill import from southern area.

Rest of site OK.
### Conceptual Site Model

<table>
<thead>
<tr>
<th>Zone</th>
<th>Source(s)</th>
<th>Pathways</th>
<th>Receptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None - Non B-ACM fence panels. No B-ACM history</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>B</td>
<td>Dumped demolition waste - large pieces of B-ACM sheeting</td>
<td>Disturbance of B-ACM causing airborne asbestos fibres</td>
<td>Local pedestrian traffic Site intruders, including children Construction workers Future residents</td>
</tr>
<tr>
<td>C</td>
<td>Surface B-ACM fragments around former buildings Possible foundation termite chemicals</td>
<td>Disturbance of B-ACM causing airborne asbestos fibres. Soil disturbance causing chemical affected dust release</td>
<td>Site intruders, including children Construction and utility workers Future residents</td>
</tr>
<tr>
<td>D</td>
<td>Possible B-ACM lined dam covered with fill</td>
<td>Excavation of buried B-ACM causing airborne asbestos fibres</td>
<td>Construction and utility workers Future residents</td>
</tr>
<tr>
<td>E</td>
<td>Demolition waste stockpile with fragmented and burnt B-ACM (FA) Crushed B-ACM &amp; possible wind-blown AF on adjacent surface soils</td>
<td>Disturbance of B-ACM causing airborne asbestos fibres Disturbance of B-ACM/AF material</td>
<td>Site intruders, including children Construction workers Existing adjacent residents Future residents</td>
</tr>
</tbody>
</table>
PSI Recommendations

- Implement an Immediate Response Action Plan (IRAP) incorporating warning signage, temporary fencing & dust management measures.
- No further actions re fence line (A).
- Fly tipping (B) is simple surface impact. Professional manual removal, hand-picking & raking if necessary (2x at 90°).
- Stockpile (Eb) be delineated contaminated for management.
- Contamination not defined for stockpile surrounds (Ey), former building site (C) & dam area (D) DSI.
DSI Preparation

- Develop a Sampling and Analysis Plan.
- Incorporate Contingency Plan*.
- Incorporate Dust Management Plan*.
- Notify neighbours and local government.
- Specify screening criteria i.e. 0.001% for any AF, B-ACM 0.01% for housing, 0.02% for POS areas.
Excavate 60cm deep trenches across centre of whole area (incl. footprints), 1 N-S, 1 E-W. Or > 22 Grid/Judgmental short trenches.*

Find depth of soil disturbance, >10L sample for B-ACM per 5m of long trench, or per short trench.

Disturbance down to 20cm, B-ACM >0.01% (3x3cm frag per bucket) in 35% samples across broad area.

Undertake till sampling/remediation to 30cm across whole area on 10m x 10m basis.

Some grids >0.01% 1st pass, not 2nd.

Finish with 10cm certified clean fill cover (or raking).
Assume & conservatively manage as fibre contaminated, or undertake further sampling then management as follows (WA Guidelines vs NEPM vs WA Fire)*:

- Focus on delineating outer contamination boundary.
- Grid/Judgmental - 30 x >500ml wetted lab samples. 2cm x 20cm x 20cm i.e. surface slice
- 15 positives at low levels, boundary within yellow zone.
- Surface skim to 5 plus cm on sector stage-wise basis. Dust management and fibre monitoring.
- Validated clean visually plus Judgmental/Grid15 lab samples, as above.
- Excavated material managed with debris stockpile (Eb).
Stockpile (Eb) Plan/Results

- Proposed POS in SW corner excavated as containment cell 3 m deep.
- Stockpile & excavated apron material transferred.
- Dust management and dust/fibre monitoring.
- Contamination buried under warning barrier & 1m local clean fill.
- Contamination subject to Ongoing Site Management Plan (OSMP) – Memorial on Title, surface treatment, SOPs.
Dam Site (D) Plan/Results

- Excavate 150cm deep trenches across centre of whole area, 1 N-S, 1 E-W. Or > 14 Grid/Judgmental short trenches
- Determine nature of any sub-fill material sample fill @ 10L per 7 m of long trench, or per short trench, for each suspect strata.
- B-ACM cement sheeting at 90-150cm depth, no likely B-ACM fragments or building debris in fill.
- Dam area to become a POS and managed as part of OSMP etc. Current barrier depth sufficient, plus other measures.
Asbestos and Fire
Features of Asbestos Fires
(asbestos cement)

- 1000s WA asbestos fires pa
- Three major relevant bushfires in last 4 years
- Breaking, shattering & spalling
  - Spalling i.e. delamination/flaking from explosive steam release, fibre bundles mainly parallel to sheet surface
- Potential for scatter & dispersion by fire effects, wind action, fire fighting & rain
- Probability of matrix compromise -> friable
- Possibility of asbestos denaturing -> less toxic
Likely Asbestos Impacts

- Bulk material in building footprint/remaining structure
- Adjacent coarse fragment scatter (brittle/friable)
- Flake deposition nearby & especially with plume track
- Fire fighting water runoff
- Initial free fibre & fibre bundles:
  - Not a lot is released
  - Massively diluted/dispersed
  - Not denatured
Asbestos Fire Flake under EM
Where is the Risk?

- Disturbance of footprint during remediation
- Disturbance of scattered/deposited material prior to or failing remediation
- Not dispersed/diluted free fibre/fibre bundles, in the case of most asbestos products
- Old coastal asbestos roofs in WA with blue asbestos of greatest concern
- Note the need to address copper-chrome-arsenate treated timber & other toxic residues
Impact Management

- EHD has done literature & regulatory review, sought input from frontline agencies & attended several fires

Draft Guidance Note on incident, immediate actions, assessment, remediation, validation & lessons which:
  - Integrates OHS & environmental guidance
  - Is mainly for LG & consultants
  - Has usability tools ie flow diagrams, checklists
  - Accompanied by a community brochure
  - Has by a technical/regulatory advice service
  - Includes other disasters
Attachment 5 - Asbestos contamination resulting from disaster events

In the case of asbestos impacts resulting from other disasters the management process may be often simpler and in some cases different from what is experienced with fire, especially major fires. Some of the features that may be associated with disaster related asbestos impacts are provided in the accompanying table. Also listed below are some of the situational factors that may require a more rigorous assessment and management process in regard to any asbestos contamination problem:

- Uncontrolled recovery demolition and soil disturbance
- Larger quantities of material
- Asbestos present as roofing and therefore elevated
- Poorer condition of the pre-existing asbestos material
- Dry and windy conditions
- Presence of amosite (brown asbestos) and in particular crocidolite (blue asbestos)
- Nearby undamaged residences, schools or buildings containing sensitive populations

<table>
<thead>
<tr>
<th>Asbestos Contamination Event</th>
<th>General Contamination Features</th>
<th>Contamination Management Aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone/major wind storm</td>
<td>On site &amp; potentially widespread downwind scatter of asbestos fragments, pieces &amp; sheets</td>
<td>Building fabric &amp; footprint</td>
</tr>
<tr>
<td></td>
<td>Largely well bonded asbestos debris, so lower risk</td>
<td>Scatter remediation by visual mechanical/manual removal and handpicking unless inadvertent burial</td>
</tr>
<tr>
<td>Earthquake</td>
<td>Likely in-situ contamination, except possibly any topping multi-storey buildings</td>
<td>Largely building fabric &amp; footprint specific remediation</td>
</tr>
<tr>
<td></td>
<td>Largely well bonded asbestos debris, so lower risk</td>
<td></td>
</tr>
<tr>
<td>Explosion (without fire)</td>
<td>Potentially larger area of circular contamination</td>
<td>Building fabric &amp; footprint</td>
</tr>
<tr>
<td></td>
<td>Possibility of brittle material but not in the form of flakes</td>
<td>Also focus on visible scattered possible brittle fragments</td>
</tr>
<tr>
<td>Fire (urban or bush)</td>
<td>See Guidance Note</td>
<td>See Guidance Note</td>
</tr>
<tr>
<td>Flood Damage</td>
<td>Potentially widespread downflow spread of asbestos pieces &amp; sheets</td>
<td>Building fabric &amp; footprint</td>
</tr>
<tr>
<td></td>
<td>Possibility of material being buried in other areas under debris &amp; sediment</td>
<td>Scatter remediation by visual mechanical/manual removal and handpicking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Possibly sampling &amp; excavation related to buried material</td>
</tr>
<tr>
<td>Hail Storm</td>
<td>Largely damage to asbestos roofing resulting fragments in roof space &amp; roof compromise</td>
<td>Handpicking &amp; preferably roof replacement rather than repair</td>
</tr>
</tbody>
</table>
Soil Assessment Features

- WA Guidelines primary reference
- Mainly delineation by observation
- Need for community reassurance e.g. consultation, staining of impacted areas, & air monitoring
- Treating all asbestos materials as friable
- Value of standardised procedures & personnel
- Close engagement with LG & regulators
- Possible presence of other toxic residues e.g. burnt CCA treated timber
In Conclusion

- Asbestos soil contamination is still a growing problem
- Concerns can be over- as well as under-managed
- We have many of the tools and resources
- There is still a need for some more of these & for engaged & flexible regulators
Webpage Details

WA Asbestos Guidelines etc available at:

http://www.public.health.wa.gov.au/3/1144/2/contaminated_sites.pm
(including low risk sites, mining, parks/reserves, fire..)

NEPM Asbestos Guidelines etc available at:
