National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April

Impact Statement

DRAFT VARIATION TO THE

National Environment Protection (Assessment of Site Contamination) Measure

September 2010

NEPC

NATIONAL ENVIRONMENT PROTECTION COUNCIL

This document is also available on our website
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Table of contents

1 Introduction

Site contamination is recognised as a major environmental issue for Australia. In addition to posing a possible threat to public health and the environment, contaminated sites have significant economic, legal and planning implications.

1.1 National Environment Protection Council

The National Environment Protection Council (NEPC) is a national body established by the Commonwealth, state and territory governments. The objective of the NEPC is to work cooperatively to ensure that all Australians enjoy the benefits of equivalent protection from air, water, soil and noise pollution and that business decisions are not distorted nor markets fragmented by variations in major environment protection measures between member governments.

The NEPC stems from the Inter-Governmental Agreement on the Environment 1992, which agreed to establish a national body with responsibility for making National Environment Protection Measures (NEPMs). The NEPC and its operations are established by the *National Environment Protection Council Act 1994* (Commonwealth) (the NEPC Act) and corresponding state and territory Acts.

1.2 National Environment Protection Measures

National Environment Protection Measures (NEPMs) are broad framework-setting statutory instruments, which, through a process of inter-governmental and community/industry consultation, reflect agreed national objectives for protecting particular aspects of the environment. NEPMs may consist of any combination of goals, standards, protocols, and guidelines, although for the assessment of site contamination, the NEPC Act specifies that guidelines may be developed. Implementation of NEPMs is the responsibility of each participating jurisdiction. Any supporting regulatory or legislative mechanisms that jurisdictions might choose to assist in implementation of proposed NEPMs are developed using appropriate processes in those jurisdictions.

1.3 Assessment of Site Contamination NEPM

Australia, as a signatory to the Rio Declaration, is committed to conserving, protecting and restoring the health and integrity of Australia's ecosystems. The development of the National Environment Protection (Assessment of Site Contamination) Measure (hereinafter in this document referred to as the NEPM) in 1999 was a significant step in ensuring that commitment was met.

The purpose of the NEPM is 'to establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, landowners, developers and industry'.

The desired environmental outcome for this NEPM is 'to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination'.

The NEPM comprises an overarching framework for the assessment of site contamination and its relationship to the management of site contamination. The NEPM (1999) is supported by 10 Schedules, which contain guidelines on various technical and administrative aspects of site assessment.

The NEPM and its implementation is a significant tool for the protection of human health and the environment with the redevelopment of sites, particularly former industrial areas in Australian cities. There is a continuing trend for redevelopment of former industrial areas for commercial and residential uses through urban renewal. Many of these former industrial areas may have hazardous substances in the soil and groundwater as a result of poor or inadequate operational practices associated with the manufacture, use, storage and disposal of chemicals. These substances can cause environmental and health concerns and, when disturbed, may render the land unsuitable for more sensitive land uses such as residential, educational and child care facilities. Often, the extent and degree of contamination at a site is dependent upon its physical characteristics such as soil type, depth to groundwater, or proximity to sensitive environments such as wetlands and rivers. Each site where contamination exists is therefore unique.

1.4 Variation to the NEPM

In varying a NEPM, the NEPC must have regard to a number of considerations. These are detailed in section 15 of the NEPC Act and include:

- consistency with the Inter-Governmental Agreement on the Environment 1992
- environmental, economic, and social impacts
- relevant international agreements
- any regional environmental differences.

In addition to addressing the requirements of the NEPC Act, impact statements are developed which are mindful of the requirements of the Council of Australian Governments as outlined in the Principles and Guidelines for National Standard Setting and Regulatory Action by Ministerial Councils and Standard Setting Bodies.

The NEPC Act requires that both the draft variation to the NEPM and the impact statement be made available for public consultation for a period of at least two months. NEPC must have regard to the impact statement and submissions received during public consultation in deciding whether or not to make or vary that NEPM.

1.5 Structure of this document

The structure of this document is as follows:

Section 1 Introduction

(This section)

Section 2 Public consultation documents

Section 2 describes the purpose of the documents released for public consultation and outlines the public consultation process. Details are also provided on how to make a submission.

Section 3 Background to the variation to the NEPM

Section 3 describes the role and objectives of the NEPM, an overview of why NEPC decided to vary the NEPM, and the decisions taken by NEPC in the lead up to that decision. The section also lists the Schedules (which contain guidelines) supporting the NEPM.

Sections 4 - 15 Variation to the NEPM

Sections 4 to 15 describe the nature, objective and impact of the variations to the NEPM and each of the Schedules.

Section 4	Variation to the Measure
Section 5	Variation to Schedule A – Recommended general process for assessment of site contamination
Section 6	Variation to Schedule B1 - Guideline on investigation levels for soil and groundwater
Section 7	Variation to Schedule B2 - Guideline on data collection, sample design and reporting
Section 8	Variation to Schedule B3 - Guideline on laboratory analysis of potentially contaminated soils
Section 9	Variation to Schedule B4 - Guideline on health risk assessment methodology
Section 10	Variation to Schedule B5 - Guideline on ecological risk assessment
Section 11	Variation to Schedule - B6 Guideline on risk-based assessment of groundwater contamination
Section 12	Variation to Schedule B7A - Guideline on health-based investigation levels and Schedule B7B - Guideline on exposure scenarios and exposure settings
Section 13	Variation to Schedule B8 - Guideline on community consultation and risk communication
Section 14	Variation to Schedule B9 Guideline on protection of health and the environment during the assessment of site contamination
Section 15	Variation to Schedule B10 – Guideline on competencies and acceptance of environmental auditors and related professionals.

Section 16 Summary of environmental, social and economic impacts

Section 16 provides a summary of the environmental, health, social and economic impacts of the variation. A number of case studies are included to illustrate the impacts.

Section 17 Shortened forms

This section provides the full terms for shortened forms used in the text of this document.

Appendix A COAG competition policy assessment

2 Public consultation documents

2.1 Introduction

In accordance with the requirements of section 18(1) of the NEPC Act, NEPC has authorised the release of a draft variation to the Measure and an impact statement for the assessment of site contamination. The purpose of this action is:

- to invite public comment on the appropriateness of the draft variation to the Measure and the impact statement
- to encourage public discussion on the development of appropriate guidelines for inclusion in the Schedules of the final Measure as varied
- to ensure the process of developing this variation to the Measure is as open and transparent as practicable.

2.2 Draft Variation to the Measure and Impact Statement Status

The draft variation to the Measure and the impact statement are provided as the basis for discussion about what the final Measure as varied (as required under the NEPC Act) might include and so does not carry the endorsement of the NEPC or any member government.

The draft variation to the Measure (and associated draft variation to the Schedules) and the impact statement are made available only for the purpose of obtaining comment. They should not be used as *de facto* guidelines.

2.3 Public Consultation

In developing and releasing this draft variation to the Measure and this impact statement, the NEPC recognises the importance of effective consultation during the development of the draft variation.

The NEPC is particularly interested in your comments, information and feedback about:

- the appropriateness of the draft variation to the Measure
- the usefulness of the draft variation to the Schedules
- the analysis of the potential environmental, social and economic impacts of the draft variation to the Measure as provided in this document.

The information provided will be used to facilitate the development of a robust final Measure as varied, and will maximise community ownership of this important document. A summary and response document, summarising the public comments made and the NEPC's responses, will also be developed.

2.4 Public Meetings

To assist people who wish to make submissions, public meetings will be held in every state and territory. These meetings will be advertised on the EPHC website at <www.ephc.gov.au>. It is expected that the release of this draft variation to the Measure and this impact statement, and the subsequent consultation on its contents will lead to a better-informed community on the issues that need to be considered when developing the final Measure as varied.

The NEPC encourages you to make your views known on this matter and to make available any information that you consider pertinent to the development of the final Measure as varied. Your input will ensure that when the NEPC meets to make a decision on this important variation to the Measure, that decision is confidently made on the basis of the best possible information available.

2.5 Making a Submission on the Draft NEPM Variation and Impact Statement

Two months have been set aside for consultation on this draft variation to the Measure and this impact statement (24 September to 26 November 2010). All written submissions received on the draft variation to the Measure and this impact statement will be acknowledged by the NEPC. After the closing date for submissions (26 November 2010), they will be collated and categorised. The categorisation involves separating the submissions made on the various sections of the draft variation to the Measure and the impact statement, for example:

- comments raised on the draft variation to the Measure
- comments on the information included in the impact statement
- comments on the draft variation to the Schedules
- additional information on the potential economic, health, social and environmental consequences of making this variation to the Measure.

An electronic form for lodging comments is available. The form can be emailed to you by the NEPC Service Corporation or downloaded from the EPHC website at <www.ephc.gov.au>. This form can be filled out and submitted electronically.

Should you wish to provide your comments in another format, submissions may be made by:

- email to swhitehead@ephc.gov.au
- hardcopy sent to Ms Kerry Scott
  Project Manager
  NEPC Service Corporation
  Level 5/81 Flinders Street
  ADELAIDE SA 5000

  Fax (08) 8224 0912

Submissions should be received by the NEPC Service Corporation by close of business **26 November 2010.** To allow ease of photocopying, hardcopy submissions should be unbound. Electronic submissions should preferably be provided as a Word for Windows file.

**Please note: Subject to Freedom of Information Act (FOI) provisions, public submissions are considered public documents and will be posted on the EPHC website unless clearly marked ;confidential'.*

2.6 Summary and Response Document

The NEPC is required to consider all submissions made by the closing date for submissions (26 November 2010) and every effort is made to incorporate relevant comments into a 'Summary and Response' document on public submissions made regarding the draft variation to the Measure and the impact statement. The Variation Project Team will carry out this work.

After this work is completed, the final draft variation to the Measure and the impact statement will be forwarded to the National Environment Protection Council for consideration in making the Measure as varied. It is expected that this will occur in April 2011.

3 Background to the variation

3.1 Role of the Assessment of Site Contamination NEPM

The Assessment of Site Contamination NEPM has been in place since 1999 and is the premier guidance document in Australia for the assessment of site contamination. The NEPM has been recognised by regulators, environmental auditors, consultants, developers and others as a comprehensive source of guidance. It addresses a complex area that is particularly subject to new developments in scientific knowledge and technology.

The NEPM is implemented in conjunction with existing jurisdictional guidelines and provides support in jurisdictions where guidance for specific aspects of site assessment has not yet been developed. The NEPM guidelines (contained in the Schedules) are used predominantly by auditors and consultants in the private sector who undertake site assessment work.

3.2 Assessment of Site Contamination NEPM objectives

The desired environmental outcomes of the NEPM, which relate to clause 14 (1) of the NEPC Act, are to:

- establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, land owners, developers and industry
- provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination.

3.2.1 Structure of the NEPM

The NEPM, which includes the policy framework for assessment of site contamination, is supported by two Schedules, A and B. Schedule A identifies, in the form of a flowchart, the general process for assessment of site contamination, while Schedule B comprises a series of guidelines about how the desired environmental outcomes of the NEPM can be achieved. The variation to the Measure has included changes to the structure and numbering of the guidelines contained in Schedule B.

The guidelines that comprise Schedule B are:

- Guideline on investigation levels for soil and groundwater (B1)
- Guideline on site characterisation (B2)
- Guideline on laboratory analysis of potentially contaminated soils (B3)
- Guideline on site-specific health risk assessment methodology (B4)
- Guideline on ecological risk assessment (B5a)
- Guideline on methodology to derive ecological investigation levels in contaminated soils (B5b)
- Guideline on soil quality guidelines for arsenic, chromium (III), copper, DDT, lead, naphthalene, nickel and zinc (B5c)
- Guideline on risk-based assessment of groundwater contamination (B6)
- Guideline on health investigation levels (B7)
- Guideline on community engagement and risk communication (B8)
- Guideline on competencies and acceptance of environmental auditors and related professionals (B10).

3.3 Reason for intervention

With the high cost of site assessment and remediation, it is important that new scientific and technical information is incorporated into the NEPM to provide well-informed investigation levels, and provide clarification on the site investigation process to minimise unnecessary remediation. The benefits of assessment and remediation, in terms of safeguards for human health and environment protection as well as realising the commercial benefits of remediating degraded land, far outweigh the costs of appropriate assessment and remediation.

3.3.1 Council decisions

At its ninth meeting in December 2004, the NEPC agreed to review the NEPM in accordance with Clause 10 of the NEPM which outlines the requirements for a review of the NEPM and states:

> *10 . This Measure will be subject to a review five years from the date of commencement, or within any lesser period determined by the Council, which will consider:*
>
> *i. the effectiveness of the Measure in achieving the desired environmental outcome set out within it;*
>
> *ii. the resources available for implementing the Measure; and*
>
> *iii. the need, if any, for amending the Measure, (in accordance with the Act) including:*
> - *whether any changes should be made to the Schedules; and*
> - *whether any changes should be made to improve the effectiveness of the Measure in achieving the desired environmental outcome set out within it.*

A review of the NEPM (the Review) was carried out during 2005 -2006 at the behest of NEPC. The Review was completed in September 2006 and the final report can be found on the EPHC website at <www.ephc.gov.au/site contamination/assessment of site contamination NEPM/report of the review of the Assessment of site contamination NEPM September 2006>.

The Review recommended changes to significantly improve the effectiveness and efficiency of the NEPM by addressing technological, scientific and health risk issues raised by site assessors, consultants, land developers, auditors, the public and jurisdictions. The variation , if implemented, would provide improved protection of the environment and levels of site management of contaminants commensurate with the hazard they pose to the environment. Submissions to the review by site assessors, consultants, land developers, auditors, the public and governments demonstrated strong support for a variation to the NEPM.

In December 2006, the NEPC accepted the report of the review and, in June 2007, the NEPC agreed to initiate a variation to the NEPM, with the scope encompassing the 27 recommendations of the review report.

3.4 Variation to the NEPM

Amendments to the NEPM and the Schedules are to enhance the desired environmental outcomes and to improve NEPM application effectiveness.

The nature, objective and impact of the amendments are discussed, Schedule by Schedule, in Sections 4 to 15.

Sections 4 to 15 are structured as follows:

- statement of the problem
- proposed variation to the Measure/Schedule
- impacts of the proposed variation to the Measure/Schedule.

A summary of the environmental, social and economic impacts of the variation is provided in Section 16.

4 Variation to the measure

4.1 Statement of the problem

Submissions to the NEPM review indicated that there is insufficient understanding of the NEPM in the context of the process for the assessment of site contamination (Schedule A – see section 5), confusion arising in regard to consideration of aesthetic issues, and a need to improve the clarity and consistency of the NEPM in a number of areas.

4.2 Variations to the NEPM

A number of changes were made to the NEPM, including:

- The removal of the definition of response level. This definition is not used in the NEPM and the associated documents as the NEPM is about the assessment of site contamination. The inclusion of response level relating to remediation and/or management of site contamination is outside the scope of the NEPM.
- The inclusion of decommissioning of industrial activities in the policy framework section of the NEPM. A review of the *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*[1] has highlighted that this principle could be further emphasised in the NEPM policy framework and that appropriate precautionary measures need to be taken when decommissioning industrial premises.
- The fine tuning of other definitions and descriptions in the NEPM to ensure clarity and consistency throughout the NEPM.

4.3 Impacts of the variations to the NEPM

The changes are minor in nature and are not anticipated to have any negative impacts to the industry, government or the community. They are made to improve clarity and consistency. The principle of decommissioning industrial sites has been in existence in the national policy since 1992 and thus is not anticipated to have any impact.

[1] ANZECC & NHMRC 1992, *Australian and New Zealand guidelines for the assessment and management of contaminated sites*, Australian and New Zealand Environment and Conservation Council & National Health and Medical Research Council.

5 Variation to Schedule A - general process for assessment of site contamination

5.1 Statement of the problem

Schedule A provides the recommended general process for site assessment. A key issue with the application of the NEPM is that there has been a focus on remediation of sites to investigation or screening levels rather than undertaking a risk-based assessment for individual sites. Although the risk-based approach has been emphasised in text, the flowchart in the current Schedule A could be interpreted to encourage remediation to investigation or screening levels.

The current Schedule A also does not recognise the role of site management to manage site-specific risks. Although this has commonly been the case in managing contamination, its role is not adequately reflected in the current Schedule A. The outcome of this has been that remediation activities have been undertaken when management actions would have been more efficient and cost effective.

5.2 Variation to Schedule A, the General process for assessment

The process flowchart in Schedule A has been modified to reflect the following:

Focusing on the decisions in the process

The decision elements are specified more generally to indicate that practitioners are to consider the multiple ways to reach a solution to ensure the best outcome.

Emphasis on site-specific risk assessment rather than remediation

At the conclusion of the preliminary site investigation and comparison with investigation and screening levels, the process and methodology have been modified to allow consideration of site specific condition data in deriving site-specific investigation levels based on the proposed land use. It is noted that, where contamination is localised, it is possible to make the decision to remediate at this point. However, the emphasis is on appropriately considering the risks posed by the contamination in the specific site land-use setting prior to making any decision to remediate.

Incorporation of site management

The flow process also recognises the role that site management can play in managing site specific risks.

5.3 Impacts of the variation to the General process for assessment

The changes to the general process for assessment are expected to result in a better understanding of individual site issues prior to taking action for remediation. This may result in a cost increase in the initial stages in order that the appropriate dataset is collected. However, once the understanding of the site is complete, the assessment process is expected to be better informed and result in cost savings through more efficient remediation.

The variation should have a positive impact by:

- providing more relevant and consistent investigation and screening levels for considering the risks on a site specific basis
- recognising that there are multiple ways to reach the best outcome.

6 Guideline on investigation levels for soil and groundwater (B1)

6.1 Statement of the problem

The appropriate use of investigation levels is an important component in the assessment of site contamination. In particular, it is important to be able to select the most appropriate investigation levels for use from a range of environmental settings and land-use scenarios that are based on considerations including the protection of health, ecology, groundwater, structures, and aesthetics.

A site may be assessed wholly by site-specific means or, alternatively, the initial assessment can be based around the use of investigation levels. Schedule B1 of the NEPM details a framework for the use of investigation levels. The framework is based on a matrix of health, and environment-based soil and groundwater investigation levels.

Investigation levels are commonly health-based or ecologically-based or specific to groundwater. An investigation level is the concentration of a contaminant above which further appropriate investigation and evaluation will be required.

6.1.1 Health investigation levels

The current health investigation levels (HILs) incorporate assumptions about the general population exposure and the exposure scenario. Site and context-specific considerations may allow concentrations above the guidance values to be acceptable. Currently, a 'residential' land-use setting is employed for deriving the guidance value and values are based on a default exposure scenario for a 2-year-old child.

Schedule B7a of the NEPM lists HILs for common substances in soil in 'standard residential', 'high-density residential', 'open parklands' and 'commercial/industrial' land use areas. These levels were compiled from various national workshops on health risk assessment and management of contaminated land held up to 1999. There has been one subsequent national workshop, held in 2002[2], at which information was presented to establish, inform, or revise the basis for soil criteria for a range of substances and land-use scenarios including benzene, total petroleum hydrocarbons (TPHs), chlorpyrifos, bifenthrin, imidacloprid, endosulfan, copper, lead, cadmium, arsenic and DDT.

For soil contaminants, the health investigation level (HIL) is generally derived by first using toxicological and epidemiological evidence to generate an estimate of what is the acceptable or tolerable intake. The second step is to consider what the total intake of a sensitive individual, such as a young child, would be in a model exposure scenario such as a suburban house block. These values are aimed to be protective of human health. They are conservative, and exposure to soil levels below these can be considered very unlikely to result in adverse human health effects. Hence, these levels indicate the concentrations above which further assessment and considerations for site management are required. It should be remembered that site and context-specific considerations may make concentrations above the guidance values acceptable.

[2] NEPC 2003, *Proceedings of the 5th National Workshop on the Assessment of Site Contamination*, eds A Langley, M Gilbey & B Kennedy, National Environment Protection Council, Adelaide.

It was acknowledged that the adopted values were generally conservative and were derived using varying assumptions about exposure factors, percentage of tolerable intake, exposure routes and body weights, and using the methodology outlined by the World Health Organisation (WHO, 1994)[3] . These values need to be revised to reflect recent developments in risk assessment methodology, in particular, the publication of the enHealth risk assessment and exposure factor documents[4], the availability of new internationally peer reviewed hazard assessments, and newly refined tolerable intakes.

6.1.2 Health screening levels for petroleum hydrocarbons

The most commonly found form of site contamination involves TPHs. The contamination often results from leakage of underground storage tanks which are widely spread throughout Australian communities, for example, from retailing of petroleum products, diverse manufacturing and transport industries, motor and machinery maintenance and repair, fuel depots and oil refineries.

Petroleum products are complex mixtures of aliphatic and aromatic organic compounds comprise hundreds of individual compounds of varying toxicity and chemical properties. Health risks arise from these compounds by inhalation of vapours from volatile lighter fraction components such as benzene and from heavier components such as naphthalene, a substance of the chemical group called polycyclic aromatic compounds (PAHs). TPH contamination can spread through the sub-surface, depending on the local geology and groundwater conditions. It can cause health and ecological risks on and away from the site of origin, particularly by vapour penetration of buildings or even consumption of contaminated groundwater.

Australian health-based soil criteria for TPH components were not fully developed at the time of the original NEPM. The models used to determine the level of vapour exposure in buildings from sub-slab soil, groundwater and soil gas sources were yet to be agreed and field measurements were often markedly different to predicted values from known sources. Because of the lack of an agreed volatile model, the NEPM adopted limited health criteria for the heavier TPH fractions but was silent on the more problematic and volatile lighter fractions due to the lack of a scientific basis for derivation of protective health criteria. These limitations led individual jurisdictions to adopt a limited range of TPH criteria, mainly Netherlands criteria from the mid 1990s.

Most respondents to this issue in the NEPM review called for more guidance and models on the assessment of impacts and risks from volatiles. There were additional comments made on the analytical approaches and field methods to be employed in risk assessment. Some respondents specifically raised the need for a validated model on the movement of volatiles into buildings in Australian conditions. In addition, stakeholders requested that consideration be given to providing guidance on the analytical approaches and field methods used in measuring volatiles and to validate and monitor predictions from any models used in risk assessments.

The assessment of impacts from volatile substances, particularly intrusion into indoor air, is a rapidly developing field of science. Complex fate and transport mechanisms apply to the exposure assessment process, particularly when assessing potential issues to indoor air. Inhalation, rather than direct ingestion, is recognised as the principal sensitive pathway for human intake of volatile substances arising from underground sources.

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[3] [3] WHO 1994, Environmental Health Criteria 170: *Assessing human health risks of chemicals: derivation of guidance values for health-based exposure limits*.

[4] enHealth 2002, *Environmental health risk assessment - Guidelines for assessing human health risks from environmental hazards,* and enHealth 2001, *Exposure scenarios and exposure settings.*

The assessment of health impacts from volatile substances is therefore dependent on the methodologies utilised, as well as the processes and procedures used for measuring volatile emissions.

Resolution of these issues would enable assessment of the human health risks from this commonly encountered group of compounds. The absence of a nationally consistent and scientifically based assessment approach has caused uncertainties on sites, project delays, risk of costly over-remediation or understatement of the risks on individual sites, and inconsistencies of approach between different sites.

6.1.3 Asbestos in soil

Asbestos contamination in soils may take the form of 'free' or fibrous asbestos material often used for thermal insulation. This material is intrinsically 'friable', that is, it is generally quite soft and loose and can be crumbled into fine material or dust with very light pressure, such as crushing by hand. Such material easily releases free asbestos fibres.

Another common form of asbestos in soils is 'bonded' asbestos or asbestos cement material (ACM) where asbestos has been combined with cement as a filler and reinforcing agent to make building materials such as wall sheets and roofing. While this material is generally stable and does not release fibres to the air, ACM which is badly weathered or damaged by storms or fires is regarded as friable.

Free asbestos material is often associated with older industrial sites where it was used for insulation as lagging or bundles or sprayed onto structures. It tends to be found in 'clumps' or localised areas on these sites where it has been buried or used as fill. It is also present in older commercial and other non-residential buildings. It is less likely to be found in soil on normal residential sites but may be present. This form of asbestos presents an inhalation health risk as fibres are more readily made airborne if material is disturbed.

ACM has been widely used in Australian buildings and, if the material in situ is intact and in sound condition, presents a low risk of fibre inhalation. Generally, when found in soil, ACM in sound condition also presents a very low risk of fibre inhalation due to the restrictions in most settings on fibres becoming airborne.

The presence of ACM, usually in fragments and in small quantities, or in a narrow soil profile, is relatively common in site assessment in Australia. Free fibre in soil is often found in the decommissioning of industrial sites, for example, former power stations, and can be found in soil on sites of commercial and other non-residential buildings.

The NEPM currently does not provide definitive guidance on assessment of the risks associated with different forms of asbestos in soil. This lack of guidance has caused difficulties in site assessment where site assessors have had limited health-based criteria on which to base decisions about site-specific contamination. Practices and policies between jurisdictions and among environmental auditors and third party reviewers are inconsistent.

The absence of guidance has led to unwarranted, costly excavation and removal of very low risk soil for landfill disposal. Building sites have been subject to extensive project delays and industrial disputes, with workers and contractors having concerns about asbestos exposure in the absence of human health-based soil criteria for asbestos.

6.1.4 Ecological investigation levels

The NEPM currently has two components relating to terrestrial ecological risk assessment: interim urban EILs (Schedule B1) and a framework for ecological risk assessment (Schedule B5).

The purpose of EILs is to determine whether contamination at a site warrants further investigation from an ecological protection point of view when an EIL is exceeded.

The EILs were based on considerations of phytotoxicity of heavy metals (that is, arsenic, cadmium, chromium, copper, lead, mercury, & zinc) and soil survey data from four Australian capital cities and ANZECC B values (ANZECC/NHMRC 1992). Those EILs based on phytotoxicity data have limited application for urban land, as they are only applicable to sandy loams with a pH of 6 – 8 (NSW DEC *Guidelines for the NSW Site Auditor Scheme, 2006*). The limited scope of these EILs arose from a lack of appropriate data to establish them. There is no published methodology to explain how the phytotoxicity-based EILs can be modified for other soil types or soil pH.

The major criticisms associated with the use of these interim EILs are that they are generally regarded as rigid and conservative and that they cannot be modified for application to different soil types and pH. These issues stem from the problems inherent in the lack of a nationally agreed methodology for terrestrial ecological risk assessment and EIL derivation.

The NEPM warns of inappropriate use of investigation levels as default remediation criteria and the potential for unnecessary disturbance of local environments, unwarranted remediation costs and waste of landfill space.

Site contamination caused by human and industrial activity is most likely to be encountered in urban environments that are being redeveloped to new, often more sensitive land uses in terms of human health protection. The soil criteria that are lacking in practical consideration of protection of relevant environmental values in various settings have led to some costly misuse of the Interim Urban EILs as clean-up criteria.

Site assessment and remediation is a high-cost activity in many property developments. The misuse of EILs can result in unwarranted remediation involving earthworks, soil transport, landfill disposal and additional professional consulting services that can significantly increase property development costs. These costs are ultimately passed on to consumers. In some cases, the property owner or developer may require that more stringent soil criteria be applied to counter any potential consumer concern regarding site contamination. Auditors and consultants may defer to more conservative criteria because of liability concerns. Scientifically developed EILs would provide an effective basis to manage unwarranted costs and consumer concerns.

6.1.5 Ecological screening levels

The NEPM currently does not provide guidance on ecological assessment for soil contamination from total petroleum hydrocarbons compounds (TPH). While the initial focus of TPH contamination at sites is addressing human health risks consideration of the ecological risks of TPH contamination must also be given to ensure protection of ecosystems, including essential soil processes, soil microorganisms and other organisms that inhabit or contact soil.

Site assessors do not have an adequate scientific basis on which the full assessment of human health and ecological risks can be completed for this complex contaminant group. This also includes levels of contamination that may lead to free phase separation of hydrocarbons in soil and aesthetic concerns. The lack of guidance leads to inconsistent national practices and difficulties for adequate regulation of site contamination.

The identified need for screening levels for TPH discussed in Section 6.1.2 necessarily includes consideration of screening levels for ecological protection assessment.

6.1.6 Groundwater investigation levels

Schedule B1 of the NEPM provides GILs that are based on the NHMRC/ARMCANZ drinking water guidelines of 1996, and the ANZECC Australian water quality guidelines (AWQG) of 1992. The 1996 drinking water guidelines have been updated in the Australian drinking water guidelines of 2004. The 1992 guidelines were updated in the National Water Quality Management Strategy (NWQMS) 2000. The aesthetics and recreational use criteria in NWQMS (2000) were updated in the guidelines for managing risk in recreational waters (NHMRC) in 2008. The revision of these guidelines was based on risk-based approaches which are clearly documented in the latest versions of the documents.

Some submissions to the NEPM review indicated that the NEPM should not duplicate existing national guidance and considered that appropriate references would be sufficient for defining GILs. Other comments were that acceptable soil criteria, protective of groundwater uses, needed development and that inconsistency had arisen due to differences in state policy overriding use of NEPM GILs. Consequently, it would be more relevant to provide a decision process for selection and use of GILs.

More detailed proposals involved derivation of GILs from first principles, using toxicity data (such as chronic 'no observable effect concentration') known to cause low or insignificant adverse effects on groundwater dwelling organisms, and methods consistent with the WQG 2000 approach. Other submissions accepted the merits of use of updated water quality guidelines but sought additional guidance on their relevance in assessment.

Varied perspectives on the need and nature of further guidance ranged from clarification of the use of GILs as investigation levels at the point of extraction and response levels at the point of use, to abandonment of this approach in favour of site-specific direct assessment of the potential damage to receptors. Guidance was also sought on the development of GILs for light non-aqueous phase liquids such as TPH compounds and dense non-aqueous phase liquids such as chlorinated solvents that are denser than water and relatively insoluble, and that accumulate at the base of groundwater aquifers causing ongoing contamination by slow dissolution and leaching.

The majority of submissions supported the updating of the GILs to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* (WQG 2000)) and the *Australian Drinking Water Guidelines*, (ADWG 2004).

6.1.7 Aesthetics guidelines

The NEPM contains no numeric aesthetic guidelines, providing only the fundamental principle that the soils should not be discoloured, malodorous (including when dug over or wet) nor be of abnormal consistency. The natural state of the soil should be considered. Currently the aesthetic guideline is being used inappropriately to drive costly remediation actions for materials that do not pose any risks on the site.

During the review of the NEPM, stakeholders sought the provision of clarification and guidance on the aesthetic guideline through a variation process to provide assessors with clear and more practical guidance for assessing aesthetic considerations of a site.

6.2 Variation to the guideline on investigation levels for soil and groundwater

6.2.1 Health-based investigation levels

The health-based investigation level in the NEPM (1999) were evaluated in relation to relevant international research and up-to-date and rigorously reviewed toxicity criteria for the contaminants for which there were an existing HIL and for additional priority soil contaminants.

The evaluation of the HILs applied the five-step risk assessment process central to the Australian health risk assessment procedure outlined by enHealth (enHealth, 2011)[5].. Uncertainty and sensitivity analyses were undertaken during the derivation of the HILs. The process identified the key assumptions and data gaps associated with the derivation of HILs and established the exposure parameters that have the greatest implications for the resultant HILs. The uncertainty and sensitivity analyses provide a 'reality check' for the derived HILs. Finally, derived values were peer reviewed by Australian health representatives and senior toxicologists with recognised expertise in this field.

The variation outcome is a revised list of HILs that have used risk assessment methodologies consistent with Australian policy and best international practice. The heath risk assessment methodology and details of the HIL derivation process are provided in Schedules B4 and B7 respectively. The HIL list has increased from 31 to 41 substances in keeping with recommendations from the NEPM review for the inclusion of priority contaminants and commitments to the Stockholm Convention ratified by Australia in 2004. The land-use scenarios have been condensed to the four common urban land uses, that is, low and high density residential, parkland/recreational space, and commercial/industrial. This approach maintains consistency with other health and ecologically based soil criteria in the NEPM variation.

Part of the review process considered the derivation of soil criteria for volatile organic chlorinated compounds (VOCCs) that have been widely used as solvents by industry. Difficulties were encountered in deriving acceptable soil criteria for these contaminants due to insufficient development of models to predict the movement of vapours from sub-surface sources into building interiors for these particular compounds. Consequently, the review process identified interim sub-surface soil gas HILs for specific VOCCs that are protective of human health.

The Variation proposes the adoption of revised generic HILs and interim sub-surface soil gas HILs for VOCCs to a depth of 3 metres. The generic HILs, which are not soil specific, apply across Australia and provide Tier 1 heath risk assessment guidance for frequently encountered contaminants of concern. The depth of contamination may need to be characterised for the site-specific uses. The HILs apply generally to all soil depths to which humans might reasonably be exposed for that site use.

6.2.2 Heath screening levels for petroleum compounds

Concurrent with the review and variation of the NEPM, the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) under its risk characterisation and communication program undertook a project to derive health screening levels (HSLs) for TPH compounds for various land-use settings, soil types and depth below surface.

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[5] enHealth 2011, *Environmental health risk assessment. Guidelines for assessing human health risks from environmental hazards*, Department of Health and Ageing & enHealth Council, Canberra.

The 3-year project was conducted under a policy advisory group with a range of stakeholders including the NEPM variation team, health and environmental regulator representation. A technical working group closely reviewed the multidisciplinary aspects of the project. This is a developing field and the project considered various approaches to modelling the movement of volatiles from sub-surface soil and groundwater sources to building interiors. The project was subject to local and international peer review at critical milestones.

Analytical aspects of assessing contamination from petroleum sources was based on the total recoverable hydrocarbon (TRH) analytical method including the volatile BTEX components, naphthalene and specified carbon chain fractions. The Canadian TRH carbon fractions F1—F4 were adopted for more appropriate alignment with internationally accepted toxicity data

The widely applied Johnson and Ettinger vapour intrusion model, assuming a finite hydrocarbon source without biodegradation, was selected as the basic model for development of HSLs following a CSIRO review[6] of current and developing models of vapour transport. Emphasis was placed on determining appropriate assumptions for Australian conditions including relevant soil and building parameters. International peer review identified shortcomings with the use of models for deriving health-based soil and groundwater criteria and discrepancies between field-measured sources and model-predicted volatiles levels in buildings. The review process enabled revision of the assumptions made and on the role of volatile migration by diffusion through soil from deeper sources and advection from shallow sources into building interiors.

The process further identified the current international approach using multiple lines of evidence where soil and groundwater criteria may be supplemented by soil gas determinations, the latter being a useful assessment tool for existing building structures underlain by contaminant sources.

The CRC CARE HSLs project[7] was developed in conjunction with a separate CSIRO project[8] to assess the effects of biodegradation on TPH components and to enable site assessors to determine the site conditions that were conducive to biodegradation. This project established biodegradation factors that would apply to hydrocarbon sources greater than 2m below surface when specific site conditions apply.

HSLs have been developed to be protective of human health by determining the reasonable maximum exposure from site sources for a range of situations commonly encountered on contaminated sites and for proposed land uses. They are based on best available science and are applicable for Tier 1 screening purposes in Australian settings, with supporting documents on application and sensitivity issues. The application document[9] summarises the HSLs, how they should be used and their limitations. A checklist/spreadsheet tool has also been developed to guide correct application of the HSLs and to highlight circumstances where the HSLs would not be applicable (such as the presence of preferential pathways).

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[6] Davis GB, MG Trefry & Patterson, BM 2009, *Petroleum Vapour Comparison* CRC CARE Technical report no. 9, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

[7] Friebel E & Nadebaum, P 2010a, *HSLS for petroleum hydrocarbons in soil and groundwater; part 1: technical development document*, Technical report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

[8] Davis GB, Patterson, BM & Trefry, MG 2009, *Biodegradation of petroleum hydrocarbon vapours,* CRC CARE Technical report no. 12, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

[9] Freibel, E & Nadebaum, P 2010b, *Health screening levels for petroleum hydrocarbons in soil and groundwater; part 2: application documen*t (draft), Technical report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

The sensitivity analysis[10] presents the results of a detailed sensitivity assessment of the assumptions of the parameters in the vapour modelling used to develop the HSLs.

The variation proposes to adopt the derived HSLs. They apply to the same land-use settings as HILs and include the additional dimensions of groundwater, soil gas, soil type and depth to source to identify the relevant site-specific criteria.

6.2.3 Asbestos in soil

A number of scientific studies relating to the risk of generation of airborne asbestos fibres from free asbestos and asbestos cement material (ACM) in soil have been undertaken since the commencement of the NEPM. These studies are reviewed in the Netherlands work by Swartjes and Tromp 2008[11]. The work has led to recommendations regarding risk-based levels of asbestos in soil that relate to land use in the Netherlands. The Environmental Health Committee (enHealth) produced guidance titled *Management of asbestos in the non-occupational environment (*2005), relating to the management of asbestos in the broad non occupational environment[12]. This guidance detailed a risk-based approach to dealing with sites contaminated with asbestos.

In May 2009, the WA Department of Health, following a consultation and peer review process, released detailed guidelines[13] dealing with asbestos contaminated sites. The guidelines referenced the above papers and other relevant studies. The WA procedures adopted a conservative screening level of asbestos for sites impacted by free asbestos expressed as %w/w asbestos in soil. Screening levels were also identified for %w/w asbestos in ACM for various land uses, reflecting the lower risk associated with sound ACM materials in soil. The land uses are consistent with those applying to HILs and HSLs.

The variation proposes adoption of these screening levels and emphasises a need for a pragmatic approach to be taken, given the limitations of quantifiable measurement. The levels are supported by guidance on the identification and assessment of sites affected by asbestos contamination and appropriate responses to managing this contaminant in its different forms.

6.2.4 Ecological investigation levels

The derivation of EILs for ecosystem protection for a range of urban land uses involves consideration of complex variables including the wide range of species exposed to soil, their toxicity response, and the physiochemical properties of the site soils and target contaminants.

Since the commencement of the NEPM, the national and international approach for developing environmental criteria has tended to methodologies based on a species sensitivity distribution (SSD) methodology. The 2000 Australian and New Zealand water quality guidelines[14] is an example.

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[10] Freibel, E & Nedabaum, P 2010c, *Health screening levels for petroleum hydrocarbons in soil and groundwater; part 3: sensitivity assessment (draft)*, Technical report no. 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

[11] Swartjes, F & Tromp PC 2008, 'A tiered approach to the assessment of human health risks of asbestos in soil', *Soil and Sediment Contamination*, vol. 17 pp. 137-149.

[12] enHealth Council 2005, *Management of asbestos in the non-occupational environment.*

[13] WA Department of Health 2009, *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia*, WA Department of Health , Perth, WA.

[14] ANZECC & ARMCANZ 2000, *National water quality management strategy. Australian and New Zealand guidelines for fresh and marine water quality*, Australian and New Zealand Conservation Council and Agriculture, & Resource Management Council of Australia and New Zealand.

In the SSD methodology, toxicity data from a representative range of species are considered and environmental criteria are mathematically derived to provide protection for a specified percentage of species.

A CSIRO project[15] for the NSW Environmental Trust was commenced in 2007 to develop a new methodology for deriving soil EILs for four chemicals. The project was later extended for the NEPM variation to include four additional metals commonly found in Australian urban environments.

The CSIRO project included a thorough review of the latest advances in soil chemistry, soil ecotoxicology and the methods being used in Australia and internationally to derive soil ecological investigation levels. The review process for the development of the methodology has comprised:

- a public workshop on the methodology in June 2007
- release of the draft methodology for public comment in February 2008
- a second public workshop on the revised methodology in November 2008, and
- international peer reviews of the methodology.

The methodology uses lowest observed effect concentration (LOEC) or EC30 toxicity data to derive EILs for national park, residential/parkland and commercial/industrial land uses with 99%, 80% and 60% species protection respectively. An additional 5% protection is included for the residential/parkland and commercial/industrial land uses where the contaminant is considered likely to biomagnify.

The methodology considers that the toxicity of some contaminants is affected by the physicochemical properties of soil in which the contaminant is located. It is known that the bioavailability of many contaminants in soil is lowered over time and that aged contamination is the normal condition for site contamination. Where toxicity data for aged contamination were not available, ageing factors have been applied based on studies of the effects of ageing for particular soil contaminants.

The variation proposes to adopt the eight derived EILs using EC30 and LOEC data. The EIL methodology and the derivation of the eight EILs are detailed in Schedule B5b and Schedule B5c respectively. The EIL methodology provides a sound basis for the derivation of EILs for other substances as ecotoxicity studies extend scientific knowledge on the effects of soil contaminants on various species.

6.2.5 Ecological screening levels for petroleum compounds

The Canadian Council of Ministers of the Environment (CCME) have adopted risk-based total petroleum hydrocarbon (TPH) standards for human health and ecological aspects for various land uses in the *Canada-wide Standard for Petroleum Hydrocarbons in Soil*, (January 2008, CWS PHC). The standards established soil values including ecologically based criteria for sites affected by TPH contamination for coarse and fine-grained soil types and apply from surface to 3 m depth. The TPH fractions are the same 4 fractions (F1 {C6-C10}, F2 {>C10-C16}, F3 {>C16-C34}, F4 {>C34}) adopted for health screening levels (HSLs). The standards include other TPH compounds such as benzene, toluene, ethyl benzene and xylenes (BTEX) and specific polycyclic aromatic hydrocarbons (PAHs).

[15] Heemsbergen D, Warne MStJ, McLaughlin, MJ, & Kookana, R (2009) 'The Australian Methodology to Derive Ecological Investigation Levels in Contaminated Soils' CSIRO Land and Water Science Report 43/09, Adelaide, Australia.

In many cases, sites assessed for TPH contamination are driven initially by human health concerns with the more volatile components (F1 and F2) in the 0-4 metres below ground level setting where the less volatile longer chain fractions may be not limiting for human health. In circumstances where human health risks are addressed through use of HSLs, ecological impacts, particularly from contaminant levels assessed using biodegradation factors or those associated with the longer chain fractions (F3-F4), may become the predominant concern.

Similar to the EIL methodology the CWS PHC approach utilised a SSD method and, when there were insufficient data, a weight-of-evidence approach was applied to derive ecologically based Tier 1 ecosoil contact values for TPH fractions and specific compounds. The protective criteria were developed based on EC25 toxicity (compared with Australia EC30 and LOEC data).

The Canadian approach was independently reviewed for consistency with the EIL methodology. There were sufficient ecotoxicity data available for F1 and F2, BTEX and the PAH benzo(a)pyrene to enable adoption of the values for these compounds as moderate reliability ecological screening levels (ESLs). The ecotoxicity data for the F3 and F4 fractions were less comprehensive and a weight-of-evidence approach was used in review of the criteria. Consequently, the F3 and F4 values are adopted as low reliability ecological screening levels. Similarly, the CWS PHC management levels are adopted to ensure that F3 and F4 phase separated contamination is not left on urban sites without further appropriate assessment and considerations.

6.2.6 Groundwater investigation levels (GILs)

The 2000 and 2004 revisions of the Australian and New Zealand water quality guidelines and the Australian drinking water guidelines, together with the 2008 guidelines for managing risk in recreational waters, form the basis for revision of the GILs. The Variation proposes upgrading of the GILs to be consistent with current Australian guidance for aquatic environments. Schedule B6 provides a framework for the application of GILs.

Additional groundwater criteria for petroleum compounds are also provided in Schedule B6. These levels relate to the movement of volatiles from groundwater sources into building spaces. These are human health-based HSLs and relate to petroleum compounds only. They are not appropriate for application to other aquatic receptors.

6.2.7 Aesthetic guidelines

The limited guidance on aesthetic issues in the NEPM has been reviewed in light of the issues commonly faced in site assessment. This includes situations where land has been filled, often with foreign essentially inert materials which are not of concern in terms of toxicity. Sites may have been assessed and cleared with contaminant levels less than relevant health or ecological levels but with offensive odour, chemical discolouration of soil or other aesthetic concerns.

The variation provides more guidance on the issues to be considered in reaching a balanced pragmatic approach for individual sites where aesthetics are an issue of concern. While there are generally no specific numeric aesthetic values, circumstances are identified where risks of concern would require additional assessment and others where no further action would be warranted.

6.3 Impacts of the variation to the Guideline on investigation levels for soil and groundwater

6.3.1 Health investigation levels

Health aspects

The revised health investigation levels (HILs) are based on the most recent peer reviewed human toxicology studies and extend coverage with an additional 10 HILs, principally for selected organochlorine compounds found in urban environments. The updated HILs, transparent derivation methodology and wider range of substances covered provide a scientifically sound basis to manage health risks from site contamination in urban land use.

Financial impacts on industry and the community

In current Australian practice, the sign-off on site assessment work may involve an independent review by accredited auditors or third party reviewers when land use changes or development is proposed. The potential liability on site assessors and auditors can lead to conservative decisions about site contamination, particularly when there are no authoritative soil criteria available. This can delay development projects, increase holding costs and add further costs through excessive remediation and disposal of low grade contaminated soil. The wider range of HILs should remove some of the current uncertainty about appropriate health-based criteria to apply on specific sites.

The revised HILs should provided greater confidence in the actual level of risk posed, and therefore provide more consistent decision-making regarding the management and/or remediation of a site. The revised HILs are, in most cases, the same or greater than the existing HIL values. Therefore there should be no increase in costs in the assessment against the HILs.

Some contaminants, for example, polychlorinated biphenyls (PCBs) have lower HILs due to more recent studies that have revised the toxicity status of the contaminant. PCBs impacted sites are relatively limited in number and are usually associated with the electricity industries and former industrial sites with large transformers. The cost impact may be significant for a limited number of these sites, depending on the proposed land use. (However the cost may be offset by the wider range of soil treatment technologies currently available.)

The revised HILs also provide improved community protection as the wider range of contaminants covered will ensure that any potential risks from site contamination to householders and local communities can be better defined and managed.

Government and regulatory impacts

Schedule B1 provides more information on the application of HILs and their relationship to other soil criteria. The revised HILs and associated guidance should improve consistency in their application between jurisdictions.

In the absence of nationally adopted health-based soil criteria justifications must be made by contaminated land professionals to address regulatory requirements. The greater number of generic HILs should reduce regulatory concerns and potential risks to government in considering health risks on specific sites.

The associated guidance on use and application of HILs should assist in preventing an understatement of site health risks or unnecessarily conservative responses that cause other concerns from over-excavation of sites and waste of landfill space for disposal of soil.

6.3.2 Health screening levels for petroleum compounds

Health aspects

Currently there are limited total petroleum hydrocarbon (TPH) criteria applied in Australian jurisdictions and there are inconsistencies in screening levels being applied between the states and territories. The existing criteria do not adequately cover the common contaminants of health concern. Few international jurisdictions have nationally consistent and comprehensive environmental criteria to identify human health risks from various contaminants of concern in petroleum products.

The variation provides comprehensive screening levels for soil and groundwater contamination for various soil types, depths below surface and a range of land uses. The more comprehensive approach includes screening levels for sub-surface soil gas to deal with health risks from toxic hydrocarbon vapours including benzene as a carcinogen of concern in site assessment.

Use of the variation HSLs will resolve many current issues of concern regarding health risks from TPH due to the current lack of scientifically derived criteria. The CRC CARE derived HSLs for soil, groundwater and soil gas provides a sound scientific basis for protecting against human health risks from TPH contamination in various land uses.

Financial aspects

TPH contamination is clearly the most prevalent form of site contamination, affecting greater than 60% of sites requiring assessment. The national cost of assessing these sites is estimated to be of the order of $0.5 - $0.7 billion annually, although the real costs cannot be accurately determined as information on costs is privately held for each site. The adoption of HSLs is expected to deliver significant cost benefits to assessment and development of affected sites.

A common result of the lack of adequate site assessment guidance is the flow-on costs to the community caused by overly conservative reactions to contamination that is not defined by risk assessment criteria acceptable to regulators. The response relates to personal liability concerns about future legal action on real or potential health risks and to blighting effects on property affecting valuations.

The current limited coverage of health-based criteria for site assessment of TPH compounds is a major concern to contaminated site professionals and regulators. Apart from uncertainties about human health risks, costly additional risk assessment or remediation works are often carried out to achieve an overly conservative site outcome while further costs are incurred in delays to development projects.

The HSLs will assist to resolve many of the financial risks associated with liability concerns by providing a comprehensive basis on which to assess human health risks for a wide range of Australian conditions. The multiple-lines-of-evidence approach for soil, groundwater and soil gas provides practical tools to conduct a low cost Tier 1 human health risk screening within site specific parameters. The approach will reduce the current uncertainty and inconsistency about individual site risks and the unwarranted costs that can be a consequence of uncertainty.

While new skills will be required to assess soil gas and additional assessment costs for soil gas testing will be incurred in some sites, the benefits of clear and comprehensive screening levels to progress site development without delay while being protective of human health will outweigh additional costs. The HSLs have generally not added more conservative criteria than those currently used in Australian jurisdictions. In some cases, the levels are slightly more conservative than current practice. In most sites, the HSLs are less conservative and will result in a net cost saving by more sites passing the screening levels and not requiring further action.

Government and regulatory impacts

While industry and the public are adversely affected by the lack of acceptable health-based criteria, regulators in each jurisdiction do not have agreed and nationally consistent guidelines to assist administration of TPH-impacted sites.

Some states have adopted practical approaches such as Victoria's 'clean-up to the extent practicable' while others require comprehensive site-specific health risk assessment to resolve individual site concerns. While these approaches would remain in operation, the provision of the a more comprehensive range of HSLs will assist in resolving individual site issues with a greater certainty and with less project delays. Regulators would be able to operate nationally on a consistent basis for Tier 1 assessment with fewer unresolved issues or disputes about site decisions involving accredited auditors, third party reviewers and regulators.

6.3.3 Asbestos in soil

Health aspects

The absence of adequate screening levels for soil and definition of the health risks from the different forms of asbestos has resulted in public concern about asbestos contamination in soil.

The variation screening levels for different forms of asbestos in soil are based on health studies conducted or collated since the NEPM (1999) and Australian guidance from public health organisations. A conservative approach is taken for the more 'available' forms of asbestos that pose a greater likelihood of enabling airborne transmission of fibres and consequent inhalation risk. A less conservative approach is taken for soil contaminated with asbestos cement material (ACM) material in sound condition where there is a very low risk of airborne fibres. ACM in sound condition in soil in smaller fragments and relatively small quantities is widely spread in Australian urban areas and presents a low risk to human health.

The screening levels and associated guidance will provide health protection and allow pragmatic approaches to be taken to manage low-risk ACM material in situ rather than costly and potentially high risk excavation and disposal. A conservative approach has been maintained with forms of asbestos material that present a greater risk of airborne fibres.

Financial aspects

In keeping with HILs and HSLs, the liability concerns with sites containing asbestos in soil are pronounced without nationally adopted criteria to conduct Tier 1 health risk assessment. These issues add considerable cost to the development of affected sites and are passed on to the community.

The response to detection of all forms of asbestos in soil on sites has often been excessive excavation and costly disposal of soil. The sites often have minor amounts of sound ACM, which does not pose a health risk of concern. The lack of accepted criteria and information about the risks with different forms of asbestos has added further cost to development through industrial disputes arising from concerns by building site workers and contractors about exposure.

The asbestos screening levels will improve management of sites and enable differentiation of risk on the basis of the forms of asbestos and the land use. The variation approach is expected to deliver considerable cost benefits in the assessment and management of affected sites.

Government and regulatory impacts

The variation screening criteria will assist regulators to effectively manage concerns about asbestos in soil that relate to the levels of risk from the different forms of asbestos and the land use. Asbestos forms that are a higher risk of generating airborne fibres are conservatively managed for all sites.

Screening levels for low-risk materials are dealt with on the basis of land use with a more conservative approach being taken for residential land uses. The health-based screening levels will provide regulators with a sound basis for the preferred approach of pragmatic site management with soil contamination and will assist risk communication and consultation processes for public issues.

6.3.4 Ecological investigation levels

Ecological aspects

The use of land in urban environments is accompanied by accumulation of anthropogenic contamination in soil to varying degrees depending on land use. Consequently, the protection of ecological values in the urban environment is an essential component of site assessment.

The NEPM recognised the need for ecosystem protection but the science for development of EILs was poorly developed and limited interim urban EILs only, based on phytotoxic effects, were adopted at the time. The derivation of EILs is complicated by the paucity of toxicity data for a broad range of species that require protection, the proposed land use and the physicochemical properties of the host soil and contaminant types.

A methodology by CSIRO (Heemsbergen and Warne 2009) based on the species sensitive distribution (SSD) model to derive ecological investigation levels has been included in the variaton of the NEPM. The derived EILs for eight substances commonly found in the urban environment from anthropogenic sources will provide a scientific basis for the assessment of ecological risk for various land uses. The EILs are supported by practical guidance on their use and limitations.

Financial aspects

The limited interim urban EILs have been mid-used in many cases as default remediation criteria for clean-up of contaminated sites. This response and the adverse cost implications for site development is a reflection of the common theme of conservative actions when soil criteria are deficient or there is insufficient guidance on their use.

While the NEPM clearly identified that use of interim urban EILs as remediation criteria was inappropriate, the lack of a practical ecological risk assessment and EIL derivation methodology did not provide a means of deriving site-specific ecologically based levels. This led to excessive excavation of soils on many sites and added to development costs.

The new EILs, while limited in extent, provide a scientific basis for assessing ecological risks for urban sites. The EILs relate to various urban land uses and include consideration of the physicochemical properties of the soil which plays a significant role in the derived level of contaminant. Assessment of sites will involve some minor additional soil analysis costs and training for professional site assessors. However, many of the derived EILs will be greater than current values. This will result in a net cost benefit for site development as more soil values will fall below the EILs.

Government and regulatory impacts

Regulation of the ecological impacts of contaminated sites is contentious due to the limited basis on which the NEPM interim EILs were derived and limited information on their application.

The new methodology and the EILs provide government and regulators with a scientific basis to make regulatory decisions about the effects of contaminated sites on ecosystems. This will reduce disputes about acceptable levels of protection with assessors, accredited auditors and third party reviewers. The variation EILs are supported by clearer information about the site circumstances for their use including the depth below surface to which they apply.

6.3.5 Ecological screening levels for petroleum compounds

Ecological aspects

The ecological screening levels (ESLs) apply solely to petroleum compounds in soil and were not able to be addressed within the EIL program in the scope of the variation. The adopted values have been based on the Canadian soil values for petroleum compounds. The Canadian approach employs a similar SSD process and has been reviewed against the variation EIL derivation methodology.

The adopted values will provide protection of ecosystem when elevated levels of contamination, which are not considered a human health risk, are found on sites. The elevated levels of contamination are likely to cause adverse ecosystem impacts if not addressed and in other cases leave a potential fire or aesthetic concern. The ESL and associated 'management' levels will address these issues.

Financial aspects

The ESLs are complementary to the HSLs to provide balanced assessment of health and ecosystem risks and the financial aspects are of a similar nature as previously discussed. The use of ESLs does not involve any additional analysis costs. The variation EILs are generally at higher levels than current Australian practice for the particular petroleum compounds of concern. This will result in a net cost benefit for most TPH-impacted sites as a greater number will pass the Tier 1 screening process.

Government and regulatory impacts

The ESLs will complete the suite of criteria to define the potential ecosystem and health risks for the range of contaminants commonly encountered on Australian contaminated sites. The absence of ecological criteria for petroleum compounds in the Measure has created difficulties for regulators in identifying suitable regulatory levels and resulted in inconsistent national practices.

Clearer guidance is provided in the use of ESLs by case studies and routine application. The ESLs and associated guidance will improve policy development for contaminated sites by integrating human health and ecological risk assessment in a nationally consistent manner.

6.3.6 Groundwater investigation levels

Health and ecological aspects

The variation GILs adopt the revised Australian drinking water guidelines and the Australian and New Zealand water quality guidelines for aquatic environments. These guidelines are standard Australian practice for human health and ecosystem protection.

Financial aspects

The adoption of the revised guidelines is consistent with previous practices in the Measure and is of a technical nature only. The adoption does not have any financial implications.

Government and regulatory impacts

The use of the current water quality guidelines for GILs is standard in Australian jurisdictions and does not raise any regulatory issues of concern. It is consistent with current practice for application to assessment of site contamination.

6.3.7 Aesthetic guidelines

Health aspects

The current guidance in the NEPM is limited and does not specifically address human health issues. There are no numeric aesthetic levels other than some TPH components that have an ESL aesthetic component in 'management limits'. The variation discusses assessment aspects relating to health, such as the risk of injury to persons using sites that have been filled with inert wastes such as glass, metal and other sharp objects, and sites that may have potential to produce hazardous levels of methane. It also provides guidance on chemically discoloured or highly malodorous soils that may cause health concerns to individuals who are sensitive to this type of contamination.

Financial aspects

The aesthetic guidance directs site assessors to develop a balanced assessment of any risks associated with material that does not pose a direct health or environmental risk but has other potentially unacceptable characteristics. It is often the case that sites with aesthetic concerns pass Tier 1 soil criteria.

In some cases, insufficient guidance and overly conservative approach to the presence of foreign but apparently inert material, has led to project delays and added costs due to further assessment and over-remediation. The variation guidance should lead site assessors to take a more practical approach by considering a range of issues from land use, depth of contamination and site history to considering any less obvious potential ecological or health risks. This approach aims to minimise over-reaction to aesthetic issues while ensuring that real risks to human health and ecosystems or clearly unacceptable levels of diverse foreign material are considered.

While the issue will always involve a level of subjectivity, the guidance should improve practices and provide a net cost benefit to site assessment due to savings from unwarranted remediation.

Government and regulatory impacts

The issue of aesthetics is an additional aspect of site assessment where regulators have had limited nationally accepted guidance to provide consistent and effective administration. The problem is of greater concern for sites with proposed low-density residential use. The variation guidance is expected to provide improved clarity for site assessors, accredited auditors and third party reviewers, and will facilitate regulation.

7 Guideline on data collection, sample design and reporting (B2)

7.1 Statement of the problem

Adequate data collection forms the foundation for acceptable assessment of health and environmental risks associated with site contamination. Schedule B2 of the original NEPM provides guidance on the collection of data, design and implementation of soil and groundwater sampling programs, presentation of data and preparation of site assessment reports.

Specific issues raised by review respondents included provision of more guidance on:

- The preparation and identification of data quality objectives
- Parameters and requirements in the collection of field data
- Methods and techniques for delineation and characterisation of contamination
- Assessment of impacts from volatile substances
- Leachate testing procedures and their application combined with clearer guidance on their use to enable nationally consistent assessment practices.
- Asbestos assessment
- The use of 'indicator' substances to screen sites for the potential presence of dioxin-like substances.

7.1.1 Data quality objectives

The data quality objective (DQO) process is used to define the type, quantity, and quality of data needed to support decisions relating to the environmental condition of a site. It provides a systematic approach for defining the criteria that a data collection design should satisfy, including where, when and how to collect samples or measurements, determination of tolerable decision error rates, and determination of the number of samples or measurements that should be collected.

Regulatory agencies cite concerns that many sites are not being adequately investigated in terms of the collection of sufficient field data of quality and quantity, sufficient vertical delineation of contamination, and the adequacy of information to enable decisions on management of contamination to be made. These gaps may occur because the DQOs of the investigation and/or a conceptual site model (CSM) are not properly prepared and considered in the site investigation planning stage.

The NEPM does not provide sufficient detail on the application of the DQO process and, in practice, there are deficiencies in site assessment and reporting related to inadequate application of DQO processes.

7.1.2 Collection of field data

The current Schedule B2 contains guidance on presentation of field data in bore logs; however, it does not consider minimum requirements for field data collection. Gaps in the collection of field data at the investigation stage mean that significant uncertainties can be created in site contamination assessments, for example, in the application of numerical contaminant fate and transport models. As a result, risk assessment and risk management decisions are often rendered difficult and can lead to inappropriate decisions.

Submissions to the NEPM review generally indicated that the collection of field parameters should be encouraged and further guidance would be useful in achieving the collection of appropriate parameters for a range of potential contaminants and site conditions.

Submissions indicated guidance should be provided on the preferred methods of data collection and the limitations of the data obtained.

Submissions suggested providing guidance on field parameter objectives to provide a basis for parameter selection and incorporation, while allowing for professional judgement to be incorporated. Most submissions indicated that checklists would be beneficial in ensuring the collection of appropriate field parameters and assessing whether appropriate field data had been collected.

7.1.3 Delineation and characterisation of contamination including groundwater investigation methods

Delineation and characterisation of contamination in relevant media are important to ensure that the extent of contamination is understood so that appropriate data are used for modelling purposes and that potential health and environmental risks are correctly identified. Schedule B2 provides general technical guidance on conducting groundwater investigations involving monitoring well establishment, groundwater sampling and plume delineation.

Most submissions to the NEPM review supported a revision of the guideline mainly by referencing guidance available in Australian jurisdictions. Submissions to the NEPM review generally noted that delineation of the lateral and vertical extent of contamination was often poorly completed and supported the provision of guidance on appropriate methods to establish the extent of contamination. Some commentators considered that more information should be provided on fate and transport modelling and the potential for attenuation of groundwater contaminants over time. Others indicated that specific issues should be more definitively addressed such as preferred well construction and implications for different well types, quantitative data for aquifer characteristics and prevention of cross-contamination of both samples and aquifers.

7.1.4 Assessment of impacts from volatile substances

The NEPM currently provides limited consideration of the assessment of volatile substances. All respondents to this issue in the NEPM review called for more guidance and models on the assessment of impacts and risks from volatiles. There were additional comments made on the analytical approaches and field methods to be employed in risk assessment. Some respondents specifically raised the need for a validated model on the movement of volatiles into buildings in Australian conditions. In addition, stakeholders requested that consideration be given to providing guidance on the analytical approaches and field methods used in measuring volatiles and to validate and monitor predictions from any models used in risk assessments. It was recognised that this was a complex and rapidly developing field of science and that any guidance in the NEPM should reflect this.

The absence of a nationally consistent and scientifically based assessment approach has caused uncertainties on sites, project delays, risk of costly over remediation or understatement of risks on individual sites.

7.1.5 Asbestos

The NEPM currently provides only nominal consideration of the assessment of asbestos. The assessment of asbestos contamination is complicated by the uncertainties such as the condition of any ACM products, the presence of mixtures of asbestos types and products and the soil conditions. Submissions to the NEPM review requested that a consistent approach be developed to permit an effective and defensible regulatory framework to be established.

7.1.6 Dioxins and dioxin-like substances (dioxins)

Australia is a signatory to the Stockholm Convention on Persistent Organic Pollutants (POPs treaty) which includes dioxins (polychlorinated dibenzo-p-dioxins) and furans (polychlorinated dibenzofurans) ('dioxins'). The assessment of POPs chemicals, particularly dioxins, can be a major cost factor in site assessment and remediation.

Submissions to the NEPM review gave qualified support for the development of guidance on the use of 'indicator' substances to screen sites for the potential presence of dioxin-like substances. Such guidance would need to include comments on the relevance of site history and the reliability of the chosen indicators as dioxin signals.

7.2 Variation to the guideline on data collection, sample design and reporting

Schedule B2 provides general guidance on the characterisation of potentially contaminated soils, groundwater, vapour and soil gases in order to inform appropriate human health and ecological risk assessment. Schedule B2 was varied to:

- emphasise the importance of the iterative development of a CSM and appropriate application of the DQO process in site assessment
- incorporate additional information and guidance on the assessment of soil stockpiles, volatile substances, asbestos and dioxins
- update the guidance provided to reflect current Australian and international guidance.

Specific issues raised during the review have been addressed as follows.

7.2.1 Data quality objectives

Additional guidance on the DQO planning process, based on NSW DECCW guidance to their site auditors is included in Schedule B2. The references therein discuss the application process in more detail and provide examples to illustrate the process. The text has been revised to provide increased emphasis on the integration of the DQO process into the site assessment process, including the iterative development of a CSM and sampling and analysis plan (SAP).

7.2.2 Collection of field data

A checklist in spreadsheet format has been developed (available online at <www.ephc.gov.au>), which is intended to be used, in combination with Schedule B2, as a reference tool to assist practitioners in planning and the collection of data for site contamination assessments. The checklist provides a list of parameters to be considered, based on the investigation objectives and contaminants of concern. The checklists are not intended to be exhaustive but identify information and parameters typically expected to be considered.

In addition, the guidance currently provided for contaminant fate and transport modelling has been revised to include a tabulation of where site-specific data are useful and where they are essential. This, together with the field checklists, should ensure that the collection of appropriate field parameters is identified at an early stage and that appropriate data are recorded in the field.

7.2.3 Delineation and characterisation of contamination including groundwater investigation methods

Schedule B2 has been considerably revised to incorporate current Australian jurisdictional and international guidance and appropriate references.

The updates cover design of sampling and analysis plans, sampling methodologies for relevant media, stockpile sampling, monitoring well construction and sampling, delineation of contamination, attenuation of groundwater contaminants and contaminant fate and transport modelling. In addition, the site investigation process has been clarified to emphasise the role of the CSM, DQOs and the SAP.

7.2.4 Assessment of impacts from volatile substances

Volatile contaminants, as vapours, can migrate into buildings and pose a risk to residents and/or workers. As a result of the high uncertainty in quantifying vapour exposures, past practice has been to adopt very conservative assumptions. Although the risks posed by volatile contaminants in the sub-surface remain uncertain, the results of a large number of investigations carried out in recent years have provided greater certainty around the behaviour of vapours.

A component of the CRC CARE/CSIRO project on models of vapour transport focused on the field assessment of vapours. The report[16] provided a substantial update of an earlier CSIRO review[17] and included a critical review of available guidance, a framework for vapour assessment and field methods for the assessment of volatile contaminants.

Additional guidance, based on the CSIRO report and international best practice on the assessment of vapours, has been added to provide:

- a framework, including a multiple-lines-of-evidence approach, for the assessment of volatile organic compounds (VOCs) with particular reference to volatile petroleum hydrocarbons and chlorinated hydrocarbons
- a summary of field methods for assessment of vapours.

As for soil and groundwater, the vapour assessment framework emphasises the role of the CSM, DQOs and an appropriate SAP in the site assessment process.

Primarily, the field methods included are applicable to chronic low levels of vapour concentrations as are typically encountered in contaminated site assessments. The guidance provided is not targeted at the assessment of landfill gas and appropriate professional advice should be sought for application to this type of assessment.

7.2.5 Asbestos

Additional guidance has been added to schedule B2 on the identification and assessment of sites affected by different forms (whether bound in a matrix or present as free fibres) of asbestos contamination in soil. The assessment framework supports the guidance on investigation levels and health risk assessment of asbestos contamination included in Schedules B1 and B4. The assessment framework is largely adapted from guidance released by WA Department of Health in 2009[18].

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[16] Davis GB, Wright, J & Patterson, BM 2009, *Field Assessment of Vapours*, CRC CARE Technical report no. 13, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

[17] Davis, GB, Trefry, MG & Patterson, BM 2004, *Petroleum and solvent vapours: quantifying their behaviour, assessment and exposure*, CSIRO Land and Water Report to the WA Department of Environment.

[18] WA DoH 2009, Guidelines for the *Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia,* WA Department of Health, Perth, Western Australia.

7.2.6 Dioxins and dioxin-like substances (dioxins)

A literature review[19] was undertaken to identify the relevance of site history and activities which may indicate the need to screen sites for the potential presence of dioxins. Guidance has been added to Schedule B2 which clarifies the particular circumstances when screening for dioxins would be required.

This guidance stresses that analysis should only be undertaken where the site history clearly indicates that dioxins are very likely to be present as a by-product resulting from specific manufacturing and industrial activities or waste disposal in order to prevent unnecessary (and costly) analysis.

7.3 Impacts of the variation to the Guideline on data collection, sample design and reporting

Financial impacts on industry

Significant savings to industry should be realised by more efficient sampling and analysis plans (SAPs) arising from the developing and refining of a realistic conceptual site model (CSM) and implementing an appropriate DQO process described in Schedule B2. Cost savings are anticipated through more efficient data gap filling through better targeted samples and reduced data redundancy. The application of the updated and expanded guidance on sampling of soils, groundwater and vapours and soil gases included in B2 and use of the checklists provided will assist in this process.

Substantial savings could be made on complex sites by using rapid real time investigation techniques; new guidance is included on tools such as Membrane Interface Probe and Laser Induced Fluorescence to provide more detailed and accurate delineation of contaminants and increased coverage compared with conventional techniques. The increased understanding gained may reduce the amount of follow-up investigation work required (saving additional mobilisation costs) and reduce the overall time required to complete the assessment and provide a more realistic basis for remediation costing.

More explicit guidance on vertical and lateral delineation of groundwater contamination may result in additional monitoring requirements (increased numbers of wells, number of monitoring events and sampling equipment) and hence cost. The recommended sampling practices included for some analytes can be more time consuming than more traditional approaches (for example, low flow groundwater sampling replacing bailers for sampling volatiles and redox sensitive metals) but the increased costs will be offset by higher quality, less ambiguous results. This increased expenditure is already being incurred where best practice methods have been adopted by site assessors.

The inclusion of guidance on the assessment of volatiles (and new HILs and HSLs for volatile substances) will likely result in increased investigation costs (for example, soil gas measurements) at some sites. However, the increased costs are outweighed by improved confidence that a more effective site remediation and/or management plan is implemented to ensure that human health is adequately protected.

Impacts on government and the community

In current Australian assessment practice, site investigation reports are usually reviewed by accredited third party professionals or jurisdictions when statutory decisions are required in response to land-use change or development proposals.

[19] Golder 2009, *Sources of dioxins and dioxin-like compounds – selective literature review*, Report to Department of Health and Ageing, Canberra.

Reductions in time and resources expended by third party reviewers and jurisdictions in clarifying requirements and assessing site investigation reports should be realised from the provision of updated and expanded guidance on the assessment of soils, vapours and groundwater in Schedule B(2). The expanded guidance should reduce regulatory concerns and potential risks to government in considering the adequacy of investigations undertaken.

The reduced timeframes for assessment (and clean-up if required) will mean that land is returned more quickly to use benefitting the wider community.

The adoption of improved site assessment practices has the potential to reduce impacts and disturbance to the community by reducing the number of phases of investigation, with consequent savings in vehicle movements, exhaust emissions and treatment of generated wastes.

8 Guideline on laboratory analysis (B3)

8.1 Statement of the problem

Use of sound analytical procedures underpins the assessment of site contamination by providing an element of quality assurance in the generation of data upon which decisions can be made. The NEPM defines procedures for the analysis of some, but not all, commonly encountered contaminants. For those not defined in the NEPM, and for contaminants that are encountered less often practitioners and regulators may determine an agreed analytical techniques to be used in site assessments.

Currently, Schedule B3 of the NEPM provides general guidance on laboratory procedures, and provides specific guidance on which analytical methods should be used for some analytes. In the absence of specific guidance, or where jurisdictions have not specified which analytical procedures to use, the analyst or the site assessor may decide on which method to use. Frequently, the choice of analytical method used for a given parameter can influence the result of that analysis. This, in turn, can influence decision making about site contamination. In some cases, specified analytical methods offer options or alternatives that leave the analyst with a large influence on the result, simply through the choice of method.

Some jurisdictions overcome this problem by specifying acceptable sources of analytical procedures that can be relied upon to provide defined laboratory procedures. Examples of these include US EPA, American Society for Testing and Materials (ASTM), American Public Health Association (APHA) and Standards Australia. However, this approach does not fit within the NEPM development framework in that it would entail endorsement of procedures that are yet to be developed and have not been tested or validated. This approach also relies on the ability of organisations maintaining their capacity to produce reliable and robust procedures.

In a similar vein, the submissions to the NEPM review were divided on the process for approving analytical procedures for contaminants for which there have not previously been procedures. Increased flexibility in the NEPM was identified as an option. However, this, and other options, still did not address which body would have the role of approving such procedures and identifying those that were important. Also, some submissions discussed the monitoring and enforcement of whichever approach was adopted. There was no identifiable body or individual which would enforce the use of standard or specified procedures, or which could monitor that the procedures being used were meeting any specified performance standard. In some jurisdictions, such tasks fall to auditors or third party reviewers, usually by reference to the requirements of Australian Standard *Guide to Sampling and Investigation of Potentially Contaminated Soil* AS4482.1 and AS4482.2.

Decisions on development of remediation plans and the sufficiency of site assessment and clean-up depend on the results of reliable laboratory soil analyses for the contaminants of concern. The NEPM laboratory methods are in general use in Australian commercial and governmental laboratories.

The NEPM provides that laboratories obtain National Accreditation and Testing Authority (NATA) or equivalent certification for the specific methods used. However, individual laboratories have adopted variations to existing methods and new methods that are not included in the NEPM.

Consultancies and jurisdictions frequently forward sample duplicates and split samples to separate laboratories for quality control/quality assurance purposes. Exercises have also been undertaken using blind spiked samples of known contaminant levels that are forwarded to different laboratories so that results can be compared. The results of this approach are mixed, with significant variations identified in analytical results between laboratories using the same or different methods.

Inaccurate laboratory data can lead to poor assessment of human health and environmental risk, the potential for poor remediation or site management outcomes, and adverse economic implications for site development. There are significant benefits in addressing these concerns for consistent and acceptable practices between laboratories.

There are associated issues of appropriate soil and water sampling and preservation for various contaminants of concern and a lack of homogeneity of the contaminant in the collected samples that can cause disparities between sample results.

8.2 Variation to the guideline on laboratory analysis

Schedule B3 provides a reference to quantitative laboratory methods specific to known or expected soil contaminants identified in the NEPM. Schedule B3 was varied to:

- incorporate quantitative laboratory methods for new contaminants included in the varied NEPM
- update quantitative laboratory methods to reflect current accepted methods.

In recognition of the competing needs for speed and reliability, the philosophies applied to development of methods incorporated into the varied Schedule B3:

- are simple to understand and perform, using readily available reagents
- are rapid but not at the expense of meaningful analytical results
- are accurate and precise — accepted as rigorous techniques by the scientific community
- are capable of batch or automated analysis to achieve cost efficiency
- are capable of simultaneous analysis to achieve cost efficiency
- have an appropriate limit of reporting (LOR) -
- are safe when applied to batch, automated and simultaneous analysis.

The variation incorporates consideration of submissions to the review and consultation with laboratories, consultants and environmental auditors. The key outcomes of the review process were:

- Use of industry standard reference methods, replacing NEPM described methods. Where possible, the revised Schedule B3 adopts established 'standard methods' from recognised sources such as Standards Australia, US EPA, APHA, ASTM and International Standards Organisation (ISO).

- Incorporation of 'equivalent' methods. Alternative methods represent potential opportunities to manage sample handing and analysis that affects the overall cost. The revised NEPM Schedule B3 recognises alternative methods where the user demonstrates that:
  - the alternative method is at least as rigorous and reliable as the reference method; and/or
  - it has been validated against an appropriate certified reference material. This requires adequate recovery of analytes using certified reference materials during method validation, as well as regular participation in national proficiency trials by bodies such as National Measurement Institute or Proficiency Testing Australia, or other accredited provider, and/or
  - it has been verified against a laboratory NATA-accredited for that method.
- Incorporation of leachability of contaminants is a more useful parameter for assessing site contamination. Schedule B3 includes two leachability methods for assessing the mobility of common metal contaminants.

  Misuse of leachability testing can occur when laboratory procedures designed to determine the mobility of contaminated soil in an active landfill setting are applied to soils intended to remain in situ. There is no specific reference in the NEPM to leachability – rather, guidance is limited to some references to US EPA procedures for determining leachability (for example, toxic characteristic leaching procedure testing).

  A review of relevant leachate testing procedures and their application combined with clearer guidance on their use would enable nationally consistent assessment practices.

The varied Schedule B3 provides quantitative laboratory methods for soil contaminants identified in the varied NEPM. By utilising industry standard methods, the most recent and recognised relevant methods are applied. Cost-effective handling and analysis is achieved through the use of standard methods, and by allowing equivalent methods to be used (providing they meet appropriate criteria), maximising laboratory flexibility.

8.3 Impacts of the variation to the Guideline on laboratory analysis

Impact on industry

The changes to required analytical methods will result in savings for some contaminants and minor increase in costs for others. Some cost savings may also be realised as performance-based options have now been included.

The inclusion of new TPH analytical methods may require some changes for laboratories, but this is expected to be minimal and an initial cost, not one that is ongoing.

Impact on government

There will be no apparent impact on government arising from the new analytical methods.

Impact on the community

The variation will have a positive impact to the community by:

- providing more relevant /consistent methods for the analysis of contamination in soils.
- increasing the certainty in the analytical data used to assess the level of contamination.

9 Guideline on health risk assessment methodology (B4)

9.1 Statement of the problem

Schedule B4 of the NEPM provides guidance on health risk assessment methodology. Submissions to the NEPM review described the current methodology for deriving HILs as adequate but requested it be updated to reflect international best practice.

Specific issues were raised by review respondents including:

- the approach to quantitative carcinogenic risk assessment
- dealing with asbestos containing material on sites
- the use of bioavailability data for site-specific risk assessments
- the risk assessment of mixtures of chemicals of concern.

9.1.1 Carcinogenic substances

The NEPM currently has limited guidance on the conduct of a risk assessment for carcinogenic substances at contaminated sites. HILs have been developed for only a limited number of carcinogenic substances, but general methodologies do exist for conducting risk assessments for carcinogens in any environmental media and these are applicable to carcinogens in soils.

In the absence of HILs for important carcinogenic site contaminants and the lack of consensus on the best methodologies for the risk assessment for carcinogenic site contaminants, the actual risks from substances in soil may be overstated with resultant increases in compliance costs. Most submissions favoured a review of the available methodologies to determine best practice for carcinogenic risk assessment, and the use of this to develop HILs for a priority list of carcinogenic contaminants.

It is noted that the NHMRC *Toxicity assessment for carcinogenic soil contaminants (1999)* describes a modified benchmark dose methodology (mBMD) for carcinogenic risk assessment; this document has been rescinded. Recent developments in international risk assessment practice indicate that this methodology could possibly be revised to achieve acceptance among Australian regulators and future variations to the NEPM may adopt such a revised methodology for carcinogenic risk assessment.

9.1.2 Asbestos contamination

Asbestos may be encountered in the assessment of site contamination as bonded (asbestos sheet materials) or as free fibres (for example, insulation or lagging). The main exposure pathway is through inhalation and the relationship between soil and air levels of respirable fibres is complex.

The different asbestos fibre types have differing physical, chemical and biological properties resulting in different potential risks to human health. The dose-response characteristics of the various fibre types have been extensively studied, and a number of them indicate that there may be a threshold concentration for the onset of the effects of asbestos.

The assessment of asbestos contamination is further complicated by such uncertainties as the condition of asbestos cement materials, mixtures of asbestos types and products, soil types and meteorological conditions. Consequently, the objective determination of potential human health risks is often difficult.

The risks associated with installed, undisturbed asbestos cement products are negligible, as the fibres are bound together in a solid cement matrix. Even weathered asbestos cement roofing does not release significant amounts of airborne fibres unless the material is significantly disturbed [20].

The risk associated with site contamination by asbestos cement products is considered low as the fibres are bound together in a solid cement matrix. However, the presence of asbestos-containing materials on sites may pose aesthetic and practical limitations as well as health-based limitations on potential land uses.

Asbestos receives only nominal consideration in the NEPM. As it is difficult to predict the entrainment of asbestos fibres from the soil into the atmosphere and acknowledging the difficulties of determining its concentration in soil, it is currently general practice to use qualitative methods in assessing the extent of asbestos contamination in soils. Given this, alternatives to setting a HIL were considered.

The issues considered in deriving the NEPM guidance for asbestos included:

- the appropriate level of site assessment required to inform the remediation strategy
- ensuring the sustainable and adequate protection of human health and the environment for the reasonable and usual long-term use of a site
- the health management measures necessary during the conduct of investigations and particularly any remediation activities.

The assessment of risk for asbestos is also inextricably linked to the consideration of acceptable management options. Submissions to the NEPM review requested that a consistent approach be developed to allow an effective and defensible regulatory framework to be established.

9.1.3 Mixtures

Contaminated sites frequently contain mixtures of substances; these may be commonly occurring combinations arising from a single activity or a more unusual mix arising from multiple diverse activities at a site. Guideline values for soil contaminants are generally derived for single substances and there are no established techniques for deriving soil guidelines for such mixtures.

Some methodologies for the risk assessment of chemical mixtures have been developed; for example, guideline values for total exposure to dioxins from all sources have been derived using the WHO revised 2005 TEF scheme[21]. There are other methodologies such as the US EPA Hazard Index[22] that allow the grouping of dissimilar substances according to their common mechanism of action. It is much more difficult to develop methodologies for human health or ecological guidelines for mixtures that may exhibit synergistic and antagonistic effects.

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[20] enHealth Council 2005, *Management of asbestos in the non-occupational environment*.

[21] Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M & Fiedler, H 2006, 'The 2005 World Health Organisation re-evaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds', *Regul Toxicol Pharmacol*, vol. 45, pp. 9–23.

[22] US EPA 2000, 'Supplementary guidance for conducting health risk assessment of chemical mixtures', *Risk assessment forum*, pp. 1-209.

As a comparison, the 2004 Australian drinking water guidelines (ADWG)[23] provide a method for estimating the toxicity of mixtures in water using a general formula. The ADWG also indicate that the best method to take into account the toxicity of mixtures is direct toxicity assessment of the concerned water. Direct toxicity assessment is a complementary method adopted in many OECD countries to characterise the toxicity of wastewater and establish discharge criteria.

Currently there is no agreed Australian approach to assessing mixtures of substances. Where data are available on the interaction of substances, these can be taken into account in the risk assessment.

In the absence of an acceptable methodology for assessing site contamination by chemical mixtures, there is potentially reduced confidence that the site assessment methodologies are sufficiently protective of human health. Submissions to the NEPM review requested that international practice in the risk assessment of chemical mixtures be reviewed to determine whether a regulatory framework could be established.

9.1.4 Bioavailability

Exposure routes are affected by various factors including the type, fate and transport of substances, soil characteristics and receptor behaviour. One factor that is gaining increased attention is bioavailability. Bioavailability relates to the fraction of the total amount of a chemical that is able to interact with an organism.

The NEPM defines bioavailability as a 'measure of the ratio of the amount of chemical exposure (applied dose) and the amount of chemical that enters the tissues of exposed biota (absorbed dose)'. The NEPM Schedule B4 indicates that 'where bioavailability data for ingested soil contaminants is unknown, the value of 100% absorption should be used. If bioavailability data are available they can be used providing the values are able to [be] justified'. A similar logic is applied to the bioavailability of substances that are inhaled or absorbed through the skin.

Though the NEPM supports the use of bioavailability in site-specific risk assessments, it does not include any guidance on how to do this. Some of the HILs incorporate bioavailability considerations but this is not consistently applied in the NEPM risk assessment framework.

In the absence of approved techniques for determining bioavailability, the actual risks from substances in soil may be overstated with resultant increases in compliance costs. Submissions to the NEPM review requested that international practice in the application of bioavailability data in site assessment be reviewed to determine whether a suitable regulatory framework could be established.

9.2 variation to the guideline on health risk assessment methodology

The principles and guidelines in this Schedule are intended to assist in determining whether or not remediation is required at a site given the proposed land use. The Schedule has been updated from the previous NEPM and provides a national approach to conducting site-specific health risk assessments at contaminated sites.

[23] NHMRC & NRMMC 2004, *National water quality management strategy. Australian drinking water guidelines*, National Health and Medical Research Council & Natural Resource Management Ministerial Council, Australia.

The variation aims to:

- provide a framework for policy making and undertaking risk assessments that is transparent, logical and compatible with current scientific principles and practice
- provide a basis for deriving HILs
- provide guidance to allow departure from the standard approach to a site-specific one.

Specific issues raised during the review have been addressed as follows.

9.2.1 Carcinogenic substances

A review of the available methodologies for quantitative carcinogenic risk assessment was undertaken to determine best practice[24]. The identified methodologies were used in the development of HILs for a priority list of carcinogenic contaminants. These are included in Schedule B7.

9.2.2 Asbestos contamination

Submissions to the NEPM review requested that a consistent approach be developed to allow an effective and defensible regulatory framework to be established.

The minimal guidance on asbestos in the current NEPM has been expanded and is contained in Schedules B1 and B2. The 2009 guidance from the WA Department of Health[25] has been adopted including general screening levels for the exposure scenarios. This guidance is meant to apply to the most common presentation of asbestos on sites, that is, bonded asbestos cement material. The guidance recommends semi-quantitative estimates of asbestos fibre concentration on a weight-by-weight basis. It is noted that the assessment of a site contaminated with asbestos is inextricably linked to the consideration of acceptable management options for that site.

Currently, small amounts of asbestos can have significant and potentially unjustified impacts on the costs of remediation projects. The current costs of unnecessary asbestos remediation arise from a combination of poor risk communication and evolving legal precedent dealing with asbestos contamination. The NEPM amendments are expected to provide more surety and better decision making for sites with asbestos contamination and eliminate wasteful unnecessary remediation.

9.2.3 Mixtures

The current NEPM contains limited guidance on the risk assessment of chemical mixtures.

The existing NEPM guidance has been expanded based on a review of the existing literature and international practice[26]. The guidance is in the form of a summary of current relevant information which can be referred to by the community, consultants and regulators. Schedule B4 now provides guidance on deriving site-specific health guideline values for complex chemical mixtures and in B5 for consideration of mixture effects in dealing with ecological impacts.

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[24] NHMRC 2009, 'Cancer risk assessment methodology: a review and recommendations' *Health Investigation Levels Review,* prepared by Environmental Resources Management Australia.

[25] WA DoH 2009, *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia*, Department of Health, Perth, Western Australia.

[26] Priestly 2009, 'Review of risk assessment of chemical mixtures', unpublished, provided to NEPC.

9.2.4 Bioavailability

Submissions to the NEPM review requested that international practice in the application of bioavailability data in site assessment be reviewed to determine whether a suitable regulatory framework could be established.

Based on reviews of the literature and international best practice in this area, the NEPM (Schedule B7) provides guidance on modifying the listed HILs based on evidence of bioavailability on a site-specific basis. It is noted that the science for these adjustments is best developed for arsenic and lead.

9.3 Impacts of the variation to the Guideline on health risk assessment methodology

Financial impacts on industry

Significant savings to industry should be realised by the revisions to the current methodology for deriving health investigation levels (HILs) to reflect international best practice, the additional guidance dealing with the risk assessment of carcinogenic substances and complex chemical mixtures, and the use of bioavailability data. Guidance on asbestos is provided in Schedule B1.

The changes to the Schedule establish the fundamental principles of risk assessment as they relate to contaminated land decision making in Australia. Due to the complexity of the risk assessment approach, a standard approach to all sites is not practicable and site-specific considerations will often need to be made. This Schedule provides a guide to assist the decision-making process and in determining whether or not remediation is required at a site given the proposed land use. Industry and regulators will both benefit from the mutual acceptance of an Australian standard methodology for contaminated site assessment.

Cost savings will be realised, for example, through the availability of HILs for some carcinogenic substances that would previously have required site assessments commencing at Tier 2 or above. The assessment of chemical mixtures can be both complex and a regulatory hurdle but it is expected that the guidance provided in Schedule B4 should provide clarity and certainty, leading to lesser costs. The guidance on the use of bioavailability data has led to less conservative HILs for arsenic and lead, meaning cost savings for remediation activities.

The impacts of the inclusion of guidance on the assessment of asbestos are included earlier in this document.

Impacts on government and the community

The revised guideline should reduce costs to, and impact on, the community by ensuring that health protective soil standards are maintained and reducing the extent of unnecessary remediation. Additionally, the timeframes for assessment should be reduced overall. Complex and expensive remediation may be avoided by the more comprehensive guidance provided for site assessment.

Government will benefit from the provision of more reliable and comprehensive assessments from auditors/third-party reviewers.

10 Guideline on ecological risk assessment (B5)

10.1 Statement of the problem

The NEPM Schedule B5 provides a framework for ecological risk assessment. It consists of three levels of assessment:

- Level 1 - essentially a comparison of measured concentrations to the EILs.
- Level 2 - largely a desktop study where site-specific factors are used to modify the EILs which are then compared to the measured concentrations.
- Level 3 - a detailed site-specific probabilistic ecological risk assessment (ERA).

Fifteen (15) EILs for inorganic contaminants are published in the NEPM. The basis of the EILS is believed to be largely opportunistic and there is no approved methodology published. The EILs apply a single numerical value to all Australian soils and they do not consider land use, soil physicochemical properties, bioavailability and ageing effects. Therefore, they are conservative due to consideration of high bioavailability soils only (that is, sandy, low pH soils) and cannot be adjusted for site-specific conditions. Given these limitations, the application of the EILs can be impractical especially when the EILs are below the ambient background concentrations.

10.2 variation to the guideline on ecological risk assessment

National advances over the last few years in the derivation of new methodologies have allowed improvements to be made to the ERA process. The process is now sufficiently mature to be developed into more robust guidance with the overall aim being to promote a consistent and clear framework for ERA that can be used nationally by jurisdictional environmental agencies and risk assessors.

The varied Schedule now proposes to include the EILs for eight chemicals: arsenic, chromium (III), copper, lead, nickel, zinc, DDT and naphthalene. *The Australian methodology to derive ecological investigation levels in contaminated soils*[27] has provided the means for deriving the EILs used within the ERA framework. In developing the EIL derivation methodology, the approaches used by other countries (such as USA, Netherlands, Canada, EU and UK, Germany and New Zealand) were investigated.

This risk-based methodology incorporates the latest scientific findings in the areas of ecotoxicology, soil science and geochemistry.

It enables for:

- the protection of introduced and native animals, plants, micro-organisms and microbial processes (including nutrient cycling)
- setting levels of protection based on the three categories of land uses (national park/area with high ecological value, urban residential/public open space, and commercial/industrial)
- accounting of background concentration of contaminants
- the ability to account for changes in bioavailability of contaminants over time and in different soils
- the ability to account for contaminants that biomagnify.

[27] Heemsbergen D, Warne MStJ, McLaughlin, MJ, & Kookana, R (2009) 'The Australian Methodology to Derive Ecological Investigation Levels in Contaminated Soils' CSIRO Land and Water Science Report 43/09, Adelaide, Australia.

The EILs are calculated using a species sensitive distribution (SSD) method which permits the EILs to be set to protect any selected percentage of species. They take into account ambient background concentrations, and physicochemical properties of the soils which may affect toxicity and biological availability of the element in different soils. Thus, rather than having a single numerical limit for a contaminant, different soils will have different limits. Where it is not possible to derive soil-specific EILs, generic EILs are derived. In addition, the derivation of the EILs considers the ageing effects of contaminants as it is known that contaminants become less bioavailable in the field and over time. Thus, laboratory-based experiments using freshly spiked chemicals may overestimate toxicity in the field. Whenever ageing/leaching factors are available, the laboratory-based toxicity data are corrected using these factors.

By deriving EILs that account for soil-specific properties and ageing, the first ERA component under the NEPM is, in effect, a combination of the level 1 and level 2 of the previous ERA framework (NEPC 1999). The variation to Schedule B5 involves the framework for conducting ERAs being updated and simplified to two levels: a Preliminary ERA and a Definitive ERA.

10.3 Impacts of the variation to the guideline on ecological risk assessment

Impact on industry

There will be significant cost savings to industry arising from the variation because:

- the less stringent EILs will reduce the likelihood for further assessment of soil above EILs
- inherent conservatism is reduced as the methodology incorporates the latest scientific findings which will reduce the net cost of site assessment and remediation.

The EIL methodology is more flexible as it enables the derivation of site-specific and more realistic EILs by allowing the information from the preliminary and detailed investigation to be considered. The EILs and the methodology will reduce delays and the need to conduct an expensive site-specific ecological risk assessment where the EILs are exceeded because the site specific risk assessment will involve collection of significantly more site data and species toxicity testing relevant to the site .

Impact on government

There will be no apparent impact on government arising from the new methodology and the revised set of EILs as the process for the regulation of the site assessment remains largely unchanged.

Impacts on the community

The variation will have a positive impact to the community by:

- enabling the site assessment and remediation process to be more ecologically sustainable through the adoption of the more realistic EILs. This is likely to reduce the amount of soil to be disposed of off site or managed on site
- increasing the efficiency of the site assessment process without going through a detailed ecological risk assessment to derive site-specific targets
- increasing certainty through the use of the revised EILs which are derived based on the latest scientific findings.

11 Guideline on risk-based assessment of groundwater contamination (B6)

11.1 Statement of the problem

The NEPM Schedule B6 provides a risk-based process framework to assess groundwater impacts associated with point-source site contamination. This framework must consider the regulatory requirements of each jurisdiction and is not intended for application to broad scale groundwater issues associated with agriculture, catchment management or salinity.

Schedule B6 of the current NEPM outlines how GILs should be used 'as investigation levels at the point of extraction and as response levels at the point of use (unless a site-specific risk assessment has been carried out and an alternative, more appropriate response level has been determined)'. The Schedule adopted the 1992 AQWGs and the 1996 ADWGs as the basis of the GILs; these have been replaced by updated guidelines.

All jurisdictions and contaminated land professionals acknowledge the clear linkage of site contamination and associated groundwater impacts for many sites as an issue of concern. There appears to be general consensus for revising and updating groundwater investigation guidance.

11.2 Variation to the guideline on risk-based assessment of groundwater contamination

The major change to Schedule B6 is replacement of the former national guidelines by the updated ones, comprising:

- ANZECC & ARMCANZ 2000, *National water quality management strategy. Australian and New Zealand guidelines for fresh and marine water quality*, Australian and New Zealand Conservation Council and Agriculture, & Resource Management Council of Australia and New Zealand.
- NHMRC & NRMMC 2004, *National water quality management strategy. Australian drinking water guidelines*, National Health and Medical Research Council & Natural Resource Management Ministerial Council, Australia.
- NHMRC 2008, *National water quality management strategy. Guidelines for managing risk in recreational water*, National Health and Medical Research Council, Australia.

These guidelines have been adopted nationally and have been used by various stakeholders since their release.

11.3 Impacts of variation to the guideline on risk-based assessment of groundwater contamination

No negative impact is anticipated to industry, government and community arising from the changes to this schedule, given that:

- the Schedule is mainly updated with reference to current national guidelines
- these national guidelines were subject to public consultation processes, have been adopted nationally and are already used by all stakeholders.

Updating the GILs will ensure consistency in groundwater assessment processes.

12 Guideline on health based investigation levels B7a & Guideline on exposure scenarios and exposure settings B7b

12.1 Statement of the problem B7a

For soil contaminants, the health-based investigation level (HIL) is generally derived by first using toxicological and epidemiological evidence to generate an estimate of what is acceptable or tolerable intake. The second step is to consider what the total intake of a sensitive individual, like a young child, would be in a model exposure scenario such as a suburban house block. These values are aimed to be protective of human health. They are conservative, and exposure to soil levels below these can be considered very unlikely to result in adverse human health effects. Hence health-based investigation levels for contaminated sites are the concentrations above which further assessment and considerations for site management are required. The underlying health risk assessment methodology for the derivation of HILs is presented in Schedule B4, while asbestos contamination is dealt with in Schedule B1 and Schedule B2.

It should be remembered that site and context-specific considerations may make concentrations above the guidance values acceptable. As discussed earlier, (Section 6.1.1) currently a 'residential' land use setting is employed for deriving the guidance value and values are based on a default exposure scenario for the most sensitive receptor, a 2-year-old child.

The general method for deriving HILs is to allocate a proportion of the tolerable intake to the various sources of exposure, either as a fixed percentage, or as a percentage derived from local data on background exposures for each medium.

Schedule B7a of the NEPM lists HILs for more than 24 common contaminants or groups of contaminants in soil in 'residential' land-use areas. It was acknowledged that the adopted values were generally conservative and were derived using varying assumptions about exposure factors, percentage of tolerable intake, exposure routes and body weights, and using the methodology outlined in the World Health Organization Environmental Health Criteria No.170 monograph *Assessing Human Health Risks of Chemicals: Derivation of Guidance Values for Health-based Exposure Limits* (1994). Some of these values need to be revised to reflect recent Australian and international developments in risk assessment methodology, and the availability of new internationally peer reviewed hazard assessments, and newly refined Tolerable Intakes.

Review respondents called for clear guidance to further clarify the use of HILs to counter their inappropriate use as remediation criteria. Most submissions favoured revision of the current HILs, development of additional HILs for priority contaminants of concern including carcinogenic substances and non-dioxin persistent organic pollutants (POPs) that are not addressed in the current NEPM (1999). Submissions also supported the involvement of national health advisory bodies in any review of the HIL development process.

12.2 Statement of the problem B7b

Schedule B7b provides guidance on exposure scenarios and exposure settings. Submissions to the NEPM review called for more guidance in the application of these scenarios and settings and that HILs for the differing exposure scenarios (scenarios A, D, E, and F in Schedule 7b of the NEPM) should be established for all contaminants of concern.

12.3 Variation to the guidelines on health-based investigation levels

Schedules B7a and B7b have been updated and combined into one Schedule B7. The revised Schedule presents an expanded list of HILs and sets out the revised and updated methodology adopted to derive the HILs. The methodology presented is also designed for use in site-specific risk assessment noting that additional guidance on site-specific risk assessment is also provided in Schedule B4.

The exposure scenarios and exposure settings in what was B7b have been reviewed and are now simplified to 4 generic land-use scenarios as follows:

- HIL A — Standard low-density residential scenario with a substantial garden
- HIL B — Standard high-density residential scenario without a substantial garden
- HIL C— Developed open-space scenario, including parks, recreational areas and secondary school playing fields
- HIL D — Commercial/industrial scenario.

For each land use, the exposure pathways have been expanded beyond those considered previously and now include:

- incidental ingestion of surface soil and dust
- indoor and outdoor inhalation of dust
- consumption of home-grown produce (including vegetables and fruit)
- consumption of soil adhering to home-grown produce
- dermal contact with surface soil and dust particulates
- indoor and outdoor inhalation of vapours derived from shallow soil.

Human exposure parameters used in HIL derivation have been updated in accordance with the latest information and generally derived from the enHealth Australian Exposure Factors (2011).

Appendices to the Schedule provide a summary of toxicity profiles for the chemicals for which HILs have been derived, a list of the formulae used in the exposure modelling and HIL derivation, and a description of the specific modelling approach used for the HIL derivation for lead.

12.4 Impacts of the variation to the guidelines on health-based investigation levels

Health aspects

The revised HILs are based on the most recent peer reviewed human toxicology studies and extend coverage with 10 additional HILs. The updated HILs, transparent derivation methodology and wider range of substances covered provide a scientifically sound basis to manage health risks from site contamination in urban land use.

Financial impacts on industry and the community

In current Australian assessment practice, site work is usually reviewed by accredited third party professionals when statutory decisions are required about land-use changes or development proposals. Professional liability concerns can arise when there are no authoritative soil criteria available, particularly for Tier 1 health risk assessment. This can delay development projects, increase holding costs and add further costs through excessive remediation and disposal of low grade contaminated soil. The wider range of HILs and the interim HILs for common volatile chlorinated compounds should remove some of the current uncertainty about appropriate health based criteria to apply on specific sites.

Based on current toxicology data, the revised HILs are in most cases the same or greater than the Measure HIL values. This should generate a net cost benefit for most development sites as more soil will fall below health screening levels and not require any further management for health concerns.

Some contaminants, for example, PCBs have lower HILs due to more recent studies that have revised the toxicity status of the contaminant. The use of PCBs in Australia has been gradually phased out since 1995 and PCB-impacted sites are relatively limited in number and are usually associated with the electricity industries and former industrial sites with large transformers.

The revised HILs also provide improved community protection as the wider range of contaminants covered will ensure that any potential risks from site contamination to householders and local communities can be better defined and managed.

Government and regulatory impacts

Schedule B1 provides more detailed information on the application of HILs and their relationship to other soil criteria. The revised HILs and associated guidance should improve consistency in their application between jurisdictions.

In the absence of health-based soil criteria derived by recognised health authorities, justifications must be made by contaminated land professionals to address regulatory requirements and to account for differing site conditions. The greater number of generic HILs should reduce regulatory concerns and potential risks to government in considering health risks on specific sites.

The associated guidance on use and application of HILs should assist in preventing an understatement of site health risks or unnecessarily conservative responses that cause other environmental concerns from over-excavation of sites and waste of landfill space for disposal of soil.

13 Guideline on community consultation and risk communication (B8)

13.1 Statement of the problem

The assessment of site contamination can become a major issue of public anxiety, particularly when a site has actual or perceived adverse health or environmental impacts from previous land uses. The concerns can become the major driver for any actions or works associated with such sites. There have also been instances where contamination concerns are exacerbated due to public opposition to the proposed site development. It is more common for site management or remediation activities to initiate public complaints from offensive odours, other fugitive air and water emissions, excessive noise, truck movements, traffic disruption and difficulties with access to private property.

Schedule B8 of the NEPM provides a framework for consulting the community and communicating risks associated with site contamination. Sometimes, members of the community have high levels of anxiety and express concern during site contamination assessments. In some cases, hundreds of public complaints are received by regulators and proponents – particularly with complex and difficult sites. Many complaints associated with site contamination issues could be avoided if the community is engaged and consulted with, and informed of issues relating to the site before any assessment work is undertaken. Perceived risks to health from site contamination can create as much community concern as confirmed risks; there is often no difference in the political and social effect or the costs involved.

The majority of submissions to the NEPM review considered that the current NEPM guideline was 'adequate' in addressing the issues of community consultation and risk communication; however, they considered that the guideline should be updated to reflect new developments and approaches to risk communication and to provide more comprehensive guidance and references to published information of issue-specific risk communication.

13.2 variation to the guideline on community consultation and risk communication

The variation refers to community engagement rather than community consultation in order to recognise the interactive, collaborative and empowering nature of the risk communication process. Improvements in the principles, methodologies and practices of community engagement and risk communication have resulted in a better appreciation and understanding of the processes and benefits of working collaboratively with the community and other stakeholders in relation to site contamination.

Community engagement should start as early as possible and continue throughout the site assessment. By commencing the engagement early, the community is able to actively participate in the decision-making process and community members will feel that they have some ownership and involvement in the risk assessment process.

The level of community engagement will be project or site-specific and may be influenced by factors such as the type of contaminant of concern, the extent of site contamination, site proximity to sensitive receptors or whether a site has a controversial history that may be related to the site contamination, or the development of the site is controversial for political, economic or social reasons.

Risk communication is an interactive process and must be delivered in the context of a well-structured community engagement process, involving the development and implementation of community engagement and risk communication plans by appropriately skilled professionals.

It is important that site assessors and managers accept that community perceptions of risk are as valid as scientifically derived risk estimates in the context of the community engagement process. For many situations, it may be just as important to address the community perceptions of risk as it is to address problems highlighted by the outcomes of risk assessments.

The varied Schedule B8 incorporates current principles and practices of community engagement and risk communication with the aim being to promote a clear framework that can be used nationally by jurisdictional regulatory agencies, practitioners and managers for site contamination issues.

The variation incorporates updated and additional guidance and references for jurisdictional regulatory agencies, site practitioners and managers in relation to issue-specific risk communication on the following aspects:

- key principles of community engagement and risk communication
- planning and preparation of community and engagement and risk communication plans
- identification of target audience and undertaking audience analysis
- message development
- determining requirements for consultation
- incorporation of evaluation and feedback processes
- development of consultation and communication protocols
- methods and techniques for community engagement.

13.3 Impacts of the variation to the guideline on community consultation and risk communication

Community engagement which effectively conveys information and enables community participation in the decision-making process can provide significant cost savings and improve credibility for organisations involved in site assessment. The community also benefits by contributing to improved risk assessment inputs, increased ownership of negotiated decision processes and more acceptable site management options. When the community participates in a risk management decision, it is more likely to accept it.

Well planned and well executed community engagement and risk communication will result in informing the wider community of risks in constructive ways and more effective communication and explanation of risk.

Site operators can benefit through:

- enhanced understanding of public perceptions helping to anticipate community response to actions and decisions
- increased efficacy and sustainability of risk management decisions
- empowering the community by involving them in decision-making processes
- shared understanding of problems and solutions, preventing unwarranted tension between the wider community and other stakeholders
- improved company reputation
- preventing community outrage and media scrutiny
- preventing potential litigation
- preventing delays in the progress of a project.

14 Guideline on protection of health and the environment during the assessment of site contamination (B9)

14.1 Statement of the problem

Protection of the environment and the health and safety of site personnel and other potentially impacted stakeholders is an essential consideration in assessments. A guideline containing a uniform methodology for health and safety management on sites was included in the NEPM Schedule B9 to ensure a minimum level of protection and to ensure that responsibility for such protection was undertaken by industry during assessments.

Since the introduction of the original NEPM, more specific legislated requirements for occupational health and safety obligations and responsibilities have greater authority and must be complied with. A NEPM guideline on health and safety is therefore seen as redundant.

The Schedule also contained information guidance on minimising adverse environmental effects during assessments. This information is retained but will be provided in Schedule B2 – Guideline on site characterisation.

14.2 Variation to the guideline on protection of health and the enivronment during the assessment of site contamination

The proposed variation to the Guideline entails removing Guideline B9 entirely, retaining the information on guidance on protecting the environment during assessment. That guidance will be provided in Schedule B2 – Guideline on site characterisation.

14.3 Impacts of the variation to the guideline on protection of health and the enivronment during the assessment of site contamination

The guidance provided in the 1999 NEPM Schedule B9 relating to protection of human health and the environment during site assessment was generally well regarded according to public consultation during the review consultation process. Removal of redundant guidance relating to occupational health and safety left a body of material that relates to best practice environmental management during site assessment. Consequently the core guidance was retained and incorporated in Schedule B2 to be considered by site assessors as part of the development of a site conceptual model, setting data quality objectives and integrating protective measures in planning field data collection.

The guidance deals with preparation of environmental management plans to ensure that contamination is not released into the environment during site assessment by the action of wind or water; vehicle movements; mismanagement of test pit , trench excavations or excavated soil; release of offensive odours; and creation of associated nuisance such as excessive noise and vibration. The guidance does not add any new requirements or addition costs to site assessment but encourages appropriate planning and best practices to protect the public and the environment during site assessment.

15 Guideline on competencies and acceptance of environmental auditors and related professionals (B10)

15.1 Statement of the problem

The assessment of contaminated sites is a specialised area involving a number of disciplines. Practitioners must have a range of competencies and be able to recognise the need for supporting professional advice beyond their expertise when assessing contamination and its effects on land use and the environment. The extent to which these competencies are applied varies with the complexity of contamination issues on individual sites.

Professional assessments of site contamination deal with health and environmental issues of concern to landowners, occupiers and the public. These assessments are required by regulatory and planning authorities for determination of appropriate management of contaminated land and in development approval processes.

Schedule B10 of the NEPM (1999), *Competencies and acceptance of environmental auditors and related professionals*, identifies competencies that are essential to undertaking site contamination assessments. It also provides a general framework for acceptance by regulatory authorities of contaminated land auditors and similar professionals who are required to certify site assessments.

Criteria for evaluation of the competencies, qualifications and relevant experience of contaminated land consultants and practitioners is determined and managed by the jurisdictional regulatory authorities.

The majority of submissions to the NEPM review considered that the current NEPM guideline was generally adequate but should be updated to better define the competencies required of consultants in site contamination assessment and revised to reflect current practices in Australian jurisdictions. It was recommended that improvements to this guideline relevant to site assessors should further assist stakeholders in selection of appropriate professionals, identify the relevant competencies for individual professional development, and support policy development.

15.1.1 Consultant competencies

Jurisdictions, accredited auditors and related professionals have raised concerns regarding the standard of site assessment work of some contaminated land consultants as reflected in the quality of site work and the standard of site assessment reports.

The issues raised relate to deficient assessment practices, lack of application of relevant NEPM and jurisdictional guidelines on basic data collection, poor report preparation, limited appreciation of assessment requirements for impacted groundwater and poor understanding of health and environmental risk assessment.

In some cases, consultants may be experienced and competent site assessors but place less emphasis on adequate report preparation. In other cases, the demand of workloads may influence consultancies to use less experienced personnel to undertake work on particular sites. Other practitioners may have limited access to the support of a team of specialists in aspects of site contamination.

The impact of poor work standards is often an increase in costs and time delays to clients, as re-work is necessary to ensure that an adequate standard of assessment has been undertaken to address uncertainties. In some cases, standards are demonstrably poor and are the cause of regulatory intervention and costly litigation. Such delays can cause criticism of all stakeholders and impairment of the achievement of the desired environmental outcomes.

Schedule B10 states that the guideline may be used by landowners, developers and consultants to assist with decision making in the employment or training of professionals for contaminated site assessment work. However, the guideline does not provide specific detail on how this may be achieved.

15.1.2 Auditor acceptance

The Victorian and NSW governments have mature and well-regarded auditor schemes with a significant number of senior professionals appointed to service the local markets. WA and SA have more recently established legislative audit systems in place. Other states' governments are considering similar schemes, or operate or are considering a graded system under administrative arrangements. Schedule B10 provides general guidance for states or territory governments that already operate or wish to adopt auditor schemes.

Schedule B10 also provides general guidance for states or territory governments that wish to adopt a graded auditor system. This approach engages competent private sector professionals to undertake limited auditing of either basic site contamination issues in remote areas with lower land values or in urban areas with less former industrial usage and limited contamination types.

These systems seek to utilise contaminated land competency in the private sector when private and public sector environmental services are limited and decentralisation is a major consideration.

Jurisdictions receive occasional criticisms or perceptions of accredited auditor systems regarding the market seeking auditors with the most favourable interpretations of risk, inconsistency in decisions between auditors, auditor conservatism relating to liability concerns, mutually beneficial auditing arrangements between major consultancies and with major customers, and insufficient supply of auditors to service market demand. Regulators undertake review and audit of specific assessments and auditor reports and conferences are regularly held by jurisdictions with appointed auditors to resolve issues of concern and improve operational practices.

15.2 variation to the guideline on competencies and acceptance of environmental auditors and related professionals

The variation to Schedule B10 (varied to be designated Schedule B9) incorporates revised and updated guidance for jurisdictional regulatory agencies in relation to: professional competencies for auditors, third party reviewers and consultants; applications and acceptance criteria for acceptance; and ongoing practice by jurisdictions.

The variation has taken into account current jurisdictional requirements and identifies the technical competencies, experience, ethical behaviours and professional associations that must be addressed by regulatory bodies when considering accrediting such persons and for the mutual recognition of these professionals between jurisdictions.

It also establishes a minimum level of knowledge, experience and technical competency for environmental professionals or consultants carrying out the assessment of site contamination.

Schedule B10 (now Schedule B9) has been revised to clarify that it is primarily intended to be used by jurisdictional regulatory authorities with the aim being to promote a consistent framework that can be used nationally by jurisdictional regulatory agencies. However, by clearly establishing minimum requirements for consultants, it is also expected to be referred to by stakeholders and clients to assist in their selection of consultants to carry out assessments of site contamination.

It is necessary to recognise the multi-disciplinary nature of the assessment of site contamination. Assessors should be able to demonstrate knowledge, experience and understanding across a range of professional and technical competencies relevant to the issues at the site(s) being assessed. As the understanding of the broad range of issues which must be considered in site contamination has been expanded, the competencies of environmental professionals must also be expanded. Accordingly, the existing competencies listed in Schedule B10 (revised as B9) have been revised and expanded.

There are now additional competencies which better reflect the knowledge and experience required in the assessment of site contamination:

- groundwater sampling design and methodology
- identification of potential human health and environmental risk
- air quality (volatile emissions and dust) assessment relating to contamination
- environmental sampling
- geology
- human health and ecological risk assessment relating to contamination
- identification of contaminants of concern from past industrial land uses
- occupational health and safety relating to contamination
- risk communication
- statutory and environmental planning.

15.2.1 Consultant competencies

In order to carry out the adequate assessment of site contamination, environmental consultants need to be able to demonstrate a level of qualification, professional and technical competency, knowledge, understanding and experience relevant to the site under investigation. Consultants also need to be able to identify and access specialist advice in areas beyond their expertise.

Schedule B10 (revised as B9) has been varied to include minimum requirements for the qualifications, technical competencies and experience of consultants carrying out the assessment of site contamination and preparation of assessment reports. This is expected to establish a basis for professional practice in site contamination and generally improve the reliability, quality and public confidence in work standards.

15.2.2 Auditor acceptance

Many Australian jurisdictions utilise a system of independent professional certification by the third party audit or review of assessment work carried out by consultants. Accredited persons undergo expert panel appraisal and are typically more senior consultants with demonstrated advanced skills in core competencies, specialist support teams and independent audit/review capability. Some jurisdictional agencies accredit or appoint persons to undertake audits with conditional appointments. A summary and comparison of requirements in different jurisdictions was carried out to identify similarities and inconsistencies between the different systems.

The review of current jurisdictional requirements for third party accreditation identified minor variations between individual jurisdictions; however, overall, the requirements were consistent. The most significant variation related to the identification and description of professional and technical competencies, with some jurisdictions having added updated competencies to their requirements. On review, it was considered that consolidation of current jurisdictional requirements would provide a sound basis for the revision to Schedule B10 (revised as Schedule B9).

Accordingly, Schedule B10 (revised as Schedule B9) has been varied to provide updated guidance for jurisdictions accrediting third party reviewers in relation to:

- the range of professional and technical competencies in the assessment of site contamination
- applications for acceptance
- assessment criteria including addressing the technical basis of applications, knowledge and understanding of relevant national and jurisdictional legislation and guidelines, minimum requirements for experience and expertise, qualifications, professional societies, professional experience, and ongoing commitment to professional development
- acceptance and ongoing processes.

15.3 Impacts of the variation to the guideline on competencies and acceptance of environmental auditors and related professionals

The outcomes for contaminated site assessment depend on the professional competency of the site assessors, third party reviewers and auditors. Poor quality work by site assessors poses difficulties for landowners, developers and regulators and can result in inadequate environmental outcomes, adverse health impacts and costly litigation. Poor quality or inadequate work may result in increased costs associated with unnecessary remediation which are typically borne by developers and landowners. Also, if inadequate work has been relied upon there may be significant costs associated with additional assessment and remediation requirements which are again typically borne by developers and both current and future landowners.

Providing guidance on the minimum requirements for the qualifications and experience for consultants carrying out the assessment of site contamination and preparing assessment reports is expected to assist and improve the consistency, quality and reliability of work undertaken nationally. The provision of guidance on appropriate competencies for environmental consultants is also expected to assist in decision making for jurisdictions, auditors/reviewers, various stakeholders and clients including property owners, developers and financiers.

Not providing advice on minimum qualifications and experience and leaving it to market forces would not achieve a consistent framework that could be relied upon.

Environmental auditors, third party reviewers and consultants are expected to maintain and update their knowledge, understanding and technical competencies. This is an activity that should be carried out as part of their standard professional development.

The updating of Schedule B10 (revised as Schedule B9) is expected to promote greater national consistency in auditor and third party accreditation/appointment processes. The framework in the varied schedule may be considered as the basis for a national accreditation process.

16 Environmental, social and economic impacts - summary

16.1 Role of Guidelines

The NEPM has been recognised by regulators, environmental auditors, consultants, developers and others as a comprehensive source of guidance in the assessment of site contamination. The NEPM is implemented in conjunction with existing jurisdictional guidelines and provides support in jurisdictions where guidance for specific aspects of site assessment has not yet been developed. The NEPM guidelines are used predominantly by consultants in the private sector who undertake site assessment work.

With the high cost of site assessment and remediation it is important that new scientific and technical information is incorporated into the NEPM to minimise overly conservative investigation levels, and provide clarification on the guidelines for site investigation processes to minimise unnecessary remediation. The benefits of assessment and remediation, in terms of safeguards for human health and environment protection as well as realising the commercial benefits of remediating degraded land, far outweighs the costs of appropriate assessment and remediation.

16.2 Environmental impacts of site contamination

Key environmental or ecological impacts from site contamination include:

- reduced or impaired function within the soil profile of the site contamination
- toxic effects within plant species ranging from failure to thrive to lethal impacts
- impacts to fauna either directly from the contaminants in the soil, or via ingestion of plants which have accumulated the contaminants of concern
- the build-up of contaminants within the food chain
- environmental deterioration of other segments of the environment due to migration of the contaminants (to groundwater, surface water or marine receptors, or to the air segment); the direct impacts from the contaminated site may not produce a measurable or significant impact, but for larger receptors such as a river or lake, the increased loading of contaminants will have a cumulative effect.

The 1999 NEPM provides guidance on the assessment of ecological impacts and investigation levels based on consideration of phytotoxicity and Australian urban background concentrations.

The review report to NEPC in 2007 made recommendations that include the development of a methodology that uses the SSD approach and, where possible, that Australian data be used to derive investigation levels using the new methodology. The task of addressing these recommendations on EILs was awarded to CSIRO and NSW DECCW who received funding for this from the Environmental Trust.

The methodology was developed to protect soil processes, soil biota (flora and fauna) and terrestrial invertebrates and vertebrates. It provides a transparent basis for practitioners and regulatory agencies to consider the physicochemical properties of the site soils to derive the site specific EILs.

In developing the methodology, a thorough review was conducted of the latest advances in soil chemistry, soil ecotoxicology and the methods being used in Australia and overseas to derive the equivalent of EILs. The methodology was presented at two industry seminars, released for targeted consultation, and was reviewed by three independent international referees with appropriate expertise.

The EIL derivation methodology:

1. is risk-based and gives regulators the ability to protect a selected percentage of species
2. incorporates assessment of the major exposure routes for terrestrial ecosystems, including secondary poisoning
3. can handle different types of toxicity data thereby maximising the number of EILs that can be derived for contaminants
4. can be used to derive soil quality guidelines for a variety of different land uses
5. can derive soil quality guidelines for soil contaminants with a variety of purposes
6. considers ageing and leaching in deriving EILs
7. considers bioavailability and can therefore derive soil-specific EILs and thus ensure a uniform protection level for different types of soils
8. considers the ambient background concentration in deriving EILs
9. is consistent with and incorporates the most recent advances in risk assessment, terrestrial toxicity and soil chemistry
10. is consistent with the 2000 Australian and New Zealand water quality guidelines.

The EIL derivation methodology is a considerable advance on the current situation as all the major limitations of the current EILs that were identified in the review of the NEPM have been addressed. The methodology generates scientifically robust and ecologically relevant EILs.

One of the great strengths of the methodology is its flexibility which provides regulators with much greater choice in developing policy and means that a single consistent methodology can be used to derive EILs and other soil quality guidelines for contaminants or guidelines in products, wastes, industrial residues or by-products that could be applied to soil.

16.3 Health and social impacts of site contamination

A major economic and social benefit resulting from the adequate assessment and remediation of contaminated sites is the prevention or reduction in health impacts and the costs associated with health impacts. Many of the chemicals that cause site contamination are linked to various health impacts, including cancer.

The US EPA has developed a cost calculation model, and has estimated the costs of health impacts for a range of diseases linked to chemicals, in a 'cost of illness' handbook. The handbook acknowledges that the likelihood of a number of people in a given population exposed to the chemicals contracting certain diseases is increased. The US EPA publication also notes that improvements in human health in the form of avoiding adverse health effects frequently constitute a major portion of the benefits resulting from environmental regulation.

While the handbook uses a simple approach, that of calculating the direct medical and related costs avoided because of the health improvements, it recognizes that the direct medical costs represent only a portion of the total benefits associated with pollution prevention/reduction. Cost of lost productivity, lost wages, and pain and suffering, are not included in the calculations.

The US EPA concludes that a reduction in the risk of an adverse health effect is a public benefit because all the exposed individuals will experience a decrease in the likelihood of contracting a disease.

The application of the variation is intended to ensure that land is suitable for its intended use. For sensitive land uses on sites that have a history of a past contaminating activity, this will require the use of accredited auditors. A developer will need to make an economic decision as to whether the costs of assessment and remediation are offset by the revenue raised through development.

The benefits of assessment and remediation, in terms of safeguards for human health and environment protection as well as realising the commercial benefits of remediating degraded land, outweighs the costs of assessment and remediation.

16.4 Economic impacts of site contamination - remediation

It is difficult to make measured predictions on the direct economic impacts of the variation to the NEPM, given that the guidelines deal only with assessment processes, not management and remediation (where the bulk of costs and benefits are accrued). However, it is the outcomes of the assessment process in site contamination investigations that drive decisions regarding remediation requirements. As such, it is assumed that the greatest benefit will be the impacts of the variation on remediation actions taken as a result of decisions made from the improved assessment process.

As the costs of assessment and remediation are largely borne by developers, estimates and costs are held by the environmental consultant industry and are commercial in confidence. The economic assessment approach used therefore is a description of a number of case studies to illustrate identified benefits and costs of the variation to the guidelines for the assessment of site contamination, from which flow remediation decisions and actions.

There is a common belief that the assessment and remediation of site contamination is an impost on development. In fact, remediation of contaminated land has led to substantial leveraging of the property values of previously derelict land, both within Australia and internationally.

Nationally and internationally there is ample evidence to show that remediation of derelict, brownfield sites leverages development and increases property values. Not remediating a site can result in lost development opportunities and loss of on-going economic benefits. For example, remediation of the contaminated rail yards at Mile End in Adelaide enabled the construction of the Santos athletics stadium and netball complex and some 30 residential allotments. These facilities now attract local, national and international usage, such as for the 2007 International Police and Fireman's Games. It is estimated that the Santos stadium alone is used by approximately 90,000 people per year for local and national level competitions.

16.4.1 Case studies

Large gas works, Site A – major capital city

Site A had an initial estimated remediation cost of approximately $25 million with assessment costs of the order of 15% -20% ($3.75–$5 million). The remediation contract price was fixed and the contract conditions required site clean-up to enable 'any land use'. The condition for 'any land use' placed more stringent requirement on site assessment and remediation activities, raised liability concerns for all parties involved and led to cost escalation.

Without considering the specific commercial complexities for the particular site, it is notable that the absence of comprehensive human health and environmental criteria limited the available options for managing the site. Liability concerns arising from uncertainty with remediation criteria and contract requirements contributed to a doubling of the assessment and remediation cost to approximately $52 million.

The use of the varied HILs, HSLs, EILs and ESLs would have provided greater certainty for remediation actions and enabled consideration of a wider range of options to manage the site at lower cost while achieving the same final land-use options.

The high cost of site assessment and remediation and the absence of appropriate investigation and screening levels resulted in higher land costs per dwelling and commercial unit for the proposed development; costs which are ultimately passed on to the consumer. The costs increase could have been contained if appropriate investigation and screening levels had been applied.

Large gas works Site B - major capital city

Site B was another gas works assessed and remediated over two separate lots.

Lot 1

The contract restrictions for Lot 1 were less onerous than Site A and high-density residential use was achieved by statutory management of some residual low risk contamination after completion of a $7.5 million assessment and remediation program. The site was less contaminated and site assessors had few liability concerns as the 1999 NEPM soil investigation levels were sufficient guidance for most areas of the site.

The outcome for Lot 1 is a demonstration of the benefits of application of investigation levels when there are adequate criteria.

Lot 2

The contract restrictions were also less restrictive for Lot 2 which was remediated for a cost of approximately $14 million with statutory management of some residual contamination. However, the higher costs for this Lot were the result of different site conditions and the absence of appropriate investigation and screening levels for Tier 1 risk assessment for the proposed site uses.

The situation for Lot 2 was more complicated and there was a greater aversion to risk due to the limited guidance in the form of investigation and screening levels. This increased the site costs by less soil passing the investigation and screening levels with greater soil removal and disposal costs. The use of the varied investigation and screening levels would have provided more certainty about the potential land use risks to human health and the environment and reduced assessment and land development costs.

Possible asbestos impacted site - Queensland

A low lying development site in an industrial area (approximately 11 ha) was partly covered with approximately 1.5 m of preload fill of 130,000m^3 sourced from uncontaminated sites in the city area. The preload was placed for the purpose of site compaction and raising the level of the land for a proposed development.

After a period of months some of the preload was removed to enable commencement of building works in accordance with development approval. At this time a short length of 'asbestos rope' (<150 mm) was observed on the site.

The following actions ensued:

- Site workers became concerned and stopped work.
- Occupational heath and safety officers inspected the site and could not find any issues of concern with no visible asbestos present in the surface or shallow soil.
- Dispute arose between the land owner and the developer.
- Both parties engaged environmental site assessment professionals who undertook site investigations of varying sufficiency.
- The site assessors for both parties arrived at different conclusions about potential risks.

- Very small quantities of sound fragments of ACM were found in the sub-surface in limited areas.
- Lawyers were engaged by both parties and there were difficulties in information sharing.
- Environmental authorities were finally provided with assessment reports and the site was cleared of any risk of concern from asbestos with levels below 0.001% w/w.
- The parties did not reach a satisfactory resolution of the dispute.

The project was delayed for 9-12 months and total legal and site assessment costs exceeded $500,000. It is not unusual that the fill contained some minor quantities of ACM fragments, a situation common in older Australian urban land. The problems that arose were the direct result of insufficient guidance on screening levels of low risk forms of ACM in soil related to land uses and related management issues.

Examples of leveraged development and enhanced property values

Halifax Street redevelopment (South Australia)

The Halifax Street development, comprising some 240 townhouses and apartments, was built on previous Adelaide City Council land that had been used for a variety of purposes, including an asphalt plant and coal tar distillation facility that left the site contaminated with coal tars with elevated PAH and lead levels. There were also hot spots of arsenic and mercury as well as petroleum products from leaking storage tanks. The cost to remediate the site was some $7 million. Property value was, in 2002, estimated to be $65 million.

Port waterfront – Newport Quays (South Australia)

Currently under construction on contaminated land redeveloped by the Land Management Corporation in South Australia, remediation costs estimated to be $40 million which will enable construction of 2000 residential dwellings and other facilities with a development value of approximately $1.2 billion.

Melbourne Docklands development (Victoria)

An integrated, mixed-use development of residential, commercial, office, retail, hotel and public space development developed by the Docklands Authority. Individual developers are fully responsible for remediating their sites. The Melbourne gas works site, for example, was remediated at a cost of $50 million. With other remediation, this will leverage some $7 billion dollars in development value, not including the opportunity benefits such as increased tourism.

Former Islington railyards (South Australia)

Remediated at a cost of $6 million, the removal of friable asbestos and other chemicals has allowed the area to be redeveloped for open space, a playground and car parking. The site was gifted to the Port Adelaide Enfield Council.

Meyer Oval Largs North (South Australia)

The 4.6 hectares of contaminated land in the western suburbs of Adelaide was initially unsuitable for any redevelopment. The land was remediated at a cost of approximately $3 million and is now suitable for residential development, possibly for affordable housing.

West Don Lands (Toronto, Canada)

The West Don Lands, which forms part of the waterfront redevelopment undertaken by the Toronto Economic Development Corporation, will see the remediation of land contaminated by chemicals resulting from oil storage, chemical works, munitions manufacture and coal yards at a cost of $9 million (Canadian) that will result in $65 million of construction.

There are numerous other examples of remediation across the world such as the following:

- The Thames Gateway project will remediate some 4000 hectares of brownfield sites and will result in some 120,000 new homes being constructed, generating 180,000 jobs over ten years.
- The US EPA, under the Brownfields Action Agenda, has provided $280 million to states, which has leveraged some $4 billion in private and public investment.

In many instances, the remediation and development of contaminated sites is driven by unique circumstances. For example, Sydney's winning of the 2000 Olympics saw the remediation of the Homebush site. Similarly, the London Olympics will see the remediation of 200 hectares of land that, post Olympics, will be used for government use, professional offices, smaller stadiums, retail and service industries.

17 Shortened forms

ACM	Asbestos cement material
ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
APHA	American Public Health Association
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
ASTM	Australian Society for Testing and Materials
AWQG	Australian Water Quality Guidelines
BTEX	benzene, toluene, ethyl-benzene and xylenes
COAG	Council of Australian Governments
CSM	conceptual site model
DECCW	Department of Environment, Climate Change and Water
DQO	data quality objective
EC	effective concentration
EILs	ecological investigation levels
EPHC	Environment Protection and Heritage Council
ESLs	ecological screening levels
GILs	groundwater investigation levels
HILs	health-based investigation levels
HSLs	health screening levels
LOEC	lowest observed effect concentration
LOR	limit of reporting
NATA	National Accreditation and Testing Authority
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
PAHs	polycyclic aromatic hydrocarbons
PBET	physiologically-based extraction tests
POPs	persistent organic pollutants
SAPs	sampling and analysis plans
SSD	species sensitivity distribution
TPH	total petroleum hydrocarbon
TRH	total recoverable hydrocarbon
US EPA	United States Environmental Protection Agency
WQG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality

18 Appendix A: COAG Competition policy assessment

Under the COAG Competition Principles an assessment of competitive implications is required as part of the process for making subordinate legislation. If approved by NEPC, the variation to the Measure will be adopted as subordinate legislation within most jurisdictions (under the processes for adoption of Measures set out in the NEPC Act passed by each jurisdiction).

The draft Variation to the Measure for the Assessment of Site Contamination has been framed within the objects of the NEPC (as set out in Section 3 of the NEPC Act) to ensure that:

- people enjoy the benefit of equivalent environmental protection from air, water or soil pollution and from noise wherever they live in Australia
- decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures.

These objectives generally complement the aims of the Competition Policy Principles. Accordingly, every effort has been made to ensure that the variation to the Measure reflects these objectives and that due regard was given to the Competition Policy Principles.

An assessment of the COAG Competition Policy Principles against the draft variation to the Measure indicates that it will not affect competition within any market. The draft variation to the Measure does not impose a requirement for direct environmental improvement action by firms or individuals. As noted in the impact statement, the draft variation to the Measure proposes to significantly improve the effectiveness and efficiency of the Measure by addressing technological, scientific and health risk issues raised by industry, governments and community, which will:

- enhance the ability of industry to understand and apply sound environmental practices as part of its normal business procedures
- provide the community with better information on the issues involved in assessing contaminated sites
- provide up-to-date scientific and technological information as the common basis for the assessment of site contamination to be used throughout Australia.

The development of the draft variation to the Measure, which includes a consistent set of national guidelines for the assessment of site contamination, is expected to contribute greatly towards achieving the National Competition Policy Principle aims of:

- reducing regulatory complexity and administrative duplication between various governments
- ensuring that, as far as possible, the same rules of market conduct apply to all market participants, regardless of the form of business ownership (e.g. government business activities should not enjoy any special advantages).

As the Measure provides guidelines only, as required under Section 14.1(d) of the NEPC Act, it is considered unlikely to introduce inequalities which would run counter to aspects of the Competition Policy Principles Agreement. The draft variation to the Measure has been designed to provide for an improved approach, execution and understanding of contaminated site assessment, but not in such a manner that will affect a particular stakeholder or stakeholder group in an unequal manner.