CONTAMINATED SITES

Guidelines for Assessing Former Orchards and Market Gardens

Department of
Environment and Conservation (NSW)

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For the sake of simplicity, these guidelines use the term "DEC" (Department of Environment and Conservation) to refer to both DEC and the EPA. Note, however, that it is the Environment Protection Authority, rather than DEC, which has the powers and functions under the *Contaminated Land Management Act 1997*.

PREFACE

There are many former orchard and market garden sites in New South Wales that will need to be assessed for contamination before they can be redeveloped for residential or other sensitive land uses.

The Department of Environment and Conservation (DEC) has prepared these guidelines to help protect the environment and minimise the risk to public health from the future use of these sites. The guidelines take into account comments received on the earlier discussion paper, *Assessment of orchard and market garden contamination* (EPA 1995a), and draft guidelines released in December 2003.

The guidelines are primarily for local councils, the urban development industry, environmental consultants and other groups with an interest in site redevelopment. Using a mix of technical and non-technical information, they provide basic guidance about the contamination issues to consider when deciding on the suitability of new uses for former orchard and market garden sites. They also provide specific guidance to investigators of these sites. Accredited site auditors should take the guidelines into account when carrying out site audits relating to orchard and market garden sites.

DEC welcomes written comments on and suggestions for improvements to any of its contaminated sites guidelines. These should be addressed to:

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Limitations

These guidelines should be used in conjunction with other relevant guidelines made or approved by DEC under the *Contaminated Land Management Act 1997* when assessing former orchards and market gardens. The References and Bibliography section lists other relevant and useful documents.

These guidelines do not include occupational health and safety procedures and the NSW WorkCover Authority should be consulted on these. Appropriate action must be taken to manage any potential hazard and adequately protect the health of any workers on, or occupiers of, the site.

These guidelines do not apply to sites other than former orchards and market gardens. Exercise professional discretion in their use.

Disclaimer

DEC has prepared this document in good faith, exercising all due care and attention, but no representation or warranty, express or implied, is made as to the relevance, completeness or fitness of it for any other purpose in respect of a particular user's circumstances. Users of this document should satisfy themselves about its application to their situation and, where necessary, seek expert advice.

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1 INTRODUCTION

1.1 Background

Urban expansion is increasing pressure for the redevelopment of the state's former orchards and market gardens for residential use. Past horticultural practices on these lands may have left chemicals in the soil, such as organochlorine pesticides, arsenic, cadmium, copper, lead and zinc.

State Environmental Planning Policy No 55 – Remediation of Land, or SEPP 55 (DUAP 1998), requires planning authorities to take contamination of land into account when determining zoning proposals and development applications. *Managing land contamination: planning guidelines* (DUAP / EPA 1998) also provides guidance to planning authorities when considering contamination.

DEC reviewed orchard and market garden soil sampling results from across NSW prior to the preparation of its discussion paper, *Assessment of orchard and market garden contamination* (EPA 1995a). The review found that there was a relatively low potential for residual pesticide levels in these soils to pose a risk to human health or the environment, and that significant contamination appears to be rare. This conclusion is consistent with the findings of environmental consultants who have undertaken some similar site assessments.

Nonetheless, it is necessary to be confident that a site is or will be suitable for residential or other sensitive land use when considering it for redevelopment.

These guidelines build on the discussion paper mentioned above, and take into account comments received in response to the paper and the release of draft guidelines in December 2003.

1.2 Objective

These guidelines aim to provide relatively general advice on how to approach the assessment of orchard and market garden sites for possible contamination (sections 1 and 2). It also offers basic information about likely types of contamination, and sets out recommended site investigation, sampling and assessment methods for experienced contaminated land professionals (sections 3 to 6).

The guidelines are designed to be used by local council staff, developers, and contaminated land and environmental consultants.

Site auditors accredited under the *Contaminated Land Management Act 1997* should also consider these guidelines when conducting audits relating to former orchard and market garden sites.

These guidelines should not be used in isolation. Consultants undertaking investigations at former orchard and market garden sites are expected to have the necessary expertise and experience to be able to identify the chemicals of potential concern and understand contamination issues such as environmental fate and transport, exposure pathways, toxicity, persistence and potential bioavailability of the relevant chemicals.

Note that DEC has also published *Guidelines for assessing banana plantation sites* (EPA 1997b). You will find a full list of guidelines relevant to contaminated site investigation and remediation, made or approved by DEC under the Contaminated Land Management Act, at the DEC website: www.environment.nsw.gov.au.

2. CONTAMINATION OF ORCHARD AND MARKET GARDEN SITES

These guidelines address the sites of both former orchards and market gardens, as patterns of chemical use and application tend to be similar for each of these two land uses.

Orchards are typically blocks of a single variety of trees of between 1 and 10 hectares. Different blocks in the same orchard will usually have the same pesticide program, and the types of chemicals used and their manner of application should be relatively consistent across the cultivated areas.

Market gardens are generally located in non-urban areas and on the fringe of cities and towns. They are commonly small, ranging between 2 and 5 hectares. The Premier's taskforce on market gardening by people of non-English speaking background (2000) estimated that up to 10,000 hectares of land in the Sydney Basin are used for market gardening and growing cut flowers, contributing the majority of the state's perishable vegetables (leafy green vegetables with relatively short shelf life) and cut flowers.

2.1 Orchard and market garden activities

Orchards and market gardens generally have cultivated and non-cultivated areas.

2.1.1 Cultivated areas

For the purposes of these guidelines, a 'cultivated area' is any part of a site that has been used for horticulture. Cultivated areas usually have rows of planted crops separated at intervals by drainage lines. The crops are commonly irrigated using tractor spray systems.

The main contamination concern in cultivated areas is from the use of pesticides.

2.1.2 Non-cultivated areas

Non-cultivated areas can include small sections of a site where chemicals for use on the cultivated areas have been stored or handled. The main contamination concern is chemicals that may have leaked or been spilled in these areas. Old chemical storage drums may also have been buried on-site. These are matters that need to be considered as part of the site history review (see Section 3.1).

2.2 Potential chemical contaminants

2.2.1 Common contaminants

Pesticides are the chemicals most likely to have been used on former orchards and market gardens. The types and quantities of chemicals will vary according to the specific crops grown and production systems used.

Pesticides

Pesticides that are likely to have been applied include insecticides, fungicides, herbicides and soil fumigants.

Pesticides registered for use in orchards and market gardens in NSW include both organic and inorganic compounds. The organics include organochlorines, organophosphates, carbamates, synthetic pyrethroids, triazines, phenoxyaliphatics, sulfonylureas and plant hormones. Inorganic compounds include arsenicals (which also often have a lead component), copper and mercury-based products.

Appendix A lists common pesticide chemicals used in the industry.

Many of the organic compounds are likely to have decomposed in the soil within a year of application. Carbamates, synthetic pyrethroids and organophosphates are not considered major soil contaminants

because they are generally not 'persistent'. Organochlorines are typically more persistent in the environment, although the use of many that were once commonly applied was restricted or prohibited in NSW in the 1980s and 1990s.

Compared with organic compounds, the inorganic components of pesticides are generally more persistent in the environment and are therefore of greater concern as a source of residual contamination.

The 1995 review of soil sampling results from orchards and market gardens in NSW suggested that pesticide use has not resulted in significant contamination and that contamination is more likely to be the result of chemical spills or leaks.

Other contaminants

Fertilisers are commonly used in horticulture, but there is little evidence that fertiliser residues are a problem on orchard and market garden sites. However, it is possible that contaminant residues, such as cadmium, will be present on some sites.

Soils surrounding galvanised sheds may have elevated levels of zinc, caused by zinc leaching from the sheds. This is likely to be a localised issue confined to surface soils.

Other possible contaminants include tractor fluids, such as diesels and lubricating oils, which are commonly associated with storage and machinery sheds.

2.2.2 Where to expect contamination

Key areas to look for potential contamination include:

- cultivated areas
- storage and machinery sheds and spray tank fill areas
- farm dams.

The greatest contamination concern comes from inadvertent pesticide spills or leaks. Pesticides that have been used according to manufacturers' directions are unlikely to result in high levels of residual soil contamination in cultivated areas, as modern agricultural chemicals are generally not persistent in the environment. Nonetheless, assessment should consider the possibility of over-application, such as in the vicinity of tractor turning circles at the end of cultivation rows, and whether more persistent organochlorine pesticides have been used in the past.

3 ASSESSING CONTAMINATION OF FORMER ORCHARDS AND MARKET GARDENS

The following sections provide technical guidance on the recommended protocols for assessing former orchard and market garden sites. However, each site will have specific features that require appraisal by a suitably qualified and experienced consultant to identify any risks to current and future site users and the environment. Assessment should be consistent with the process recommended in the National Environment Protection (Assessment of Site Contamination) Measure 1999, or NEPM (NEPC 1999).

3.1 Preliminary site investigation

The site assessment process begins with a preliminary site investigation, which aims to determine whether any part of the site has, or is likely to have, contaminated soil. This preliminary investigation will include information on site history and condition, potential contamination and any necessary further investigation. Site assessors will also find useful guidance on conducting site history reviews in NEPM: Schedule B(2) – Guideline on Data Collection, Sample Design and Reporting (NEPC 1999).

The first step is a detailed review of the site's land-use history, which should identify whether there have been any major chemical spills or old chemical storage drums dumped or buried on the site. This may involve:

- reviewing council records of the site and adjacent areas
- reviewing aerial photographs of the area
- determining which parts of the site have been cultivated
- interviewing key people about past land uses, chemical use and storage, and where machinery and drum storage sheds have been located.

The preliminary investigation will also need to address the possibility that old farm dams on the site have been filled in with rubbish.

Depending on the outcome of the review, assessment of former orchards and market gardens should normally include the minimum soil sampling requirements outlined in Section 3.2. However, if the site history suggests other possible sources of contamination, a preliminary sampling program may be required to guide more detailed subsequent sampling.

3.2 Sampling soils

Cultivated and non-cultivated areas will require different sampling strategies, as discussed below. For more detailed information on the use of statistical sampling plans for assessing contaminated sites, refer to *Sampling design guidelines* (EPA 1995c).

The sampling plan needs to be outlined on a plan or site map identifying the cultivated and non-cultivated parts of the land, consistent with *Guidelines for consultants reporting on contaminated sites* (EPA 1997c).

3.2.1 Sampling soils in cultivated areas

The distribution of contaminants in cultivated areas will generally be uniform and confined to surface soils.

The soil sampling density established for assessing a former orchard or market garden site will need to be able to determine overall contamination levels as well as detect localised areas of elevated contamination, or 'hotspots'. *Sampling design guidelines* (EPA 1995c) provides detailed guidance for preparing a sampling strategy, including Table A, which outlines minimum sampling requirements for site characterisation, derived from the assumed hotspot size.

Sampling locations should generally be arranged in a grid pattern, although the number of samples and distance between them will differ from site to site.

Take surface samples from the top 150 mm of the soil profile immediately below any vegetative or detritus layers. If the area is covered by fill material, collect a second sample immediately below the interface of the fill and the original soil.

A higher sampling density will be necessary where localised contamination is likely to have occurred. This includes 'point sources' such as major drainage lines, the sediments in dams and ponds and areas where chemicals are known or suspected to have leaked or been spilled and where waste has been buried.

Composite sampling involves collecting a number of separate 'sub-samples', as far apart as 20 metres, and thoroughly mixing them for chemical analysis. This approach is acceptable where hotspots are not expected and the following conditions are met:

- the chemicals to be analysed are not volatile
- sub-samples are collected from the same level of soil or fill
- composite samples consist of a maximum of four equally weighted sub-samples collected from adjacent sampling points

- the soil/fill type allows thorough mixing of the sub-samples. Heavy clay would not be suitable, for example.

Each sub-sample needs to be large enough for re-analysis if the concentration of any analyte in the composite is above the adjusted investigation levels, which can be determined using Procedure 2 in Section 3.3.2 of these guidelines.

Further guidance on composite soil samples is provided in *Sampling design guidelines* (EPA 1995c) and the National Environmental Health Forum publication, *Composite sampling* (NEHF 1996).

3.2.2 Sampling soils in non-cultivated areas

Unlike cultivated areas, there is no general land-use pattern for non-cultivated areas. Investigation of these areas will usually only be necessary where they have been used to store or mix large quantities of chemicals, or where their history of use can't be determined. In these cases, develop an effective sampling program for the non-cultivated area, based on site-specific information about past activities.

Additional guidance on undertaking contaminated site investigations is available in Schedule B(2) – Guideline on Data Collection, Sample Design and Reporting of the NEPM (NEPC 1999).

3.3 Assessing contamination in soils

3.3.1 Soil investigation levels

Soil investigation levels (SILs) are commonly used to assess concentrations of contaminants in soils. SILs are the soil concentrations above which further investigations are required.

Wherever possible, use SILs based on Australian sources. These include the NEPM (NEPC 1999), particularly Schedules B(1) and B(7a and 7b) and *Guidelines for the NSW site auditor scheme* (EPA 1998 or updates). Where SILs are taken from the publications of relevant peak health forums, such as enHealth or the National Health and Medical Research Council, refer to the latest edition endorsed by DEC under the Contaminated Land Management Act. For details, see www.environment.nsw.gov.au/clm/guidelines.htm

Table 1: Soil investigation levels

Health-based investigation levels [a] (mg/kg)		
	Column 1	Column 2
Contaminant	Residential with gardens/ accessible soil (home-grown produce contributing <10% fruit and vegetable intake; no poultry), including children's day-care centres, pre-schools and primary schools or town houses or villas	Residential with minimal access to soil, including high-rise apartments and flats
Aldrin and dieldrin	10	40
Arsenic (total)	100	400
Cadmium	20	80
Chlordane	50	200
Copper	1,000	4,000
DDT, DDD, DDE	200	800
Heptachlor	10	40
Lead	300	1,200
Mercury (inorganic)	15	60
Methyl mercury	10	40
Zinc	7,000	28,000

Table 1 lists SILs that can be used to assess former orchard and market garden sites. To date, limited human health-based investigation levels (HILs) have been endorsed for pesticide compounds in soils. Where HILs are not available, the assessor will need to consider all aspects of the fate and transport characteristics of relevant contaminants, such as the rate of degradation of the chemicals, whether they bioaccumulate, and their toxicity, in order to determine an appropriate methodology for managing the contamination.

Use SILs in conjunction with the decision-making process for assessing urban redevelopment sites outlined in *Guidelines for the NSW site auditor scheme* (EPA 1998 or updates). Levels are based on an assessment of potential human health and toxicity to plants.

Where land may be used to grow crops again in the future, either for horticulture or residential gardens, seek advice from NSW Agriculture on any possible impacts that residual contamination may have on crops.

	Column 3	Column 4	Provisional phytotoxicity-based investigation levels [b] for sandy loams pH 6–8 (mg/kg)
	Parks, recreational open-space playing fields, including secondary schools	Commercial/industrial	
	20	50	–
	200	500	20
	40	100	3
	100	250	–
	2,000	5,000	100
	400	1,000	–
	20	50	–
	600	1,500	600
	30	75	1 [c]
	20	50	–
	14,000	35,000	200

(a) The limitations of health-based soil investigation levels are discussed in Schedule B(1) of the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPC 1999). More detail on the exposure scenarios in this table is also available in enHealth's *Exposure scenarios and exposure settings* (2001).

(b) The provisional phytotoxicity-based soil investigation levels proposed in this document are single-number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. The phytotoxicity-based investigation levels, intended for use as screening guidance, may be assumed to apply to sandy loam soil or soils of a closely similar texture, and at a pH of between 6 and 8. See *Guidelines for the NSW site auditor scheme* (EPA 1998 or updates).

(c) Total mercury

3.3.2 Evaluating the results of soil analysis

Soil analyses should be evaluated statistically with the objective of assessing:

- the average concentrations of contaminants
- whether there are any localised contaminations greater than a certain size.

Interpreting results from non-composite samples

Analyse the results of non-composite samples using Procedure 1.

Note: This procedure should only be used for health-based investigation levels (HILs) and not phytotoxicity-based investigation levels. Phytotoxicity investigation levels are single-number criteria and should be compared with the individual data point, not average concentrations.

Procedure 1: Analysing results for non-composite samples

(a) Calculate the 95% upper confidence limit (UCL) on the arithmetic average concentration for each analyte in an area using the methodology outlined in *Sampling design guidelines* (EPA 1995c).

(b) Check for individual sample results that are more than 250% of the relevant SIL.

(i) If the UCL for all analytes is less than their relevant SILs and no individual results are greater than or equal to 250% of that level, the site is suitable for residential use.

(ii) If the UCL for all analytes is less than their relevant SILs but at least one individual result is greater than or equal to 250% of that level, re-investigate the area with elevated concentrations to determine the extent of the exceedences. If a hotspot is confirmed, take appropriate remedial action, validate and repeat this procedure.

(iii) If the UCL for any analyte is greater than the relevant SIL, the site is unsuitable for residential use and appropriate remedial action is required.

Interpreting results from composite samples

The chemical analysis of a composite sample only provides the average contaminant concentration of its sub-samples. This approach can obscure a sub-sample with a high contaminant concentration, which may indicate a hotspot, by diluting it with other sub-samples.

The problem of hotspot dilution can be resolved by comparing the analytical results with a set of 'adjusted' SILs, calculated using Procedure 2.

Composite sub-samples often carry some background contaminant concentrations and the SILs can also be adjusted to take this into account. Table 2 provides typical background ranges for selected contaminants at former orchard and market garden sites in NSW. However, site investigators will need to determine site-specific background concentrations, rather than rely on these values. Where background concentrations are not available, compare the results of composite samples with adjusted SILs using Procedure 2b.

Table 2: Typical background concentrations for selected contaminants in NSW orchards and market gardens

Contaminants	Typical background concentration (mg/kg)
Arsenic	5[(a)]
Cadmium	0.02–2[(b)]
Copper	23[(a)]
Lead	26[(a)]
Zinc	63[(a)], 5–87[(b)]

Notes:

(a) Background concentrations of arsenic, copper, lead and zinc are obtained by averaging the sampling results of a number of consultants' assessment reports for orchard and market garden sites, published in the discussion paper, *Assessment of orchard and market garden contamination* (EPA 1995a).

(b) The background concentration ranges for total cadmium and acid-extractable zinc are based on the report, *Cadmium levels in soils and vegetables of the Greater Sydney Region, Australia* (RIRDC 1999).

Procedure 2: Adjusting SILs for composite samples

2a. Where information on background concentrations is available

$$\text{Adjusted SIL} = \frac{(n\text{-}1) \times \text{background} + \text{unadjusted SIL}}{n}$$

where:

n = number of sub-samples in each composite sample

background = estimated local background concentration of a contaminant

unadjusted SIL = unadjusted level shown in Table 1

Example: The following is a worked example of an adjusted SIL for arsenic using the health-based SIL from Column 1 of Table 1 and assuming a composite of three sub-samples. Local background concentration for arsenic is 5 mg/kg, as shown in Table 2.

$$\text{Adjusted arsenic SIL} = \frac{(3\text{-}1) \times 5 + 100}{3} = 36.6 \text{ mg/kg}$$

Any composite results higher than of 36.6 mg/kg indicate a need for further analyses of the sub-samples individually.

2b. Where information on background concentrations is NOT available

Take a more conservative approach where there is no reliable information on background concentrations. This involves adjusting the SILs by dividing the value shown in Table 1 by the number of sub-samples that make up the composite sample. This method assumes zero contaminant concentration in all sub-samples except the one that represents a hotspot.

The result for the example in 2a would therefore be:

$$\text{Adjusted arsenic SIL} = \frac{100}{3} = 33.3 \text{ mg/kg}$$

3.4 Further hotspot assessment

The lateral extent of a hotspot can be determined by collecting and analysing samples at locations surrounding the sampling point where a high contaminant concentration has been found. The lateral boundary of a hotspot is defined as where the contaminant concentration reaches the average concentration of the surrounding area.

The vertical extent of a hotspot can be determined by analysing depth samples. Take initial samples from 150–300 mm and 300–500 mm below the soil surface. Samples from greater depths may be necessary to determine the full vertical extent of a hotspot.

3.5 Assessing ground and surface waters

Groundwater contamination from the use of pesticides at orchard and market garden sites is uncommon, mainly because the levels of contaminants in these soils are usually low. However, if initial investigation suggests the possibility of contamination at depth, assess the potential for groundwater to be affected as part of the site investigation.

For detailed groundwater and/or surface water investigation, select appropriate investigation levels from Australian sources wherever possible. These include the *Australian drinking water guidelines* (NHMRC / ARMCANZ 1996) or updates and the *Australian and New Zealand guidelines for fresh and marine water quality* (ANZECC / ARMCANZ 2000).

3.6 Chemical analysis

3.6.1 Analytical parameters

As a minimum, soil samples from cultivated areas should be analysed for:

- arsenic
- cadmium
- copper
- lead
- mercury
- organochlorine pesticides
- zinc.

If there is evidence that organophosphate, carbamate or other pesticides have been used on the site during the previous year, or spills or leaks are known or suspected to have occured, add the relevant compound(s) to this list.

3.6.2 Laboratory analysis

All chemical analyses should be carried out by a laboratory accredited by the National Association of Testing Authorities (NATA) or an equivalent organisation for that particular analytical method.

Further guidance about appropriate analytical methodologies is outlined in Schedule B(3) of the NEPM (NEPC 1999). Where no suitable analytical method is provided, the US Environmental Protection Agency (USEPA 1986) and American Public Health Association (APHA 1998) or equivalent procedures may be used by an accredited laboratory.

Appendix B summarises appropriate analytical methods for contaminants that may be found in orchard and market garden sites.

Practical quantitation limits (PQLs) of laboratory analysis must be appropriate to the relevant threshold concentrations which are used for the assessment of soil and ground water. The detailed site investigation report should state the PQL for each analyte.

4 Remediating former orchard and market garden sites

It may be necessary to remediate a contaminated site before it is ready for the proposed land use.

The preferred hierarchy of options for site clean-up and management of ANZECC / NHMRC (1992) and the NEPM (NEPC 1999) may be summarised as follows:

- on-site treatment of the contamination so that it is destroyed or the associated risk is reduced to an acceptable level, or
- off-site treatment of excavated soil, so that the contamination is either destroyed or the associated risk is reduced to an acceptable level, after which it is returned to the site.

If neither of these options is possible, consider:

- removing contaminated material to an approved site or facility (refer to *Environmental guidelines: assessment, classification and management of liquid and non-liquid wastes* [EPA 1999a]), and replacement, where necessary, with validated clean fill, or
- consolidation and isolation of the soil on-site through containment by a properly designed barrier approved and regulated by DEC and/or the relevant planning authority as part of a site management plan.

Due to the small scale of orchard and market garden sites, vertical mixing of soils is not applicable to address localised contamination (EPA 1995b).

Anyone remediating contaminated orchard or market garden sites should take into account any requirements of SEPP 55. This policy provides a state-wide planning approach to the remediation of contaminated land, including:

(a) specifying when consent for remediation work is and is not required

(b) specifying relevant issues in rezoning land and in determining development applications in general and development applications for consent to carry out a remediation work in particular

(c) requiring that remediation work meets certain standards and notification requirements.

Managing land contamination: planning guidelines (DUAP / EPA 1998) provides guidance to planning authorities in their consideration of contamination under the planning process.

5 SITE VALIDATION

A former orchard or market garden site that has been remediated must be validated to demonstrate that it has reached a standard appropriate for the proposed land use and that residual contamination will not be harmful to human health or the environment.

Use a systematic sampling pattern for the validation program and statistical analysis of the data collected. For each site being validated, the 95% upper confidence limit (UCL) on the average concentration for each analyte should be below the relevant threshold

concentration, eg SIL. Areas where the 95% UCL is less than the relevant threshold value but one or more individual sample measurements are over 2.5 times the criteria need to be re-investigated to determine whether they are residual hotspots.

For further information on appropriate sampling densities and statistical analysis of validation programs see *Sampling design guidelines* (EPA 1995c); Schedule B(2) in the NEPM (NEPC 1999); and the USEPA's *Method for evaluation of the attainment of clean-up standards* (USEPA 1989).

The results of the validation should be documented in a report prepared according to *Guidelines for consultants reporting on contaminated sites* (EPA 1997c).

The procedures for the validation of on-site remediated material and the validation of imported material are given in *Sampling design guidelines* (EPA 1995c).

6 REPORTING

Information in the report of an assessment of potential contamination should be consistent with the requirements of *Guidelines for consultants reporting on contaminated sites* (EPA 1997c).

A decision not to address any of these reporting requirements should be backed up by a statement in the report. The choice of a sampling plan and design also needs to be justified and all conclusions substantiated by clear presentation and interpretation of the data. As with all contaminated land investigations, it is important that the investigator develops and presents a conceptual site model in order to understand the possible impacts of contamination at a site.

7 LIST OF ACRONYMS

The following acronyms are used in this document:

ANZECC	(Former) Australian and New Zealand Environment and Conservation Council. Now Environment Protection and Heritage Council
APHA	American Public Health Association
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
DDD	the organochlorine pesticide dichlorodiphenyldichloroethane
DDE	the organochlorine pesticide dichlorodiphenyldichloroethylene
DDT	the organochlorine pesticide dichlorodiphenyltrichloroethane
DEC	Department of Environment and Conservation (NSW)
DIPNR	Department of Infrastructure, Planning and Natural Resources
DUAP	(Former) Department of Urban Affairs and Planning - see DIPNR
EPA	NSW Environment Protection Authority. Now incorporated as part of the Department of Environment and Conservation (NSW)
HIL	Health-based Investigation Level
NATA	National Association of Testing Authorities
NEHF	National Environmental Health Forum – now known as EnHealth
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure – specifically the National Environment Protection (Assessment of Site Contamination) Measure 1999
NHMRC	National Health and Medical Research Council
PQL	Practical quantitation limit
SAHC	South Australian Health Commission. Now Department of Health SA
SIL	Soil investigation level
UCL	Upper confidence limit
USEPA	United States Environmental Protection Agency

8 Glossary

Bioavailability

The ability to be taken up by organisms.

Composite sample

The bulking and thorough mixing of soil samples collected from more than one sampling location to form a single soil sample for chemical analyses.

Confidence level/limit

The probability, expressed as a percentage, that a statistical statement is correct.

Hotspot

A localised area where the level of contamination within that are is noticeably greater than that in surrounding areas.

Health-based investigation level (HIL)

The concentration of a contaminant (arrived at using appropriate sampling, analytical and data interpretation techniques) above which further appropriate investigation and evaluation will be required.

Practical Quantitation Limit (PQL)

The lowest concentration of an analyte that can be determined with acceptable precision (repeatability) and accuracy under the stated conditions of the tests.

Soil investigation level (SIL)

Soil investigation level consists of Health Investigation Levels and Provisional Phytotoxicity Levels (*Guidelines for NSW site auditor scheme*). SIL is the concentration of a contaminant in soil above which further investigation and evaluation are required and are arrived at using appropriate sampling, analytical and data interpretation techniques. Use SILs in conjunction with the decision-making process for assessing urban redevelopment sites outlined in *Guidelines for the NSW site auditor scheme* (EPA 1998 or updates)

Appendix A

Chemicals commonly associated with orchards and market gardens

Inorganic compounds	Synthetic pyrethroids	Carbamates and dithiocarbamates	Organochlorines	Organo-phosphates
Arsenic	Alphamethrin	Carbofuran	BHC	Azinphos ethyl
Cadmium	Cypermethrin	Methiocarb	Chlordane	Azinphos methyl
Copper	Deltamethrin	Methomyl	DDT	Chlorpyrifos
Lead	Esfenvalerate	Thiram	Dieldrin	Demeton-s-methyl
Mercury	Fenvalerate	Zineb	Endosulfan	Diazinon
Zinc	Permethrin	Ziram	Endrin	Dichlorvos
			Heptachlor (and its epoxides)	Dimethoate
				Fenamiphos
			Lindane	Fenthion
				Fenitrothion
				Maldison
				Methidathion
				Methamidophos
				Mevinphos
				Monocrotophos
				Omethoate
				Parathion
				Profenofos
				Temephos

Note: Herbicides are not included as they are not commonly found at residual concentrations likely to pose a risk to human health or the environment.

Appendix B
Recommended analytical methods

Analytes	Analytical procedures			
	Water		Soil	
	Extraction	**Detection**	**Extraction**	**Detection**
Arsenic Cadmium Copper Lead Zinc	APHA 3030E USEPA 3010A (Flame AAS or ICP) USEPA 3020A (ET-AAS)	APHA 3120 (ICP-AES) USEPA 200.7 (ICP-AES) USEPA 200.8 (ICP-MS) APHA 3125 (ICP-MS) APHA 3113 (ET-AAS)	USEPA 3050B USEPA 3051	APHA 3120 (ICP-AES) USEPA 200.7 (ICP-AES) USEPA 200.8 (ICP-MS) APHA 3125 (ICP-MS) APHA 3113 (ET-AAS)
Mercury	USEPA 7470A APHA 3112	USEPA 7470A APHA 3112 (Cold Vapour AAS)	USEPA 7471A	USEPA 7470 USEPA 7471A APHA 3112 (Cold Vapour AAS)
Organochlorine pesticides	USEPA 3510 APHA 6630B	USEPA 8270C	USEPA 3550B USEPA 3545 USEPA 3540C	USEPA 8270C
Organophosphate pesticides	USEPA 3510	USEPA 8270C	USEPA 3545 USEPA 3540C	USEPA 8270C
Carbamates	APHA 6610 USEPA 8318	APHA 6610 USEPA 8318	USEPA 8318	USEPA 8318
Thiocarbamates	USEPA 634	USEPA 634	No method available	No method available
Dithiocarbamates	USEPA 630[(a)]	USEPA 630[(a)]	No method available	No method available
Synthetic pyrethroids	USEPA 3510	USEPA 8270C	USEPA 3545 USEPA 3540C	USEPA 8270C

(a) This should be considered a screening method only. It does not speciate the dithiocarbamates.

Notes:

APHA methods sourced from APHA 1998, *Standard methods for examination of water and wastewater*, 20th Edition

USEPA methods sourced from USEPA 1986 and later (*Test methods for evaluating solid waste – physical/chemical methods SW846* and various revisions); USEPA 1994 (*Methods for the determination of metals in environmental samples – supplement I*).

NEPC methods sourced from Schedule B(3) in NEPC 1999 (*National environment protection [assessment of site contamination] measure*).

The above methods are recommended as the most appropriate for validating that a site is suitable for residential development. Other appropriate USEPA/APHA methods may be used, but the site assessor will need to produce evidence that the alternative methods perform as well as those recommended.

It is not possible to prescribe specific methods for all individual herbicides. Seek advice from a consulting laboratory when there is analysis for specific herbicides. All methods should be accredited by the National Association of Testing Authorities (NATA) and fully validated.

The detection limit used in analysis of soils and waters during any site assessment should be appropriate to meet the relevant assessment criteria.

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