



Australian Government

# CLANDESTINE DRUG LABORATORY REMEDICATION GUIDELINES





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## Preface

These Guidelines have been prepared by the Attorney-General's Department and the ACC with the assistance of industry and government specialists acknowledged in this document. They are intended to provide a framework within which appropriate regulatory authorities and suitably qualified environmental specialists may administer and conduct investigation and remediation of potentially contaminated sites resulting from the operation of clandestine drug laboratories.

## Limitations

These Guidelines are intended for use in the management and remediation of locations where potential contamination exists originating from the operation of a clandestine drug laboratory. They should be used in conjunction with other endorsed guidelines, such as contaminated land management guidelines, which may be applicable depending upon the nature and location of the contamination.

## Disclaimer

The Attorney-General's Department and the ACC have prepared this document in good faith, exercising all due care and with attention to available information. Users of this document should seek expert advice to determine if these Guidelines are applicable to their individual circumstances. No liability or warranty, expressed or implied, is made or given in relation to these Guidelines.

## Definitions

**Appropriate authority**, means any regulatory or statutory body empowered under the prevailing health and/or environmental legislation or regulations of that jurisdiction, to take any actions in respect to protection of human and/or environmental health or environmental contamination.

**Assessment**, means a set of formal methods for determining the nature, extent and levels of contamination present on a site and the potential risk posed to human and environmental health.

**CAS Number**, means Chemical Abstracts Service number and is the unique number assigned to a specific chemical by the American Chemical Society.

**Chemical**, means an organic or inorganic substance whether solid, liquid or gaseous.

**Commonwealth**, means the Commonwealth Government of Australia.

**Contaminated**, means a condition or state which represents or potentially represents an adverse health or environmental impact because of the presence of potentially hazardous substances.

**EHO**, means Environmental Health Officer or other environmental officer authorised by the applicable authority to exercise or enforce legislative or regulatory powers under State and Territory environment legislation.

**Emission**, means the release or discharge of a substance to the environment whether in solid, liquid or gaseous form.

**EPHC**, means the Environment Protection and Heritage Council.

**Investigation Levels** (ILs) as described in this document, provide the basis of Tier 1 risk assessment for clandestine laboratory sites. A Tier 1 assessment is a risk-based analysis comparing site data with ILs to determine the need for further assessment or development of an appropriate remediation action plan. ILs have been developed for indoor air, indoor surfaces and outdoor soil.

ILs, Health Investigation Levels (HILs) and Health Screening Levels (HSLs) each describe the concentrations of a contaminant above which further appropriate investigation and evaluation will be required.

HILs are described in the documentation for the National Environment Protection (Assessment of Contaminated Sites) Measure 1999, (the NEPM). HILs are generic, deal only with contaminants in soil, and apply across Australia to all soil types generally to a depth of 3 metres below surface.

HSLs for petroleum hydrocarbons depend on physicochemical properties of soil as it affects hydrocarbon vapour movement in soil and the characteristics of building structures. They apply only to contaminants in soil but account for different soil types, land uses and depths below surface to >4 metre and have a range of limitations. HSLs have been developed by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), and are reported in the 2011 variation to the NEPM.

**Mandatory Notification**, where a Commonwealth Act and/or the equivalent provision of the corresponding Act of any state or territory requires an individual or other entity to notify the responsible authority of the presence of contamination.

**NEPC**, means the National Environment Protection Council.

**NEPM**, means a National Environment Protection Measure, and is a measure made under subsection 14(1) of the *National Environment Protection Council Act 1994*, a Commonwealth Act and the equivalent provision of the corresponding Act of each state and territory.

**Occupier**, in relation to any facility means a person who is in occupation or control of the facility whether or not that person is the owner of the facility.

**Pollutant**, is equivalent to contaminant, meaning any substance or compound which is not naturally occurring within a stipulated environment.

**Remediation**, means the clean-up or mitigation of pollution or of contamination.

**RAP**, means Remediation Action Plan.

**Site (clandestine laboratory)**, means all areas identified as being subject to drug manufacture, chemical, waste storage or any other activity carried out either completely or in part, and the property upon which these actions have occurred.

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# 1. CONTEXT

## 1.1 Scope

This document is intended to provide the required guidance to appropriate authorities and environmental professionals in the assessment and remediation of contaminated sites where such contamination arises from chemical processes associated with manufacture of illicit drugs. To reflect the nature and prevalence of clandestine laboratories seized by Australian law enforcement agencies, particular emphasis has been directed to the materials, practices and by-products associated with the manufacture of amphetamine type stimulants (ATS), principally methylamphetamine and 3,4-methylenedioxymethamphetamine (MDMA). The assessment and remediation principles and practices outlined in this document are, however, generally valid for the wide range of activities associated with the production and processing of other synthetic drugs.

These Guidelines are not intended to prescribe technologies, goals or precise rules for the remediation of former clandestine laboratory sites. Rather they are designed to provide a framework for the key issues that need to be considered throughout remediation programs, and aim to ensure that every effort is made to protect human and environmental health.

## 1.2 Introduction

It has been widely recognised by many governments, including the Australian Government, that the residual contamination arising from illicit drug manufacture carried out in clandestine drug laboratories presents a serious risk of harm to human and environmental health.

The contamination problems presented by such criminal activities are frequently complex. The inherent illicit nature of these undertakings results in operators ignoring conventional chemical manufacturing and handling good practices in order to avoid detection. Consequently, the locations that have been chosen for establishing clan labs vary widely and include residences, both suburban and inner city high rise, commercial and industrial

premises, remote rural properties, hotel and motel rooms, watercraft, mobile labs mounted in commercial vehicles, mines and purpose built underground facilities. Frequently the knowledge and technical skills of the operators are minimal and improvised or unsuitable equipment is utilised in the processes, resulting in vessel failures, spillages and escapes of reaction materials. The combination of compromised safety and inappropriate facilities presents a high likelihood that some level of environmental contamination will be a legacy of most clandestine laboratory sites.

In an increasing number of instances, illicit laboratories come to the attention of authorities only when catastrophe strikes in the form of fire or explosion. In these instances, contamination issues are greatly compounded and present both immediate and long term hazards to community members resident in the vicinity.

In order to minimise detection, clandestine laboratory operators will frequently avoid the use of industrial waste handling facilities and dispose of waste materials through indiscriminate dumping on public lands, sewerage systems, industrial estates, national parks or into waterways. In these events, the link between the contamination and illicit drug synthesis may not be initially evident.

The residual contaminants which arise from a drug manufacture or “cooking” process can be in the form of solids, liquids or vapours and be absorbed by floorings, walls, drains, ducting and any furnishings or fixtures in the vicinity of the clan lab. Additionally there are significant quantities of waste produced from the drug manufacture process and, dependent on the particular process being employed, may generate up to 10kg of waste for each 1.0kg of drug produced. The manner of disposal for this contaminated waste product also represents a risk to environmental and human health. These contaminants can in many instances persist within structures, furnishing and the environment and pose a risk to persons occupying the premises, potentially for many years into the future. There is clear evidence

showing that many of the residual chemical contaminants produced during the drug manufacture process are of a hazardous nature and include heavy metals, carcinogens and phytotoxic substances.

These national Guidelines have been developed to assist appropriate authorities in administering their respective environmental acts and regulations in addressing contamination arising from clandestine laboratories adequately and in a nationally consistent manner, and in this way provide protection to their local community and the environment. Further, the Guidelines will provide assistance for environmental professionals and landowners to meet appropriate assessment, remediation and reporting criteria.

To assist in achieving national consistency in the assessment of former clandestine laboratory sites, the Guidelines have been developed with close reference to the established and accepted NEPC and NEPM's currently utilised in all states and territories within Australia.

The NEPM or subsequent revisions, provide a recommended general process under Schedule A of this measure, for the investigation of contaminated sites. This NEPM should be reviewed prior to the commencement of site investigations and referenced in conjunction with these Guidelines.

Although upon first consideration, the factors associated with a clandestine laboratory site may appear distinct from traditional contaminated site issues, in reality such locations are environmentally not dissimilar to common contaminated sites such as a former service station, or dwellings containing lead or asbestos contamination. The principles, objectives and processes of site investigation are the same in all cases. For this reason, and to facilitate ease of compliance with these Guidelines and local legislation and regulations, the investigation processes detailed are based on existing nationally accepted NEPC, NEPM guidelines and standards.

The desired outputs are to ensure that the adverse impacts of illicit drug manufacturing operations on community health and the natural and built environments are minimised through appropriate and nationally consistent assessment, remediation management and reporting practices.

It is critical that at a minimum, sites suspected or known to have been utilised for illicit drug manufacture are recorded within jurisdictional environmental authority and property/lands database systems.

## 2. THE CLANDESTINE LABORATORY SITE REMEDIATION PROCESS

### 2.1 The Four Phases of Site Remediation

The four phases of clandestine laboratory site remediation are:

1. Trigger for assessment;
2. Preliminary assessment and action;
3. Site assessment and remediation; and
4. Validation.

The following information is a summary of these four phases and should be read in conjunction with Figure 2.1. Each phase is described in greater detail in subsequent sections.

#### 2.1.1 Phase 1 – Trigger for assessment

Law enforcement agencies from all jurisdictions within Australia encounter clandestine laboratories. These may be either operating at the time of police interdiction or have previously operated in that location. All state and territory police services maintain specialist units, trained specifically to operate in the hazardous environment created by these illicit manufacturing operations. Once the laboratory site has been rendered safe and processed for evidentiary purposes, police will usually notify the appropriate authority within that jurisdiction of the existence of the site. At this time, information should be provided outlining the nature of the suspected illicit manufacturing activity and the identity of chemicals detected on the site.

#### 2.1.2 Phase 2 – Preliminary assessment and action

Upon receipt of the notification of a clandestine laboratory, the responsible officer should conduct a preliminary assessment to determine whether further action is required, for example:

- Declaring a dwelling or property 'potentially contaminated' or unfit for habitation; or
- Compelling a property owner to provide sufficient evidence that the site does not pose a risk to human or environmental health, based on the requirements of this Guideline.

Given these examples, the nature of the action undertaken by the appropriate authority will be determined by their policies and practices. Any actions should be commensurate with the level of risk.

#### 2.1.3 Phase 3 – Site assessment and remediation

If phase 2 indicates that risk exists to community health, then the appropriate authority should, having imposed pollution control, clean-up notices or similar orders, and having determined who is responsible for the detailed assessment and remediation, engage the services of a suitably qualified professional, as defined below, to conduct such investigations, analysis, remediation and validation as may be necessary in accordance with these Guidelines. These investigations will be carried out to determine if the dwelling/structure and/or property pose a risk to human or environmental health.

Investigations of potentially contaminated dwellings or sites should be conducted by a suitably qualified expert with experience in the fields of environmental engineering, environmental science, environmental health or occupational hygiene, who is in possession of tertiary qualifications in one of these disciplines from a recognised educational institution.

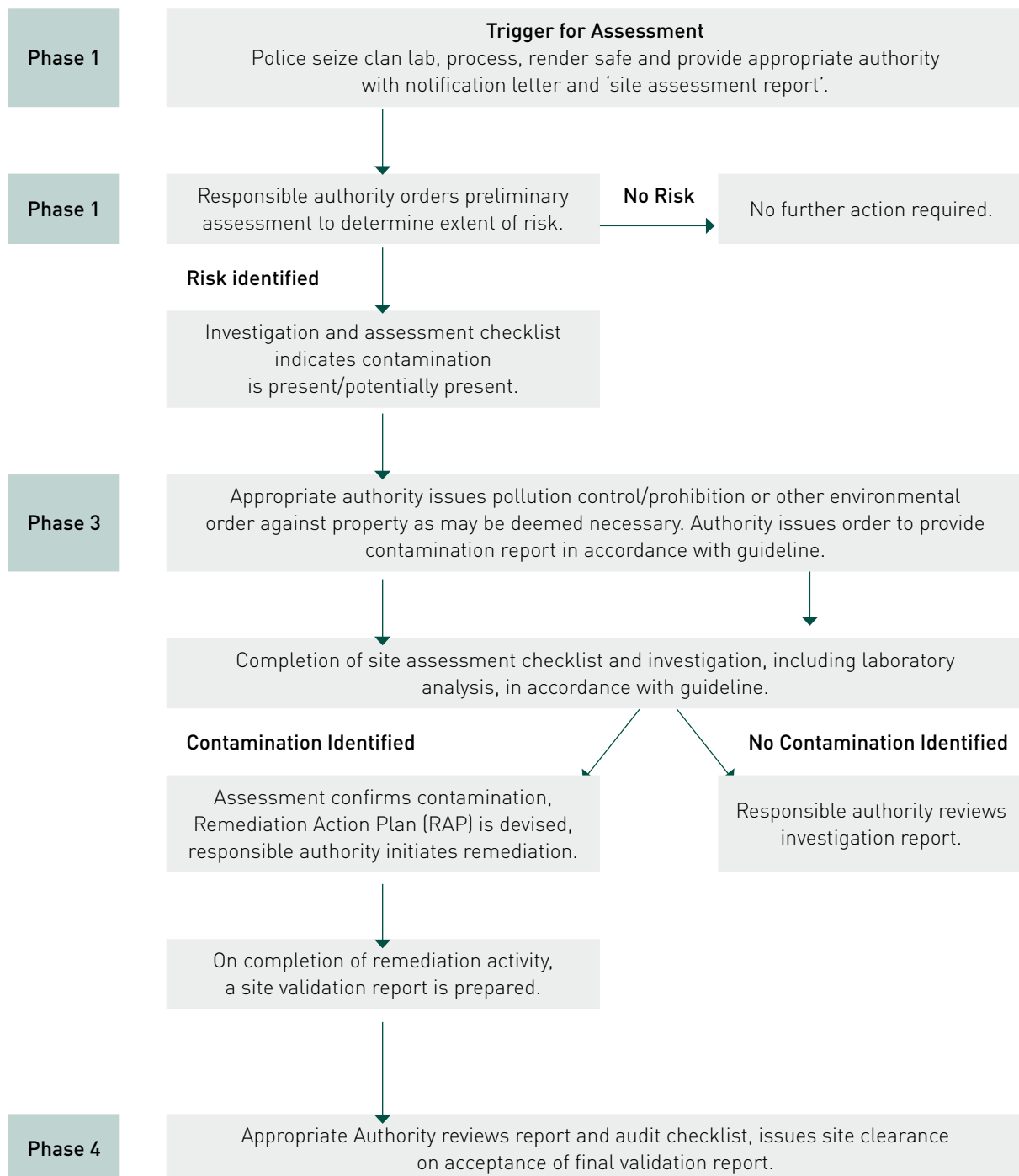
Detailed information regarding the selection of a suitably qualified consultant can be found in the NEPM, Schedule B (10) '*Guidelines on Competencies and Acceptance of Environmental Auditors and Related Professionals*'.

Following engagement by a property owner, authorised representative, mortgagee or other party having legal claim or authority over a property or dwelling, a consultant should review available site documentation in accordance with these Guidelines, and in reference to applicable NEPM measures and guidelines. A consultant should follow the process for site investigation and reporting shown in Figure 2.2 and contained in detail within this document.

#### 2.1.4 Phase 4 – Validation

Following site assessment and remediation, a site validation report is prepared. The appropriate authority may audit the report before acceptance.

**Figure 2.1: General Process for Site Investigation and Reporting**



# 3. GUIDELINES FOR PHASE ONE – TRIGGER FOR ASSESSMENT

## 3.1 Interpreting police/forensic information

### 3.1.1 Background

At a clandestine laboratory site, police and forensic chemists gather evidence on the nature of the operation to determine if a drug related offence has occurred. The operators of clandestine drug laboratories do not respect environmental laws, consequently these operations frequently result in serious environmental contamination. Since hazardous chemicals are regularly used inappropriately in such operations, police and forensic services follow safety procedures designed to protect themselves and the public from harm. In many cases, units of the fire and rescue services will be present to provide assistance in maintaining safety. In addition to safety procedures, evidence gathering protocols are applied to ensure that information obtained will be admissible in any subsequent court proceedings.

Police connected with the clandestine laboratory case will normally inform the appropriate authority regarding any potential environmental contamination. Such notification can take one of two forms.

- (i) If the potential environmental contamination is considered serious, attending police may contact the appropriate authority shortly after first attending the site and before they have finished gathering evidence.
- (ii) If the potential environmental contamination is **not** considered to be serious, a formal letter of notification may be relayed to the appropriate authority shortly after the police have left the site.

While a police objective is to render the site safe, police are not responsible for or experienced in the mitigation of environmental contamination.

### 3.1.2 Urgent / telephone notification

If there is an apparent imminent danger to the environment, or the nature of observed contamination is sufficiently widespread or of a nature that immediate action is warranted,

then police may contact the appropriate authority by telephone while still present at the site. In these instances, the responsible officer receiving the notification should discuss the nature of the hazard or contamination before attending onsite in order to ensure arrangements can be put in place for any necessary equipment and/or assistance as indicated by the conversation. In most cases, the responsible officer should attend onsite as soon as practical, ideally while police and emergency services are still present.

Some states and territories have dedicated environment and/or pollution response units, usually attached to their respective environment protection agencies. It is expected that where police or other attending services identify an imminent danger to the environment, these units should be contacted.

### 3.1.3 Written notification

Under non emergency circumstances, police will inform the local appropriate authority in writing of any suspected clandestine laboratory seizure. Dependant on operational constraints, notification should ideally be issued within 24 hours of the completion of site processing and should include the following information:

- address of the suspected clandestine laboratory – exact location;
- nature of premise – (house, high rise residential, industrial unit);
- status of occupancy;
- identified potential hazards or threats – chemical, environmental, electrical, physical, biological, human;
- description (if known) of synthesis method(s) suspected or believed to have been undertaken at the site;
- site sketch indicating suspected areas of contamination e.g. location of chemical reaction processes, spillages, waste dump locations;

- inventory of identified chemicals seized and the locations where the items were found;
- an indication of scale and physical extent/ boundaries of any manufacturing operation;
- presence of children or indications children reside at the premises; and
- contact information of a designated attending police officer.

Standard letters of notification may not always contain the level of information needed for the appropriate authority to determine if a site inspection is needed. In such instances, communications should be established with the police officer nominated on the notification in order to obtain any further information that is required. In some circumstances, the responsible officer may need to also contact a police officer or forensic chemist who was a member of the evidence gathering team.

In the likely event that a site inspection is required, communications with police officers and/or forensic chemists should include all information available on any identified or suspected safety issues associated with the site. (See section 4.1.2)



## 4. GUIDELINES FOR PHASE TWO – PRELIMINARY ASSESSMENT AND ACTION

### 4.1 Determining if a site inspection is required

Any dwelling, within which a clandestine laboratory has been detected should be considered potentially unfit for human habitation until such time as appropriate investigation can determine the presence or absence of contamination.

In addition, the property upon which the dwelling is located, or property where the reaction was carried out should also be considered potentially contaminated. Illicit drug manufacture is a 'chemical manufacturing process'. Most Australian states and territories recognise within existing environmental guidelines that a 'chemical manufacturing process' represents a potentially contaminating land-use.

Where a clandestine laboratory has been operating at an out-door, semi-enclosed or other out building separate to the principal site dwelling, these areas and the property in general should also be considered potentially contaminated, although this circumstance may not preclude the continued occupancy of the principal site dwelling. Decisions in such events are at the discretion of the appropriate authority and should be based on professional judgement.

Upon receipt of the notification of a clandestine laboratory, the responsible officer should examine the information provided, and obtain additional information if necessary. It should be remembered that the principal priorities of the law enforcement response team are the stabilisation of any processes active at the site at the time of interdiction, and the subsequent processing of evidence to ultimately determine the extent of criminality associated with the activity. While the general identification of contamination issues is incorporated into their processes, the responsibilities and expertise of this unit is not primarily focused on this task. In almost all cases, a visit by the responsible officer to the site is highly recommended and will often identify additional environmental hazards which may need to be addressed under local environmental requirements.

Unless the information received by the police indicates that:

- all chemicals found at the site were sealed and unopened; or
- there was no evidence of any chemical processing at the site

the responsible officer should personally attend the site. Section 5.1.1 gives the decision matrix which can be used to determine if further site investigation should be ordered.

#### 4.1.1 Attending site while police are present

When attending a clandestine laboratory site before the police have vacated, the responsible officer should identify themselves and request to speak to the officer in charge. At that time, the site will be the responsibility of the police and/or fire service. Attending while the police are present provides the responsible officer the advantage of working on a secure site in the knowledge proper safety precautions will be in place. In these circumstances, the responsible officer should confer with attending police, emergency services personnel and forensic staff to gain an understanding of the circumstances giving rise to concerns they may have regarding observed or suspected contamination of the dwelling or environment. Early interaction, particularly with the attending forensic chemist, may prove valuable to the responsible officer in developing a thorough understanding of what has occurred on the site, and subsequently assist in determining an appropriate course of action and the design of appropriate testing and remediation protocols.

Sites are designated crime scenes hence safety and evidence protocols will be in place while evidence is processed by police and forensic chemists. On the completion of this phase, the responsible officer will usually be conducted through the crime scene, so as to be made aware of any areas where potential contamination has been identified.

#### 4.1.2 Safety at a site inspection

The responsible officer who attends the site must ensure that their personal safety is maintained at all times. Before attending any suspected clandestine laboratory site, the responsible officer should contact a police officer or forensic chemist who attended the site to determine the nature and extent of potential hazards likely to arise with the site inspection. In this preparative phase it should be remembered that threats to safety can arise from both animate and inanimate sources.

While there is wide diversity in the nature and geographical location of sites utilised by criminals to manufacture illicit drugs and other controlled substances, the majority of clandestine laboratories detected are situated in or adjacent to domestic dwellings. It is frequently the case that, following the police activity associated with the clandestine laboratory seizure, the site of the laboratory may remain occupied, and the person or persons in residence may be the subject of charges in relation to the activities of the laboratory. In this event, it is important for the responsible officer or other authorised officer to confer with police to determine whether an escort may be necessary whilst the environmental assessment is carried out.

Police and other workers who attend and process a suspected clandestine laboratory site invariably employ personal protective equipment (PPE). The level of protection required for the operation will be determined by a number of factors, and may be scaled back during the processing of the site as facts are established, in particular, issues of air quality.

Respiratory protection, either in the form of breathing apparatus (BA) or air purifying respirators (APR) are frequently required for the duration of the processing operation. By the very nature of the protection both these equipment types afford, no reliable information can be gathered by the wearer as to any particular odours or vapours that may be present in the site or environs. Assessment of air quality during the processing operation is provided through the use of portable instrumentation designed to detect specific flammable or toxic

air contaminants, and generally to provide estimates of concentration of these substances. Consequently, any information on potential airborne hazards by process team members will frequently be limited to those substances which are monitored instrumentally, and may contain no information on 'smells' of other substances which may prove additional useful information to the responsible officer in establishing the nature and extent of contamination. It is important to remember however that the specific data provided instrumentally on gases and flammable solvents delivers reliable insight into the likely chemicals and solvents which gave rise to the airborne substances identified.

The responsible officer should be aware of the range of chemicals that can be encountered in clandestine drug manufacturing operations. These may take the form of precursors, reagents and solvents procured in order to conduct synthetic phases of the process, or may be the by-products of such synthesis. It is important that the responsible officer has at their disposal the most comprehensive information on the chemicals detected at the site, and ideally the identity of the substance under manufacture and the route of synthesis that was employed.

In some instances, the identity of substances at a site may not be readily evident at seizure as label defacing or repackaging is frequently practiced by clandestine laboratory operators to obscure the identity and source of the chemicals. Depending on instrumentation available, the response team attending may be unable to positively identify many of the chemicals on site, and will rely on subsequent comprehensive laboratory analysis to reveal their identity. In these instances, the original notification presented to the appropriate authority by law enforcement will likely not contain sufficient information to permit an adequately informed initial assessment. In this event, should laboratory analysis reveal an unanticipated hazard, then a revision of the initial assessment strategy may be required.

While many of the hazards which may be encountered at a clandestine laboratory site are common to other built environments, a number are peculiar to this form of illicit activity.

#### 4.1.3 Chemical contamination

Chemical contamination is best considered under two general classifications, transient and residual. The notification provided by the initial response unit will record those substances detected at the time of seizure. A number of these may be directly generated by particular manufacturing processes active at that time and be reasonably expected to not persist in that environment, this particularly applies to airborne contaminants.

As methylamphetamine remains the most common drug manufactured illicitly in Australia, it follows that contamination associated with the various methods by which it is produced will constitute a major proportion of cases for assessment and possible remediation.

Airborne contaminants commonly associated with methylamphetamine production include: phosphine, hydrogen iodide, iodine vapour, hydrogen chloride, ammonia, vapour forming organics, organic particulates and a number of organic solvents. The air spaces within a laboratory site may also carry organic vapours arising from spillages of a wide variety of complex mixtures present at intervals during the manufacturing process. The levels of a substance in air spaces will depend on a combination of their relative vapour pressure and the extent to which they have been distributed or adsorbed onto surfaces. Dependent on available ventilation and the time interval between the cessation of illicit operations and responsible officer's assessment, no detectable evidence of some of the more volatile of these substances may remain.

Potential contact hazards vary considerably. They may be in the form of acidic or basic deposits, precursor chemicals and reagents including heavy metal salts, alkali metals, active catalysts, reaction mixtures and intermediates, final drug products, reaction by-products, wastes and solvents. In rare instances, some pyrophoric substances and materials where elevated radiation levels are possible may be encountered.

In instances where the clandestine laboratory has undergone a fire or explosion, evidence of the identity or presence of many of these

classes of substances will have been obliterated with the destruction of their labels or packaging however the original compounds or their combustion products will remain.

Biological hazards may include:

- used syringes and paraphernalia from drug abuse;
- poor personal hygiene practices of occupants and domestic pets; or
- airborne spores from fungi and moulds.

Other hazards may include:

- compromised or improvised electrical circuitry;
- modified or poorly maintained structures;
- site accessibility;
- air quality/oxygen depletion in subterranean non ventilated spaces;
- anti personnel devices not detected by law enforcement; or
- presence or appearance of persons associated with the alleged offences.

Appendix 3 outlines the range of PPE utilised by law enforcement and emergency services and should be consulted as part of the preparation for a site inspection.

Police clandestine laboratory processing teams take every reasonable step to remove chemicals or equipment that has been, or could be, used in illicit drug manufacturing. On occasions however, items may overlooked. If an item is located by a responsible officer that is believed to be of interest to the police, they should contact the police to describe what was found.

In Western Australia, legislation does not permit the pre-trial destruction of seized items. This means that police in Western Australia on occasions are unable to remove some items that would normally be removed.

Sites present dangers not only to community and the environment, but also to those people working there. Taking all necessary precautions when inspecting a site is essential in establishing and maintaining a safe working environment.

# 5. GUIDELINES FOR PHASE THREE – SITE ASSESSMENT AND REMEDIATION

## 5.1 Preliminary Assessment Checklist

The following check list of questions is designed to provide appropriate authorities and suitably qualified experts assessing a potentially contaminated clandestine laboratory site with a rapid reference tool to indicate if additional site investigation is required. In some cases a police officer who attended the scene may need to be contacted for clarification of some matters.

For purposes of convenience, the questions have been divided into 'Outdoor and General Assessment' or environmental assessment for use in the preliminary assessment of land and surroundings of the site, and 'Indoor Assessment' or health assessment for the assessment of dwellings or other structures which may be affected by clandestine laboratory related activities. Answering 'Yes' to any of the following questions will usually indicate a preliminary site investigation will need to be conducted.

As the dumped materials may provide important evidence to police in respect of a case outside the geographic jurisdiction of the environmental authority, a notification protocol between environmental authorities and law enforcement is recommended. In this way, both parties may collaborate to establish both the identity of those responsible for the deposition and also the nature and subsequent appropriate remediation strategies for the contaminants.

### 5.1.1 Outdoor and general assessment (environmental/health assessment)

1. Was contamination identified within the police/forensic information or site assessment report?
2. Has police/forensic information identified the status of the clandestine laboratory as a category A, 'Active' or category B, 'Used Inactive'?
3. Is there evidence of any chemical process being undertaken at the site, recent or historical?

4. Is there any evidence of soil contamination such as staining, spillages, visible waste disposal sites or bare patches of soil?
5. Is there any current or historical evidence which indicates the possible use or the storage of chemicals or wastes associated with chemical processing at the site?
6. Is there any unexplained soil disturbance or evidence of excavation on the site? (Note: historical aerial photographs may provide a reference source for this information.)
7. Is the site located in close proximity to a waterway, other natural water body or potable water source?
8. Does the site adjoin, or is the site in close proximity to any public utility such as a school, playground, swimming pool or park?
9. Does the site adjoin, or is the site in close proximity to any sensitive environment?

### 5.1.2 Indoor Assessment (health assessment)

1. Was the clandestine laboratory located within a dwelling or other site structure?
2. Is there any damage (For example. corrosion or staining) to fixtures or fittings inside the building which is consistent with chemical exposure?
3. Are there any visible residues present on fixtures, fittings or any internal surface? This will include any staining of walls, bench surfaces, furnishings, discolouration of extraction fans, filters, vents or staining around sinks or drains.
4. Does the dwelling or structure have internal or improvised air ducting?
5. Are there any noticeable odours of a chemical or contaminant nature?
6. Are there any modifications to the building which could permit the transfer of contamination external to the building?

For example, extraction fans set into external walls, holes cut in flooring or improvised plumbing suited to the disposal of liquid wastes.

Other factors which should be taken into consideration may include:

- The type and condition of fences, i.e. is the site secure, and if not, is there a requirement for interim control measures to secure the property?
- Condition of roads, pavement and other access issues should vehicular access be required.
- What is the general down stream direction and destination of surface water runoff? Are any waterways potentially at risk?
- Does the site have any drainage channels or conduits?

## 5.2 Designing the sampling program

### 5.2.1 General principles and considerations for detailed site investigation

Each stage of the investigation has the potential to be reported separately, namely:

- Preliminary site investigation;
- Detailed site investigation;
- Remediation Action Plan; and
- Validation and ongoing site monitoring.

Sampling design information is based on the principals of NEPM, Schedule B (2) *'Guideline on Data Collection, Sample Design and Reporting'*. When designing a sampling program both the NEPM guideline and the following sampling design information should be considered to ensure that the program adopted is the most appropriate given the information available.

Note: The discussion in this section does not include the sampling for clandestine laboratory growing marijuana. It does, however, include sampling for a clandestine laboratory extracting marijuana to produce cannabis (or hash) oil.

A sampling plan serves to determine the existence and the extent of any contamination. The plan should include a rationale for the sampling program, taking into consideration all available information in relation to the activities conducted at the site. Given the nature of clandestine laboratories and the contamination that is generated through their operation, both systematic sampling and judgemental principals may be applied.

In sampling a dwelling or other structure allegedly used as a clandestine laboratory, testing should be primarily targeted at areas where contamination is most likely. After decontamination, the site again needs to be sampled to validate that decontamination procedures have been effective.

Efficiencies can be achieved providing the responsible officer is in possession of all information pertaining to the site prior to the formulation of a sampling plan. For example, if a decision has been made that a building is to be demolished and the materials removed as hazardous waste, there would be no need to obtain samples from the building. Sampling of the soil post demolition on that property may be all that is required to accompany an investigation and/or validation report.

Difficulties may arise in the assessment of clandestine laboratory sites situated in commercial premises. Here both licit and illicit manufacture may have been carried out simultaneously. The responsible officer will require information on both the legal and illegal activities in order to discriminate between chemicals and hence develop appropriate sampling and waste disposal plans.

These Guidelines provide advice on the numbers and locations at which samples are to be taken. If there is information from any source that would indicate a higher rate of sampling, then those samples should be taken; e.g. a neighbour may provide information about dumping areas, or suspicious odours.

### 5.2.2 Areas to target

Contamination caused by clandestine laboratories can take many forms so this must be reflected in the locations and the types of samples collected. Areas that should be targeted for testing include where:

- chemical processes were being conducted (from police information);
- chemicals and/or used equipment had been stored (from police information);
- there is visible staining or encrusted solid (judgement);
- preliminary testing indicates contamination, For example moist pH indicator strips reveal acidic or basic surface contamination;
- there is discoloured, distressed or dead vegetation (judgement); and
- children are believed to be living or playing (police information and judgement).

Illicit drug manufacture generates significant amounts of waste. The volumes produced will depend on a number of factors including starting materials, routes of synthesis and the technical skills of the operators. Estimates of waste from the production of a single kilogram of methylamphetamine vary from 3 litres to 30 litres and may take the form of liquids, slurries, resinous to waxy oils, and solids. The fate of these wastes may involve hoarding by operators in the belief that valuable components may remain to be recovered, or more generally, disposal at either the site or remotely. To adequately determine if waste products are contaminating a former site, sampling plans should include drainage systems (stormwater and sewerage), sewer traps, sullage pits, dams, ponds and water courses.

The synthesis techniques generally employed for the illicit production of ATS, for example methylamphetamine and 3,4-methylenedioxyamphetamine (ecstasy), will frequently result in traces of the reaction mixtures being deposited on the inner surfaces of a dwelling. The residues are deposited through aerosols generated from boiling reaction solutions under protracted reflux

conditions where inefficient or improvised condenser apparatus is used. The most commonly encountered synthesis routes for illicit methylamphetamine involve the direct or indirect use of hydrogen iodide, present as hydriodic acid. Aerosol deposits from this class of synthesis will, either rapidly or with time, develop some degree of colouration from pale yellow to strong brown due to the liberation of iodine. There are many other chemical processes associated with either the manufacture of drug substance or their chemical precursor which will generate entirely colourless deposits, hence visual inspection is an unreliable indicator for surface contamination.

### 5.2.3 Contaminants and wastes generated at sites

The following is a description of some of the liquids and solids that are likely to be found at sites. The purpose of these descriptions is to assist the responsible officer in recognising a substance likely to have originated from the illicit manufacture process and further, to appreciate how contamination at a site occurs.

In most jurisdictions, items associated with a clandestine laboratory will be removed by the police. In some jurisdictions, particularly Western Australia, there is limited provision for the pre-trial destruction of items seized at clandestine laboratories. In some instances, certain items can be overlooked or deemed to be unimportant as evidence and therefore left on site. These items, while perhaps of limited value as evidence, may contain potentially significant environmental contaminants.

The deposition of residues from manufacturing processes may be intentional through dumping or may be unintended, in the latter case through spillage, catastrophic equipment failure or vapour/aerosol distribution. Irrespective of the manner in which the contamination arises, the residues are frequently complex and may contain not only controlled drugs and precursors but also a wide range of organic and inorganic compounds. The identity and pharmacological activity of many of these substances is unknown. The complexity of residual materials is further compounded in instances where clandestine



laboratories experience fires as combustion and pyrolysis products are produced under these conditions.

The following contains a description of the characteristics and origins of some of the residues and wastes found at sites.

Methylamphetamine synthesis operations are the predominant class of clandestine laboratories reported nationally. An examination of the chemicals and processes used for several of the routes of production for this drug can provide a useful general model to describe likely sources where contamination may arise in illicit drug laboratories.

Pseudoephedrine has been shown to be the most common source of starting chemical or precursor used in illicit methylamphetamine in Australia. The reduction of this substance produces the desired drug. The reduction step can be achieved via a number of routes however two classes of process are most frequently utilised by illicit manufacturers:

- a) Reduction using hydrogen iodide as the reducing species – this can be achieved through the direct use of hydrogen iodide in the form of hydriodic acid, or the hydrogen iodide can be synthesised in situ by the application of various combinations of substances including hypophosphorous acid, phosphorous acid, phosphoric acid, iodine, iodide salts and red phosphorous; or
- b) Dissolving metal (Birch reduction), where condensed anhydrous ammonia is employed both as a reagent and solvent, and the active metal is generally lithium or sodium or occasionally potassium.

The pseudoephedrine precursor will generally be sourced from pharmaceutical preparations diverted from licit distribution channels. The preparations are usually in the form of tablets however gelatine capsules and liquids are also targeted. The extraction of the pseudoephedrine can be achieved through the powdering of the tablets and subsequent extraction by either, direct dissolution and filtration using the lower alcohols, or alternatively through solvent extraction. The solvents used include toluene or other readily available hydrocarbons such as

mineral turpentine or shellite. Sodium hydroxide is almost invariably used to establish basic conditions for extraction. This substance also has further application in pH adjustment in a number of other techniques regularly applied in illicit drug synthesis hence both strongly basic liquid and slurry wastes are common. Tablet extraction wastes can be single or two phased and of a high pH and contain tablet excipient and binder wastes.

An examination of reagents outlined in (a) above provides only a partial indication of the potential complex nature of the chemical matrices associated with clandestine laboratory remediation. For example, in the particular case of hydrogen iodide driven pseudoephedrine reductions, the group of reagents identified are variously present at the initial phase of the process, however as the reaction proceeds, a number of reaction products, including methylamphetamine, are produced.

At the completion of the reaction phase, an extraction or cleanup process is undertaken to isolate the target substance from the unwanted spent reaction by-products. This is typically achieved through either of two processes, distillation or solvent extraction. A common technique widely utilised in the illicit production of methylamphetamine is the steam distillation of the reaction mixture. This process can give rise to significant levels of the amine in free base form escaping in the form of vapour as a consequence of inefficient condensation equipment. The distillation residues freed of methylamphetamine also present a significant source of potential contamination as they are frequently disposed of in drains or dumped on or around the environs of the laboratory.

In general, distillation residues from not only methylamphetamine production operations but from synthesis of the wide range of controlled drugs and drug precursors will regularly contain a wide variety of organic and frequently inorganic components. The sustained elevated temperatures inherent in distillation processes will create an environment where high molecular weight oils, resins and waxes may be formed. These are frequently water insoluble and will strongly resist conventional cleaning techniques.



The use of solvent extraction as a purification technique in the isolation of a controlled drug or drug precursor can involve the use of a wide variety of organic solvents, these include toluene, benzene, xylenes, mineral turpentine, shellite, diethyl ether, dichloromethane, chloroform, acetone, isopropyl alcohol, methylated spirits and methanol. Dependent on the chemical properties of the substance intended for isolation, solutions containing combinations of water soluble and water insoluble wastes will be generated, in the form of single, or more typically, two phased solutions, and frequently in large volumes.

Spillages or leakages of liquid waste are a primary source of environmental contamination. Deposition can arise during transfer operations or through the failure of equipment, particularly the failure of inappropriate storage containers. The presence of solvents in plastic vessels or the containment of solutions of low pH in metal drums will often result in vessel failure. Upon release, the complex of components in the solutions may be carried deeply into the surfaces they contact due to the efficient solvating properties of solvents. Upon the evaporation of the solvents, the contaminants can remain deeply embedded in floor coverings, floor boards or composite sheet flooring materials, concrete or any other porous construction materials. In many cases, remediation processes such as the application of surfactants detergents or high pressure steam cleaning will succeed only in removing surface contamination and will be ineffective in removing materials which have penetrated into the medium.

Most liquids in their pure form are clear and colourless however liquids that have been used in some way at a clandestine laboratory will often carry some degree of colouration. Colour and colour intensity is variable and, in general, provides little useful insight into the chemical composition of the solution. In cases where visual indications of spillages are evident, the responsible officer should exercise judgement in determining if the cleaning of the effected surface is likely to remove contaminants. In most instances the removal of floor coverings is highly recommended however the replacement

of significantly contaminated structural components such as flooring and walls may be necessary.

Cleaning operations may result in surfaces testing negative to test analytes when re-sampled immediately after treatment. The possibility of contaminants which have deeply penetrated the surface being remobilised through diffusion back to the surface should be considered. It may be advisable in cases where porous surfaces have been subjected to liquid inundation that drilling into the structural medium is carried out to determine the depth of contaminant penetration and/or the efficacy of cleaning operations.

Seasonal temperature fluctuations can contribute to changing air quality in clandestine laboratory environments. If air quality monitoring is carried out at low temperatures, an increase in ambient air temperatures with seasonal changes can result in organic contaminants exerting considerably higher partial vapour pressures and hence, volatilising into the air space at higher concentrations than at the time of testing. While this circumstance primarily would apply to organic compounds, the levels of inorganics, particularly iodine vapour, may be similarly influenced. To avoid this possibility, the removal of contaminated structural components may need to be carried out at sites where significant permeation is suspected.

The technique of dissolving metal reductions described in 5.2.3 (b) above presents a different group of potential contaminant compounds. In these reactions, pseudoephedrine (or ephedrine) is dissolved in condensed anhydrous ammonia as solvent and subsequently reduced by the action of either lithium or sodium (or rarely potassium). The condensation or trapping of anhydrous ammonia gas presents several extreme hazards at both the time of the process and subsequently in the storage of the condensate. The process can be achieved through the venting of compressed ammonia gas into a vessel chilled in a bath of typically acetone and dry ice. The condensed ammonia may either be used immediately or stored. It is the second practice where inexperienced

operators have chosen non pressure rated sealed vessels to confine the liquid where catastrophic failure and explosion events have occurred. Similarly, stolen ammonia may be decanted into gas cylinders intended for the storage of liquid propane. These vessels are fitted with brass valving, which when exposed to ammonia for extended periods, will lose copper from the alloy and subsequently fail under the pressure of the contained gas. A visual indication of brass having been exposed to ammonia is a blue-green colouration on the surface of the alloy.

An alternative process where anhydrous ammonia can be produced is through the chemical reaction of ammonia salts and sodium hydroxide. Typically either ammonium nitrate or ammonium sulphate fertilisers are used. The reaction is carried out in a closed vessel and the ammonia thus generated is cryoscopically trapped. Improvised vessels used for this purpose may be sealed and stored or discarded while still containing significant quantities of reactants. Disturbance through movement may cause mixing of these components and re-initiation of ammonia gas production, resulting in pressurisation and catastrophic release of the contents.

Clandestine laboratory response units and fire and rescue services have standard operating procedures to deal with operations where ammonia is being illegally handled. While it is unlikely that a responsible officer would be confronted with an active process, it is possible that a propane gas cylinder or other vessel containing incorrectly stored ammonia gas or gas producing reagents may be overlooked or concealed and remain on the site after response units have departed. Should the responsible officer suspect such a device, or become aware of any persistent indication of ammonia through instrumental monitoring or smell at the site that cannot be readily accounted for, the officer should immediately vacate the premises and notify police and/or emergency services of their concerns.

All liquids at a clandestine laboratory not in a properly labelled container, or whose appearance is not consistent with its label,

should be considered suspicious and generally be removed as hazardous waste. In instances where the clandestine laboratory was located in a commercial environment, it will be necessary to determine which liquids present were associated with the illicit activity, and hence likely contaminants, and which are associated with any legitimate commercial activity operating at the location. The responsible officer should exercise good judgement in deciding whether substances found at a site should be removed as hazardous waste.

Concentrated mineral acids are used commonly in clandestine drug synthesis. These will include hydrochloric and sulphuric acid, with hydriodic and the phosphorous oxy acids, hypophosphorous, phosphorous and phosphoric being used particularly in methylamphetamine synthesis. A recognised method used illicitly for the synthesis of other ring substituted ATS requires the use of hydrobromic acid. Acids are used either as reagents to perform specific reaction steps or for pH adjustment. The wide application of these substances results frequently in residues and waste liquids of low pH becoming sources of environmental contamination.

In nearly all instances, ATS are marketed in the form of the hydrochloride salt. A final stage in the manufacture process for these substances is the conversion of the drug from the free base oil form to the corresponding solid hydrochloride salt. This is achieved by the dissolution of the drug in oil form into a suitable solvent, i.e. a solvent in which the oil is readily soluble but the hydrochloride salt is insoluble. While a number of solvents are suitable for this purpose, acetone, toluene and occasionally diethyl ether are most commonly used for this process. The salt formation can be achieved by the addition of hydrochloric acid directly to the drug/solvent solution however this technique produces some undesirable characteristics in the final product. An alternative method for salt formation is the passage of gaseous hydrogen chloride through the solvent solution. Hydrogen chloride is rarely sourced commercially but rather is generated at the site using improvised equipment. Hydrogen chloride is liberated when hydrochloric acid is added to concentrated sulphuric acid.

Alternatively it can be produced by the action of dropping sulphuric acid onto sodium chloride. To carry out these processes, common domestic or industrial vessels are modified into gas generators to effect the mixing of reagents and to facilitate the containment and controlled delivery of the gas by way of piping or tubing. In some instances, gas cylinders have been used as generators to contain sulphuric acid and sodium chloride mixtures.

The use of non pressure rated non acid resistant vessels for this purpose poses an extreme safety risk as catastrophic failure is virtually assured if the vessel is sealed. Once the reagents are mixed, there is no means to control or stop the evolution of the gas. Generators discarded by laboratory operators will generate gas if disturbed as unspent reagents are further mixed. These devices are sources of contamination at sites either through the slow sustained emission of the strongly acidic hydrogen chloride, or through their contents being poured out into drains or on to soils. Extensive corrosion of metal fixtures, or severe decomposition of cement, grout or other building materials are indicators of possible contamination by hydrogen chloride or the solutions used for its production. The responsible officer should be mindful that such apparatus exists and in the event that one is encountered at a site, police or emergency services should be contacted.

The processes outlined above represent those employed for methylamphetamine synthesis in the majority of clandestine laboratories seized nationally. It should be remembered there are many other processes, and hence chemicals, which have been applied by illicit operators for the production of ATS drugs. It is essential that the responsible officer is in possession of all information pertaining to the process activities conducted at the site to be assessed. This can be achieved either through documentation and/or direct communication with police and forensic services, to ensure the sampling plan and techniques developed for the site are appropriate to evaluate all possible contaminant candidates. In some instances, initial observations carried out at seizure will not permit the exact nature of the processes to

be fully identified. Under these circumstances, it will be advisable for the responsible officer not to proceed until preliminary chemical analysis is available to reveal details on the nature of the processes leading to possible contamination.

The choice of synthetic route selected by illicit laboratory operators will be determined by a number of factors, including ease of access to precursor chemical substances required.

#### 5.2.4 Surface contamination inside a building

The following outlines procedures for testing the interior of a building that is suspected of having been used as a clandestine laboratory for the production of illicit drugs or related chemical processes.

Methylamphetamine synthesis (or “cooking”) operations will contaminate inside surfaces of buildings with residual methylamphetamine. Studies have also established that smoking methylamphetamine will likewise contaminate the inside surfaces of buildings with methylamphetamine. Regardless, the presence of methylamphetamine on inside surfaces at a level of greater than 0.5 micrograms ( $\mu\text{g}$ ) per  $100\text{cm}^2$  is considered unacceptable.

In designing the sampling plan for inside a building, the following guidelines are provided:

1. At least five samples should be taken inside the building.
2. Areas that show evidence of contamination should be sampled.
3. Surfaces used in the drug manufacturing process should be sampled. If those surfaces have been removed, an area as close as practicable to that area should be sampled.
4. Any room or area inhabited by a child under 16 years of age should be sampled at least once.
5. Sampling may be achieved through the collection of wipe or swab samples of  $100\text{cm}^2$  areas of non-porous surfaces such as mirrors, bench tops, painted walls, and metal surfaces.

6. The selection of appropriate wipe media and solvent should be made in consultation with the laboratory where sample analysis is to be conducted. The wipe must be free of interfering substances and be capable of absorbing the suspected analyte so as to provide a true representation of the surface contamination present. (While isopropanol dampened swabs are widely used, consultation with the analysing laboratory is still advised).
  7. The technique by which the wipe is manipulated to collect the sample must be consistent and provide reproducible recoveries of the analyte.
  8. A porous surface may be sampled by removing a 100cm<sup>2</sup> portion of the surface and submitting the entire portion for analysis.
  9. Surfaces that appear to have been recently cleaned should be avoided.
  10. Areas behind furniture or appliances should be avoided.
  11. If there is reason to suspect that adjacent buildings or structures are contaminated (on the same property), then testing should be extended to those buildings or structures.
  12. Ventilation ducts (if present) closest to the area of drug manufacture should be sampled. In most circumstances a swab sample should be sufficient.
  13. If the building is a commercial or industrial property, the sampling plan should check for contamination in every immediately adjacent room (joined by a doorway or ventilation duct) to where illicit drug preparation had taken place or where chemicals had been stored.
  14. Chain of custody protocols should be followed. Each sample container should be uniquely labelled as the sample is placed within it, and each sample should always be either under the control of an authorised person or sealed in an appropriate bag or container.
  15. Quality assurance protocols should be followed. The person sampling should change gloves immediately before taking every sample. Sample containers will normally be glass containers with PTFE (Teflon) lined screw caps. Samples of porous materials can be sealed in plastic bags.
  16. Blanks should be taken at regular intervals. The number of blanks should equate to approximately 10 per cent of the total sample number.
- The standards described in Appendix 1, 'Investigation Levels' will apply, in particular:
1. If the suspected drug being manufactured is methylamphetamine, its concentration should not exceed 0.5µg/100cm<sup>2</sup>.
  2. If the suspected drug is any other amphetamine type stimulant (e.g. 3,4-methylenedioxymethamphetamine, MDMA; 3,4-methylenedioxyamphetamine, MDA; para-methoxyamphetamine, PMA), its concentration should not exceed 1.0µg/100cm<sup>2</sup>.
  3. If iodine is being used in the manufacturing method, then its concentration in any wipe should not exceed 22µg/100cm<sup>2</sup>.

### 5.2.5 Checking for Volatile Organic Compounds

Australian Standard AS 2986.1 – 2003 *"Workplace air quality – Sampling and analysis of volatile organic compounds by solvent desorption / gas chromatography Part 1: Pumped sampling method"* or Australian Standard AS 2986.2 – 2003 *"Workplace air quality – Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography Part 2: Diffusive sampling method"* should be used for the analysis of volatile organic compounds (VOC's) in air. Notwithstanding the sampling plan in the relevant standards, sampling should be targeted to where contamination is likely.

In designing the sampling plan for testing for VOC's, the following guidelines should apply:

1. Each room where a chemical process was thought to have taken place should be sampled.

2. Each room where chemicals or equipment was thought to have been stored should be sampled.
3. Each room where there is evidence of spillage or staining should be sampled.
4. Any bedroom or play room of a child under 16 years of age should be sampled.

Any samples taken under this section should comply with chain of custody and quality assurance protocols as outlined in these Guidelines.

### 5.2.6 Wastewater contamination

As outlined in 5.2.2, waste from illicit drug production is often poured into the wastewater system of the dwelling. That wastewater can be directed to the storm sewer system, a sanitary sewer system flowing into a municipal treatment system, or a sanitary sewer system flowing into a septic tank. Each of these possibilities will be discussed separately.

If the wastewater flows into the storm sewer system, the dynamics of that system should be examined to determine whether sampling is needed. (If there has been a large amount of recent rainfall and illicit drug production has been minimal in the recent past, analysis is likely not necessary unless there is evidence of an affected area.)

If the wastewater flows into a municipal sewage system, it has likely been diluted to the point that detection of any of the contaminants is unlikely. The responsible officer may nevertheless decide that it would be advisable to inform the local utility in charge of wastewater treatment to check for some of the contaminants in the relevant reaction list. This will be particularly relevant where the local municipality recycles such water.

If there is any evidence of clandestine laboratory activity in a dwelling whose wastewater flows into a septic tank, all chambers of the tank should be pumped out and the contents taken to a wastewater processing facility. In addition, at least one soil sample from the septic bed should be analysed. See section 5.2.7 regarding the sampling of soil.

Any samples taken under this section shall comply with chain of custody and quality assurance protocols as described in section 5.2.4 (items 14, 15 and 16).

### 5.2.7 Sampling soils, surface water and groundwater

Waste from clandestine laboratories is seldom disposed of lawfully and is often stored at the sites or poured on the ground near the clandestine laboratory site, down a municipal drain or into a watercourse directly. In designing the sampling plan for sampling soils, groundwater, and surface waters, the following guidelines should apply:

1. Any soil that shows evidence of contamination shall be sampled.
2. Soil sampling should be systematic, with judgemental sampling applied to areas of suspected contamination.
3. At least one sample should be taken from the septic bed (tank) (if present) on the property.
4. If there is no evidence of contamination, at least two soil samples should be taken from the property, close to well travelled paths.
5. Groundwater should be sampled if the responsible officer considers, in their professional opinion, that sufficient risk to groundwater integrity exists based on site factors such as the presence of existing groundwater bores, drug waste disposal on site, shallow groundwater (within 15 metres of surface) or the presence of deep pits on the site.
6. If there is a watercourse flowing through the property, it may be sampled if there is any evidence of contamination (for example visible surface film, bleaching or crystallisation at waters edge or fish kill).
7. Sampling should be conducted in accordance with the NEPC publication *Schedule B(2) Guideline on Data Collection, Sample Design and Reporting* which includes discussion on sampling soils, groundwater and watercourses for environmental contamination.

The sampling plan is to follow the relevant guidelines stated in NEPC publications.

8. Any samples taken under this section should comply with chain of custody and quality assurance protocols as described in section 5.2.4 (items 14, 15 and 16) and the data quality objective stated in Appendix 2 of this document.

### 5.3 Assessment criteria

The ILs table is provided in Appendix 1 of this document and should be used for the assessment of analytical data obtained from the investigation of sites. Investigation of potential surface water or groundwater contamination, where required, should be assessed against relevant NEPM's, The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines* or applicable state or territory endorsed guidelines.

Due to the unique nature of clandestine laboratories and the contaminants they produce, the assessment criteria for these guidelines have been derived with reference to three primary documents<sup>1</sup>.

Where required, additional guidance has been obtained from relevant Australian and international guidelines which are consistent with current industry best practice and relevant to the exposures that require consideration for clandestine laboratories.

With respect to the protection of the environment, published screening level guidelines (threshold or benchmarks) relevant to the protection of the terrestrial or aquatic environments have been referenced including NEPM's and The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines*. These guidelines remain appropriate for investigation of aquatic environments.

1

- enHealth "Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards", 2011, in press;
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM), draft variation, 2011.
- enHealth "The Australian Exposure Factors Handbook" 2011, in press.

The ILs have been derived using an approach that is consistent with the derivation of NEPM 2011 HILs. The NEPM HILs only provide guidelines for a limited number of chemicals in soil under a range of different land use scenarios. The ILs derived as part of the present Guidelines follow an approach consistent with the NEPM HILs, for the same key land uses; however they address the presence of key chemicals in all media significantly impacted by operations at a clandestine laboratory, namely soil (outdoors), air (indoors) and surface residues (indoors).

It is noted that a number of guidelines associated with the assessment and remediation of former sites are available in the United States. These guidelines focus on a limited number of compounds (mainly methylamphetamine, VOCs as a group, lead and mercury). Many of the guidelines are based on analytical limits of detection rather than protection of human health or the environment and hence a more detailed review of illicit methods applied in Australia and identification of key compounds associated with these methods has been undertaken.

### 5.4 Remediation Action Plans

This section provides guidance on the development and implementation of Remediation Action Plans (RAPs) at contaminated sites. It is important to note, RAP's for clandestine laboratories are not dissimilar to RAP's which would be prepared for other contaminated sites within each state or territory.

RAPs are developed to address the issue of site contamination and remediation options and form a part of the contaminated site investigation process. The broad purpose of RAPs is to establish remediation goals to ensure contaminated sites, once remediated, will be suitable for their proposed use and will not pose an unacceptable risk to human or environmental health and delineate the evidence clearly to support the RAP. In order to achieve this, the RAP should document in detail all of the procedures and plans that will be implemented to reduce risks to acceptable levels as well



as establish environmental safeguards to complete the remediation in an environmentally acceptable manner. The preparation of a RAP for clandestine laboratory sites requires the following components be addressed:

- Site information;
- Site characterisation;
- Remediation goal;
- Extent of remediation required;
- Remediation options/ hierarchy of remediation for structures;
- Remediation options- environmental;
- Building decontamination management plan;
- Environmental Management Plan;
- Proposed testing for validation;
- Contingency plan (for remediation failure);
- Site Management Plans; and
- Remediation schedule.

#### 5.4.1 Site information

The purpose of the site information is to identify potential contaminants and areas of contamination by site history and investigations including a review of information sourced from the law enforcement agency responsible for discovery/evaluation of the site. The key information will relate to the type of reaction being undertaken at the site (if known) and the locations where reactions are known or suspected of having occurred.

If known, information should be gathered on the illicit substances manufactured and the methods used. The identity of the drug(s) and/ or precursor chemicals being manufactured, the synthesis methods used and the stage at which manufacture was disrupted (or reached) are all important factors which have significant bearing on the chemicals and reaction by-products, and hence the nature of the contamination that may be found at the site. Additionally, evidence of drug use, chemical spills and disposal of chemicals within the premises will influence the type and extent of contamination.

The current lot or plan (real property) descriptions of all affected parcels and the street or lot number and name of suburb are to be provided. Where multiple lots are involved, plans which show lot boundaries in relation to significant features should be provided. Maps (including street map copies), plans or diagrams should be used to clearly identify the location of all affected parcels in relation to surrounds, for example street access, neighbouring property boundaries, parks, local watercourses and any areas of environmental significance.

#### 5.4.2 Site characterisation

The purpose of the site characterisation is to assess the type and extent of contamination existing or potentially existing on the site. The site characterisation should include an assessment of the type of environmental contamination including soil and groundwater contamination and chemical degradation products as well as potential contamination of structures (For example rooms, houses, sheds) and materials (For example carpet, fittings). This information should be sourced from the site investigation.

This section should include a record of the following (if known):

- Known or suspected chemicals used;
- Identification of chemical storage areas;
- Identification of areas where chemical processes (or 'cooks') were conducted;
- Information on synthesis methods;
- Evidence of waste disposal methods and/or areas;
- Evidence of chemical stains, fire damage or other contamination;
- Information about the premises- surfaces, fixtures, furnishings;
- Evidence of discoloured soils;
- Evidence of dead vegetation;
- A summary of materials removed from the site in the initial seizure; and
- Findings of any laboratory analysis carried out during investigation.



### 5.4.3 Remediation goal

The purpose of the site remediation goal is to identify the desired outcome of the remediation works and the intended future use/s of the site. In general, the remediation goal is to ensure the contaminated site, once remediated, will be suitable for its proposed use.

### 5.4.4 Extent of remediation required

The purpose of this section is to determine the extent of remediation that will be required for a site. This will need to be determined on a site-specific basis.

The facilities in which illicit drugs can be manufactured vary from small clandestine laboratories through to industrial scale operations. These laboratories have been discovered in a range of locations including urban and rural premises, motor vehicles and caravans, demountable homes and motel rooms. The nature and size of the site, the substances being manufactured, the extent of contamination and future land uses all influence the extent of remediation required. Similarly, the risk of harm that former clandestine laboratories potentially pose to human health will depend on the particular chemicals and the concentrations at which they are present, and the potential routes available for human exposure. The extent of remediation required, therefore, should be determined with regard to the following:

#### *Accessibility of residues, and frequency of direct contact*

The likely future use of a former site is an important factor in estimating the frequency of human contact. For example, surfaces bearing residues in a kitchen or bathroom of a house will likely be subject to contact more frequently than residues in a non-residential outbuilding.

#### *Characteristics of the inhabitants or users of the structure*

Information on likely future occupancy of a former site is important in estimating the harm that contact may pose. For example, crawling toddlers will have a high frequency of skin contact, and hence likely skin absorption with any residues present on flooring. Children of this age

regularly display 'hand to mouth' and 'hand to eye' behaviour which introduces the possibility of additional exposure to residual contamination by ingestion or through eye contact.

### 5.4.5 Remediation options/ hierarchy of remediation for structures

In general, the remediation option(s)/ requirement(s) will be dependent on the state of the site, the chemicals found, processes used and the period of time the clandestine laboratory was active. It is likely however that comprehensive information on each of these variables may not be available in all instances. For structures, the requirements may range from a simple 'clean-up' of a site through venting, detergent scrubbing, neutralization, enclosure or encapsulation through to the demolition of a contaminated structure.

For structures, remediation options are determined through a hierarchical approach. Different remediation options and methodologies include:

#### *Clean Up/Wash Up*

- Ventilation;
- Detergent washing surfaces followed by rinsing with water;
- Vacuuming surfaces with high efficiency particulate air vacuums;
- Steam cleaning/ high pressure cleaning;
- Neutralization of surfaces with weak acids/ bases; and
- Flushing pipes with water.

#### *Stripping/Encapsulation*

- Removal of all structure contents, including appliances, furnishings, floor coverings, curtains, blinds, panelling, drywall and wallpapers;
- Cleaning and vacuuming;
- Sealing of surfaces with paints or other materials;
- Disposal of contents/stripped materials; and
- Flushing pipes with water.

### ***Demolition***

- Removal of all structure contents;
- Demolition of structure; and
- Disposal of structure/contents.

### ***Clean Up/Wash Up***

In some cases, decontamination and remediation of former clandestine laboratory sites may be accomplished through a 'clean up/wash up' process. In these cases, nonporous and semi-porous surfaces such as windows, floors, tiles, walls, ceilings and other fixtures may be decontaminated by scrubbing with solutions of detergent and water. If the contamination of porous materials such as carpeting and curtains is deemed to be minimal, they may also be decontaminated through washing and vacuuming (commercial grade vacuum cleaners equipped with HEPA dust collection systems are recommended). Large areas of contamination may be steam cleaned or cleaned with high-pressure washers.

If acids or bases have been used in the manufacturing process the potential contamination may be reduced or removed through neutralization. For acids, neutralization may be achieved by washing with solutions of sodium bicarbonate, and for bases, neutralization may be achieved by washing with dilute solutions of acetic acid in water.

It is important to ensure former sites are well ventilated to assist in reducing airborne contamination and decreasing odours when undertaking remediation works. This form of contamination can arise from the spillage and subsequent absorption of liquids during former laboratory operations and processes. While many solvents can effectively be eliminated through ventilation, liquid chemicals with low vapour pressures may frequently prove resistant to this treatment. Ventilation may be performed by opening windows and doors to facilitate cross-ventilation or be provided with the assistance of mechanical fans. In instances where contamination arising from flammable organic solvents is suspected, it is recommended that the fans deployed are either (i) spark proof or (ii) are so arranged

as to provide positive pressure ventilation to the premises. Where possible, increasing the temperature above 24°C also aids in the removal of volatile chemicals.

If any materials are to be removed from the site for cleaning through an external cleaning service, the items should be vacuumed first and "bagged" or contained in a suitable vessel for transport. In addition, the cleaning service should be notified in writing prior to receiving the materials to notify them that the materials are from a former clandestine laboratory and therefore potentially chemically contaminated.

### ***Stripping/Encapsulation***

When the extent or degree of contamination is too great to be removed by clean-up/wash up processes the structure and/or its surfaces may require stripping, encapsulation and/or removal. This may include furnishings, carpet, rugs, curtains, blinds, panelling, drywall and wallpaper. All materials removed from a clandestine laboratory must be legally disposed of according to the nature of the material and/or degree of contamination. Some materials may not be suitable for general landfill and may require disposal by a licensed contractor to an appropriate waste facility.

Risks associated with contaminated surfaces may further be reduced by cleaning and vacuuming and encapsulation or sealing the contaminated surfaces with layers of oil-based paint, polyurethane or other materials.

### ***Demolition***

In cases where contamination is extreme, adequate remediation may not be achievable through washing, stripping or encapsulation and therefore may require the demolition of the contaminated structure. All demolition materials must be legally disposed of according to the nature of the material and the type and degree of contamination. It should be anticipated that, where demolition is required, extensively contaminated materials will not be suitable for general landfill and will require disposal by a licensed contractor to an appropriate waste facility.

Demolition should be considered when the building and/or its associated structures have suffered structural damage, for example through explosion or fire.

Recommendation for demolition should be justified and reported in detail to the responsible authority, and be accompanied by the required analytical data to justify the decision based on a risk assessment model. In most cases this will also require the responsible authority or jurisdictional health department to declare the dwelling unfit for habitation, and condemned, by exercising their powers under the relevant health/building or related acts and regulations.

#### **5.4.6 Remediation options – environment**

Chemicals associated with clandestine laboratories are often released both intentionally and unintentionally into the environment. For example chemicals may be spilled, buried, burned or disposed of into sinks, toilets, sewerage system and waste management facilities or piped directly onto soil. Once released, these chemicals may undergo processes such as sorption, degradation or leaching and thereby contaminate soil, sediment and surface and groundwater. Such releases have clear implications for human health and the environment.

Where relevant, remediation of environmental matrices may need to be addressed. This type of contamination will require different remediation plans to those developed for contaminated structures.

##### ***Remediation of soils and sediments***

The RAP should address the type and extent of contamination and include details of the most feasible remediation options. The RAP should detail:

- The methods/technology to be used;
- The expected by-products, wastes, discharges and outputs (including the management of these substances); and
- Any “clean” materials to be brought onto the site.

- Some chemicals may have been spilled or deposited ad hoc (for example buried or incinerated) in soil depressions or ‘burn-pits’. In these instances, the site may require soil remediation or excavation to remove the actual/ potentially contaminated material. Following remedial actions, the surrounding soil or sediment will require validation testing.

##### ***Remediation of groundwater and surface water***

Contamination of groundwater by VOCs has been identified as a primary environmental hazard caused by the manufacturing and processing of illicit substances in clandestine laboratories. Where initial site investigations reveal contaminated groundwater, the remediation plan will be required to detail methodologies to reduce contamination. The plan should incorporate follow up validation testing to confirm the success of the remediation activity.

(Section 2.2 of schedule B(6) of NEPC1999 provides a clear framework for remediation planning when groundwater assessment is required.)

Alternatively, wastes from clandestine laboratory operations may have been spilled or directly discharged into surface waters including ponds, dams, streams, lakes, wetlands and seasonally flooded areas. Where initial site investigations reveal contaminated surface water, the remediation plan will be required to detail methodologies of reducing contamination. The plan should incorporate follow up validation testing to confirm the success of the remediation activity.

##### ***Septic systems***

Septic systems are often found on rural and semi-rural properties. If a clandestine laboratory has been operating on a property with a septic system, it is possible chemicals may have been dumped into the system. If information or indicators suggest this may have occurred, all plumbing and traps should be flushed thoroughly with cold water before the septic system is pumped out. Effluent should be discharged to an appropriate water treatment facility. Management of the septic system needs to be included in the RAP.

#### 5.4.7 Proposed testing for validation

The purpose of validation testing is to confirm the success of the remediation plan by reassessing levels of contamination and comparing findings to those of the site investigation. Testing that was initially conducted as part of the Stage 2 Investigation should at a minimum be replicated for all remediated surfaces. An outline of the required validation sampling should be included in the RAP.

#### 5.4.8 Contingency plan

The purpose of a contingency plan is to provide another option to address the remediation of a site in the event that the selected remediation plan does not fulfil the remediation goal.

#### 5.4.9 Site management plan

The purpose of the site management plan is to establish environmental and occupational health and safety (OH&S) safeguards necessary to complete the remediation in a manner that is environmentally acceptable and which poses no risk to workers or the general public. The site management plan will incorporate a number of more detailed individual plans that may be applicable to each individual site. These plans may only be necessary where the consultant determines, based on professional judgement, that such a plan is required. Such plans might include:

- Storm water management;
- Soil management;
- Noise control;
- Dust control;
- Odour control; or
- OH&S.

### 5.5 Building Decontamination Management Plan

To ensure all decontamination and remediation procedures of clandestine laboratory buildings and associated structures are undertaken in a manner that does not pose a risk to human health and the environment (including workers/contractors, the general public) a Building

Decontamination Management Plan (BDMP) must be developed and form part of the RAP. The BDMP should be structured to provide details on each environmental and OH&S impact and the measures to be implemented to ensure their correct management.

For each of the proposed remedial options a number of potential issues need to be addressed, see Appendix 2 – Reporting and Data Quality Objectives.

### 5.6 Environmental Management Plan

To ensure all decontamination and remediation procedures at former sites are undertaken in a manner that causes no undue harm to the environment an Environmental Management Plan (EMP) must be developed. The aim of an EMP is to ensure adequate consideration is given to the environment during the decontamination of sites.

An EMP allows the site remediators to reduce their impacts through environmental management. In order to be able to manage any potential environmental impacts, a process must be undertaken to review all decontamination/remediation activities and their potential for impacts, including impacts to the air, water, land, waste and noise.

An EMP outlines the actions required to manage environment impacts from the decontamination/remediation activities. The format of the EMP is such that it should include (at a minimum) the objective, the impact and aspect, the control measures, monitoring and reporting requirements.

The EMP may encompass and or consolidate the plans already mentioned above into a single management plan.

For each of the decontamination/remediation options a number of potential issues need to be addressed – see Appendix 2 – Reporting and Data Quality Objectives.

# 6. GUIDELINES FOR PHASE FOUR – VALIDATION

## 6.1 Site validation

Following remediation, a site must be 'validated' to ensure that the objectives stated in the RAP have been achieved. The details of the site validation are compiled and presented in a Validation Report.

At former sites the extent of validation required will depend on:

- The type, concentration and quantity of contamination originally present;
- The type of remediation processes that were carried out; and
- The proposed land use, for example residential or other sensitive land use, commercial/industrial or public open space.

Validation will be required on all areas remediated including, dwellings, structures and the environment.

## 6.2 Validation of buildings and structures

After remediation of a building or structure small amounts of residual chemicals may remain and thus sampling should be undertaken to ensure the objectives stated in the RAP have been achieved and levels of chemicals adequately reduced. The extent of the validation sampling required will depend on:

- The preliminary assessment information;
- The chemicals used or found at the site;
- The known or expected extent and severity of pre-remediation contamination;
- The type of remediation processes carried out;
- The proposed occupancy of the building or structure; and
- Professional judgement.

In general, the validation of a building or structure should include:

- A general inspection of the site to check for re-staining or odours;

- Re-sampling of surfaces from which initial samples were taken;
- Sampling of areas which are expected to have frequent contact, for example. kitchens and bathrooms; and
- A combination of swab sampling and sampling for VOCs where required.

The validation of a building or structure prior to re-occupancy is important to human health. In many instances a greater number of samples will be taken at this stage in comparison to the initial contamination investigation. If contaminant levels are found to be above the ILs then the area of concern must be re-cleaned or treated, or another remediation option considered. The site is only deemed to be validated once all samples are below their corresponding ILs stated in this document (Appendix 1 – Summary of Investigation Levels (ILs) in the Assessment of former Clandestine Lab Sites).

## 6.3 Validation of land

The environmental component of site validation, or validation of land, will include soil, surface water and groundwater. The validation requirements will vary depending on the nature and extent of contamination and the remediation procedures employed.

## 6.4 Soil validation

Following remediation of soil, sampling is required to validate the site and confirm that the remediation was successful in removing (or adequately reducing) contamination. Sufficient samples will be required in order to be considered representative of the remediated area on the site.

Existing sampling design guidelines within each state or territory should be used to determine appropriate sampling design and density, and be considered the default guideline for this type of validation. Alternately the sampling design and methodology detailed in Schedule B (2) *Guideline on Data Collection, Sampling Design and Reporting*, NEPM may provide guidance.

Compositing of samples is not considered appropriate.

Where soil has been excavated, for example where a pit was dug to remove contaminated soil or ash material, sampling should be conducted as per relevant local requirements for the validation of excavations or underground storage tank excavations. These requirements vary from state to state, but generally require samples be collected in a systematic pattern across the floor and walls of an excavation.

If soil contamination is detected after remediation, the remediation procedure should be repeated, or alternatively, a different remediation technique should be employed. Validation testing is required until the soil contamination is reduced to a level that no longer represents a risk to human health or the environment.

Monitored natural attenuation, particularly of hydrocarbon contamination may be considered an appropriate remedial technique within some jurisdictions where no potential exposure pathway exists for site occupants.

## 6.5 Surface water validation

Each state and territory within Australia has a specified standard for the sampling and analysis of waters. The standards are generally based on the Australian and New Zealand Environment and Conservation Council Guidelines.

Sampling design and analysis for surface waters should be developed in accordance with relevant local guidelines and/or *Australian Guidelines for Water Quality Monitoring and Reporting* (2000), and *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000).

The sampling design and frequency required to validate surface water will be dependant largely on the type of water body also (for example natural or man-made, dam, pond, wetland, or creek).

For example if water was pumped or removed from a pond or dam, sediment samples should be taken from the walls and floor when the pond or dam is dry and water samples should be collected when the pond or dam has refilled.

For naturally occurring wetlands, validation sampling should be undertaken in 'dry' conditions and after a rain event. Samples should be collected from the sediment and from the overlying water.

If contamination is detected in the sediment or surface water samples after remediation, the remediation procedure should be repeated, or alternatively, a different remediation technique should be employed. Validation testing is required until the contamination is reduced to a level that no longer represents a risk to human health or the environment.

If contamination was originally detected or suspected to be present in moving water bodies such as creeks and streams, or in storm water drains, sampling should be undertaken once under low flow conditions and once under higher flow (rain event) conditions to validate the site.

## 6.6 Groundwater validation

The need for remediation or validation of groundwater in response to a clandestine laboratory is unlikely, unless waste has been either directly deposited into an existing groundwater bore or deposited into the ground at a location with a high and water table.

Following any remediation of groundwater, samples should be collected from appropriate groundwater monitoring bores quarterly or until contamination is reduced to levels that no longer represents a risk to human health or the environment.



## 7. REFERENCES AND RESOURCE DOCUMENTS

- The National Environment Protection Council (NEPC) 1999 Schedule B [2] '*Guideline on Data Collection, Sample Design and Reporting.*'  
[http://www.ephc.gov.au/sites/default/files/ASC\\_NEPMsch\\_\\_02\\_Data\\_Collection\\_199912.pdf](http://www.ephc.gov.au/sites/default/files/ASC_NEPMsch__02_Data_Collection_199912.pdf)
- NSW EPA 2000 Guidelines for Consultants Reporting on Contaminated Sites  
<http://www.environment.nsw.gov.au/resources/clm/97104consultantsglines.pdf>
- *EPA Guidelines for Environmental management of on-site remediation*  
[http://www.epa.sa.gov.au/pdfs/guide\\_remediation.pdf](http://www.epa.sa.gov.au/pdfs/guide_remediation.pdf)
- Alaska Department of Environmental Conservation. *Guidance and Standards for Cleanup of Illegal Drug Manufacturing Sites.* 2007, Revision 1.  
<http://www.methlabcleanup.com/AK%20Standards>
- Ministry of Health, Manatu Hauora, New Zealand. (2008). *Draft Guidelines for the Site Remediation of Clandestine Methamphetamine Laboratories.*
- Minnesota Department of Health (MDH) and Minnesota Pollution Control Agency (MPCA). (2007). *Clandestine Drug Lab General Cleanup Guidance.*  
<http://www.health.state.mn.us/divs/eh/meth/lab/guidance0407.pdf>
- Colorado Department of Public Health and Environment. *Cleanup of Clandestine Methamphetamine Labs Guidance Document.* 2007 Revision.  
<http://www.cdphe.state.co.us/hm/methlab.pdf>
- New Mexico Environment Department. *Clandestine Drug Laboratory Remediation*  
<http://www.nmcpr.state.nm.us/nmac/parts/title20/20.004.0005.htm>
- Department of Health and Aging. (2008). *Development of Health standards for the Remediation of Clandestine Drug Laboratory Sites- Scoping Project.*  
<http://health.utah.gov/meth/html/Decontamination/AdditionalResources.html>
- Scott, T.L., Janusz, A., Perkins, M.V., Megharaj, M., Naidu, R., Kirkbride, K.P., 'Effect of amphetamine precursors and by-products on soil enzymes of two urban soils.' (2003). *Bull. Environ. Contam. Toxicol.* 70: 824-831.
- Janusz, A., Kirkbride, K.P., Scott, T.L., Naidu, R., Perkins, M.V., Megharaj, M.
- 'Microbial degradation of illicit drugs, their precursors, and manufacturing by-products: implications for clandestine drug laboratory investigation and environmental assessment.' (2003). *Forensic Science International* 134: 62-71.
- Pal, R., Mallavarapu, M., Naidu, R., Kirkbride, P., (2009) *Illicit Drug Laboratories and the Environment.* University of South Australia.
- Abdulla, A.F., Miskelly, G.M., Yew, C.H., (2010) 'Quality scientific approach for remediating and analysing clandestine laboratory residues.' *Malaysian Journal of Chemistry* 12:1: 001-008.



# APPENDICES

## APPENDIX 1: Summary of Investigation Levels (ILs) – Assessment of Former Clandestine Lab Sites

Key Chemical	Residential (A)		Recreational (E)		Commercial/Industrial (F)			Environmental #	
	Indoor Criteria		Outdoor		Indoor Criteria		Outdoors		Outdoors
	Surface (µg/100cm <sup>2</sup> )	Air (mg/m <sup>3</sup> )	Soil (mg/kg)	Soil (mg/kg)	Surface (µg/100cm <sup>2</sup> )	Air (mg/m <sup>3</sup> )	Soil (mg/kg)	Soil (mg/kg)	
Methamphetamine	0.5	b	5	5	10	b	45	x	x
MDMA	7	b	60	60	130	b	600	x	x
Pseudo/Ephedrine	600	b	6000	6000	10000	b	50000	x	x-
Ammonia	a	0.1	1800	1800	a	0.3	10000	x	0.9 <sup>AFM</sup> **
Iodine	20	0.0008	2	2	450	0.003	6	4 <sup>U</sup>	x
Bromide	2000	0.0008	2	2	50000	0.003	4	10 <sup>U</sup>	x
Phosphorus	0.07	b	0.6	0.6	2	b	7	x	AFM**
N-Methylformamide	10	b	120	120	270	b	1200	x	x
Methylamine	a	0.004	70	70	a	0.01	600	x	x
Nitroethane	a	0.4	4400	4400	a	1	20000	x	x
Boron and compounds	1800	b	3000 (N)	6000 (N)	40000	b	15000 (N)	0.5 <sup>U</sup>	0.37 <sup>AF</sup> , 5.1 <sup>AM</sup>
Mercury (inorganic)	35	b	15 (N)	30 (N)	800	b	75 (N)	1 (NE)	0.0006 <sup>AF</sup> , 0.004 <sup>AM</sup>
Lithium	46	b	230	230	1000	b	5700	2 <sup>U</sup>	0.014 <sup>U</sup>
Benzaldehyde	1500	0.4	6300	6300	35000	1	35000	0.6 <sup>o</sup>	0.01 <sup>o</sup>
Phosphine	a	0.0004	c	c	a	0.001	c	x	x
Safrrole and isosafrole	16	0.0002	1	1	16	0.001	6	0.4 <sup>U</sup>	x
Chloroform	a	0.1	240	240	a	0.4	1400	1.2 <sup>U</sup> , 170 <sup>R</sup>	0.37 <sup>AFM</sup>
Dichloromethane	a	1	120	120	a	4	3300	4 <sup>UD</sup>	4 <sup>AFM</sup>
Benzene	a	0.0095 (A)	1 (S)	1 (S)	a	0.0095 (A)	1 (S)	210 <sup>R</sup>	0.95 <sup>AF</sup> , 0.5 <sup>AM</sup>
Toluene	a	0.4 (A)	130 (S)	130 (S)	a	0.4 (A)	130 (S)	1.4 (S)	0.18 <sup>AFM</sup>
Ethylbenzene	a	26	50 (S)	50 (S)	a	80	50 (S)	3.1 (S)	0.08 <sup>AF</sup> , 0.005 <sup>AM</sup>
Xylenes	a	0.9 (A)	25 (S)	25 (S)	a	0.9 (A)	25 (S)	14 (S)	0.2 to 0.35 <sup>AFM</sup>
TPH									
C6-C9 (aliphatic)^^^	a	0.8	1800	1800	a	3	4000	130 <sup>c</sup>	x
C10-C14	a	0.2	1000 (S) C10-C36,	1000 (S) C10-C36,	a	0.7	1000 (S) C10-C36,	150 <sup>c</sup>	x
C15+	140	b	90 (N)	180 (N)	3000	b	450 (N)	400 <sup>c</sup>	x
pH	6.5-8.5	b	6.5-8.5	6.5-8.5	6.5-8.5	b	6.5-8.5	x	[6 to 9] A**

**Notes for Table above (refer to Environmental Risk Sciences [2009] report for full detail on derivation):**

- a No surface residue IL has been derived for these key chemicals as they are considered volatile and would not be present as surface residues (or dust) for sufficient time to be of concern.
- b No indoor air IL has been derived for these key chemicals. Only volatile chemicals (or gases) have been considered as they may continue to off-gas from porous surfaces over time.
- c No soil IL has been derived for phosphine gas as it is not expected to be present in outdoor soil for sufficient time to be of concern.
- x No Tier 1 or screening level guidelines are available for these chemicals from peer reviewed sources that are relevant to the protection of the terrestrial or aquatic environments.
- ^^ IL derived for TPH fractions C6-C9 are for the aliphatic fraction. This is calculated based on the total TPH C6-C9 reported minus total BTEX (the major contributors to aromatics).
- A Monitoring Investigation Levels are available and presented for benzene, toluene and xylenes in air as per NEPM [2004], converted (at STP) from ppmv to mg/m<sup>3</sup>. Values relevant to chronic exposures (annual averages) have been presented for use in preference to derived ILs. Derived ILs are noted in the calculations presented in **Appendices C to E** of the Environmental Risk Sciences [2009] report and can be referenced where relevant. ILs adopted should reflect any changes to NEPM guidelines.
- N Investigation Levels are available from NEPM [1999b] for these chemicals in soil and are presented in this table, relevant to the land-use. Derived ILs are noted in the calculations presented in Appendices C to ED of the Environmental Risk Sciences [2009] report and can be referenced where relevant. ILs adopted should reflect any changes to NEPM guidelines.
- NE Ecological Investigation Level available for mercury from NEPM [1999b] presented in this table. ILs adopted should reflect any changes to NEPM guidelines.
- S No NEPM values are currently available, however ILs presented in NSW EPA Service Station Guidelines [1994] are commonly adopted as ILs in Australia. These are presented in the table. Exceptions are in Queensland where state specific values should be considered. Derived ILs are noted in the calculations presented in **Appendices C to E** of the Environmental Risk Sciences [2009] report and can be referenced where relevant. ILs adopted should reflect changes to state guidelines and/or release of relevant NEPM guidelines.
- # Environmental Screening Guidelines available from a ranges of peer-reviewed sources. Qualifiers noted in table refer to source of guidelines available as follows:

A = available from ANZECC/ARMCANZ [2000] for:

F = freshwater

M = marine water

\* Guideline for ammonia based on pH of 8, guideline must be adjusted for other pH levels

\*\* Range of guidelines available for phosphorous and pH in water for a range of ecosystems in different areas of Australia, refer to guidance document for relevant values

U = available from USEPA Region 5 or 6

R = Guideline available from RIVM [2001]

O = Guideline available from OECD [2005]

C = Guideline available from CCME [2000, 2008]

## APPENDIX 2: Reporting and Data Quality Objectives

### Reporting

In general, each investigation report should contain the following sections either in detail or in summary:

- Executive summary;
- Scope of work;
- Site identification;
- Site history;
- Site conditions and surrounding environment;
- Geology and hydrogeology;
- Data Quality Objectives;
- Sampling and analysis plan and sampling methodology;
- Field and laboratory Quality Assurance and Quality Control (QA/QC);
- QA/QC data evaluation;
- Basis for assessment criteria;
- Results;
- Site characterisation; and
- Conclusions and recommendations.

Reporting requirement for RAP's are detailed under Section 5.4.

### Data Quality Objectives

Establishment of Data Quality Objectives (DQO) ensures that a study is carried out in a structured way with the objectives stated initially, and the questions significant to attaining the objectives of the study defined early. In this way, the data collected are appropriate and of sufficient quality to allow decisions to be made about the site with respect to the contamination status. A unique set of DQO must be established for each site to be investigated or validated prior to the study commencing.

The outcome of the DQO process is a clear guide to data collection activities that are focused on collecting information needed to answer questions that will lead to decisions being made about the contamination on a site. In addition, the DQO process must include a plan for actions to be undertaken should the data not meet the expected DQO.

### The DQO process

The DQO process comprises seven steps that build upon the initial statement of the problem to be addressed by the investigation (Step 1) to arrive at a framework for data collection, quality control and assurance (Step 7). The DQO process, as defined by the United States Environment Protection Agency is as follows:

#### *Step 1 – State the problem*

This step defines the questions that are to be answered by the investigation and identifies the resources available to resolve the problem. A conceptual site model is developed during this step.

The following matters must be addressed during Step 1:

- Objectives of the investigation or validation must be defined and a consideration made of the limits on the ability to meet the objectives that may be imposed by constraints such as time, budget or site access;
- Based on current knowledge of the site, a brief summary is prepared of the contamination issues known and expected and which are to be addressed by the investigation or validation;
- A reason must be provided for why the investigation or validation is being completed;
- The composition and structure of the investigation team and members responsibilities must be provided;
- Other factors that may impact on the design and implementation of the investigation or validation such as budget, community relations, access limits must be considered;
- The regulatory authorities and the local government area must be identified.

The outputs from this step **should** include:

- A clear definition of the problem to be addressed by the investigation;
- A clear statement of the objectives of the investigation or validation;
- The composition of the investigation team and the responsibilities of its members including identification of the decision-maker; and
- A conceptual model of contamination on the investigation site based on a review of the history and background of the site and of past and present activities on the site.

The conceptual model of the site should be progressively refined throughout the investigation process as additional inputs are obtained.

### *Step 2 – Identify the decision*

This step identifies the decisions that need to be made to address the contamination issues on the site and what data are required to make the decisions. Based on the conceptual model of site contamination developed in Step 1, the decision statements should link the problem statement, also made in Step 1, to the data collection part of the investigation or validation program. Acceptance criteria for each medium must be considered.

An example of a decision statement is “Does contamination in the soil represent a significant risk to human health or environmental given the proposed land use?”

### *Step 3 – Identify inputs to decision*

This step identifies the information that is needed to resolve the decision statements. When identifying the inputs, consideration should be given to the following:

- What information is needed to resolve the decision statement (for example, what is the proposed land use for the site?);
- Environmental variables and characteristics that will be measured (for example, what are the chemicals of concern);

- What information should be obtained that will allow decisions to be made so that the decision statement can be resolved;
- Which media (for example, soil/fill, groundwater, sediment, carpet, paint) need to be sampled;
- What criteria are to be used to assess each medium;
- What analytical methods for the chemicals of concern are going to allow meaningful assessment against the criteria;
- Definition of the basis for decisions made from field screening instruments and methods;
- Any other information required to make a decision; and
- The outputs from this step are considered to be a starting point for refinement during later steps in the process, notably, in Step 7.

### *Step 4 – Define the study boundaries*

This step defines the spatial and temporal boundaries of the study to ensure that the data collected are representative.

The spatial boundaries of the study include property boundaries, access to areas of the site and potential exposure areas. Physical constraints to collection of a complete data set, for example, water bodies, fences or buildings, should be defined in this step. The potential distribution, particularly on larger sites, of areas in which contamination is expected to be uniformly distributed should be defined so that appropriate chemicals of concern, sampling depths and media are considered, as appropriate, for each area of the site.

The temporal boundaries of the study may be constrained by seasonal conditions (for example, the effect of heavy rain or drought on the ability to sample the soil), access restrictions (for example what times is the site open), availability of key personnel (for example, when will personnel with knowledge of the site history be available), the presence of near-surface groundwater or surface water and discharges (for example, does the presence of potentially impacted surface water depend on the season).

The potential use of the site should be considered as it will influence the sampling density required and the areas of a site that will be used for specific uses should be defined.

#### ***Step 5 – Develop a decision rule***

This step defines the parameters of interest, specifies action levels and combines the outputs from the previous DQO steps into a single statement that provides a logical rule for choosing from alternative actions.

Consideration should be given to the specification of action levels that will be used to choose between alternative actions. Action levels may be pre-determined (for example, guidelines set by the regulator) or site specific (for example, risk-based criteria calculated for the site). In general, pre-determined action levels will be more conservative (i.e. lower) than risk-based action levels.

Consideration also should be given to the definition of acceptable limits for chemicals of concern in blank quality samples (field blanks, rinsate blanks, laboratory method blanks); recoveries from spike samples (matrix spikes, surrogate spikes) and laboratory control samples; and relative percent differences of matrix spike and matrix spike duplicates.

This step should result in definition of the statistical parameter (i.e. mean, median or percentile) that characterises the population; confirmation that the action levels are greater than the detection limits of the method used; and development of an 'If ... then ...else' statement that allows the decision-maker to choose alternative actions.

An example of an 'If...then...else' statement is as follows:

If the mean concentration of chemical X in the top 250 mm of soil in a particular grid of the sampling pattern (a decision unit) exceeds the action level, then remove a 500 mm layer of soil, else leave the soil intact.

#### ***Step 6 – Specify limits on decision errors***

In this step it is acknowledged that the investigation team does not have access to perfect information, as has been assumed

in the preceding steps, and that the data are subject to various types of errors. Consequently, it is possible that an incorrect conclusion, or a decision error, may be arrived at and it is necessary to define performance or acceptance criteria that the data will need to achieve to minimise the possibility of making erroneous conclusions.

Decision errors arise due to decisions about the contamination status of a site being made based on data that is not representative of the conditions on site because of sampling or analytical error. The use of incorrect data may result in the decision being made that the site is suitable to be used for the proposed use without clean-up when it isn't or vice versa.

'Total Study Error' arises from a combination of *sampling errors* and measurement errors. Sampling errors occur when the sampling program does not result in the collection of representative samples from all strata such that the variability of a contaminant from sampling point to sampling point is not adequately defined. Measurement errors occur during sample collection, handling, preparation, analysis and data reduction.

The total study error directly affects the probability of making a decision error and is managed by the correct choice of sampling program and measurement system. The use of a statistically-based sampling program allows the nomination of the probability of a decision error occurring.

The possibility of making a decision error is controlled by the use of hypothesis testing. In hypothesis testing a baseline condition is set (for example, the site is contaminated such that it requires remediation for the proposed use). The test is then used to show that the baseline condition is true or false. The burden of proof is placed on rejecting the baseline condition i.e. it is assumed that the baseline condition is true unless there is overwhelming evidence to the contrary. The stated baseline condition is known as the *null hypothesis* and there are two types of decision errors that can occur as follows:

- A Type I error occurs when the hypothesis is rejected when it should be accepted (in the

example given above, it is decided that the site is suitable for the proposed use without remediation when actually it is not); and

- A Type II error occurs when the hypothesis is accepted when it should be rejected (in the example given above, it is decided that the site requires remediation to make it suitable for the proposed use when actually it does not).

The implications of making either a Type I or Type II error are different and depend on how the null hypothesis has been set. In the example provided, the implications of a Type I error to human health and the environment are considered greater than those of a Type II error, which would result in greater financial costs than necessary, but would be protective of human health and the environment.

As can be seen, setting the null hypothesis is an important step when considering the implications of the Type I and II errors. If the phased approach to site assessment is followed based on the guidelines (NEPC 1999<sup>2</sup>), and following completion of a Stage 1 Preliminary Site Investigation (PSI) a Stage 2 Detailed Site Investigation (DSI) is indicated, the null hypothesis should assume that the site is contaminated as indicated by the results of the Stage 1 PSI, otherwise a Stage 2 DSI would not be required. Consequently, in contaminated site assessments the null hypothesis should always assume that the site is 'contaminated'.

The probability of a Type I error occurring is known as the  **$\alpha$  (alpha)** risk and the probability of a Type II error occurring is known as the  **$\beta$  (beta)** risk, both of which are expressed as decimals. The *confidence level* is the converse to the risk and for  **$\alpha$**  and  **$\beta$**  risks would be expressed as **1- $\alpha$**  and **1- $\beta$** , respectively.

Commonly, the probability of a Type I error occurring (i.e. the  **$\alpha$**  risk) is set at 0.05 when assessing for a sensitive land use, with the probability of a Type II error occurring (i.e. the  **$\beta$**  risk) set at 0.2. This implies a higher level

of confidence (95%) that a Type I error has not occurred in comparison to a Type II error (80%). This allocation of probabilities acknowledges that, when considering contaminated sites, a Type I error has more serious implications than a Type II error. The recommended  **$\alpha$**  (0.05) and  **$\beta$**  (0.2) risk values are used to arrive at the constant (6.2) in the equation used to determine the number of samples required for determining the mean concentration in Step 7.

### Step 7 – Optimise the Design for Obtaining Data

In this step the outputs from the other DQO are brought together into a resource-effective sampling and analysis program that will result in the data collected satisfying the DQO. The outputs of the preceding DQO are applied to the design of the study that will satisfy the DQO, including the optimal sampling and analytical plan to meet the objectives of the assessment and the DQO. The main output from this step is development of the Sampling Analysis and Quality Plan (SAQP) for the study.

An important aspect of optimising the design is determining the number of samples needed to arrive at the mean concentration for each of the analytes using the following formula (AS 4482.1-2005<sup>3</sup>)

$$n = \frac{6.2\sigma^2}{(C_s - \mu)^2}$$

Where

- n = Number of samples needed
- $\sigma$  = Estimated standard deviation of contaminant concentrations in the sampling area, mg/kg
- $\mu$  = Estimated average concentration in the sampling area, mg/kg
- Cs = Acceptable limit, mg/kg

The constant 6.2 is based on a 0.05  **$\alpha$**  risk and a 0.2  **$\beta$**  risk

<sup>2</sup> National Environment Protection (Assessment of Site Contamination) Measure, National Environment Protection Council, 1999 (NEPC 1999)

<sup>3</sup> AS 4482.1-2005, Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds, 2nd Edition 2005 (AS 4482.1-2005)

## Appendix 3: Personal Protective Equipment (PPE)

### Guidelines on the Personal Protective Equipment to be worn during attendance at a suspected clandestine laboratory site

#### Background:

Clandestine laboratories involve the improper storage and use of toxic and corrosive chemicals. Although no odours or visible staining may be evident, residual chemicals may be present. Any person attending a suspected clandestine laboratory site which has not been fully decontaminated should utilise appropriate personal protective equipment (PPE).

#### Personal Protective Equipment

The following is provided to guide those attending sites after the police and forensic chemistry team are no longer in attendance. While the following recommendations describe PPE appropriate for the majority of cases, specific instances of heavy contamination may require the use of more sophisticated PPE for example breathing apparatus. In this event, only persons who have undergone appropriate training in the use of the equipment are to utilise same. Safety is the responsibility of those attending the site hence consultation with emergency services personnel and/or safety equipment specialists is recommended in the selection of PPE.

Before entering the site, the police officers who processed the site for safety and evidence purposes should be contacted and any potential hazards discussed. Regardless of the level of site contamination as determined by attending police officers, as a recommended minimum, those attending a site should wear:

**Respiratory/eye protection:** A full face mask air purifying respirator (APR), equipped with broad spectrum cartridges that filter dusts, organic vapour, acid vapour, solvents and ammonia / methylamine. APR's are to be decontaminated after use. Cartridges are to be replaced dependent on contaminant burden as

per manufacturer's instructions and disposed of as hazardous waste after use. Those using the APR's must be trained in their use in accordance with manufacturers' recommendations. The wearing of separate eye protection and half face APR's or dust masks is not recommended as these do not provide a comparable level of protection nor the comfort of a full face APR.

**Hand protection:** 'Nitrile' disposable gloves offer adequate hand protection against chemical contamination under most circumstances arising during sample collection. Additional protection may be achieved through the donning of a second set in instances where puncture or tearing is possible. When sharp, rough or significantly contaminated surfaces are present, consideration should be given to the use of heavy duty Neoprene gloves. Gloves should be changed regularly hence access to appropriately sized gloves in quantity will be required. Gloves are not to be re-used and are to be disposed of as hazardous waste. The use of latex or vinyl gloves is not acceptable as they do not provide adequate protection against a range of chemical substances.

**Foot Protection:** Two alternative types of suitable foot protection are available:

- Boots – these may be either lace up or of a rubber or 'gum' boot design, and constructed of materials which are resistant to chemical attack. These offer protection against a range of chemical substances and may be decontaminated after each use.
- Disposable latex or plastic overshoes. These should fit properly and be disposed of as hazardous waste after single use. (While paper overshoes are available, their use is not recommended. They are generally only suited for protecting against dusts and particulates and offer little protection from liquids).

**Skin and clothing protection:** Disposable cover all suits with an integrated hood are suited for the purpose and are available in a variety of materials which offer differing levels of protection against exposure to chemical contaminants. The range from composite fabrics for example Tyvek® offering protection



principally against dust and particulates only as many liquids will penetrate the fabric after relatively short exposure periods. A higher level of protection is offered by coverall suits or 'splash suits' manufactured from a variety of laminated chemical resistant materials for example Tychem®. While these offer enhanced penetration resistance to a range of chemicals, they are not 'chemical proof'. These suits cannot be effectively decontaminated and are intended to be for single use only, after which they are to be disposed of as hazardous waste.

The choice of suit composition, and PPE in general, should be made on a case by case basis and be based on site specific information including the degree and nature of contamination, and with reference to the maker's specifications for the PPE garment.

***Air monitoring instrumentation:*** When first entering an indoor site, the site is to be checked with a properly calibrated and functioning air monitoring device. The air monitor must, as a minimum, detect oxygen and lower explosion limit levels. Before beginning sampling or inspection, the air throughout the premises must be assessed. Special attention is to be paid to floor areas as many solvent vapours are heavier than air and may accumulate in low lying sections. If an air monitor alarms at any time, those present must immediately evacuate the premises and seek assistance from fire and emergency service before re-entering.

## Appendix 4: Analytical Laboratory Services

### Analytical Laboratories

Determining the identity and concentration of any chemical contaminants is an integral part of the remediation for sites. Authorities engaging in remediation processes will require the services of laboratories which can provide quantitative analysis on, at a minimum, the substances contained in Appendix 1.

It should be noted that Appendix 1 contains some substances which are controlled under federal and state drug legislation. Laboratories offering analytical services for these substances will need to be in possession of appropriate licences and permits to access the necessary standards and reference materials

It is recommended that, prior to the commencement of any sampling from a site, discussions be held with the laboratory which will carry out the analysis of the samples. This is to ensure any solvents, sampling media, sample containers or any other materials used in the collection process are compatible with laboratory requirements and will not interfere with the analysis.

The following are some of the laboratories which may be able to provide the analytical services required in the remediation of former sites. The list is provided as information only and should not be interpreted as a recommendation or an endorsement of the services offered by these institutions.

- ChemCentre  
Resources and Chemistry Precinct  
South Wing, Building 500  
South Entrance Drive (off Manning Road)  
Curtin University  
Bentley WA 6102  
Phone: +61 (0)8 9422 9800  
Fax: +61 (0)8 9422 9801
- National Measurement Institute  
1 Suakin Street  
Pymble NSW 2073  
Phone: +61 (0)2 9449 0111  
Fax: +61 (0)2 9449 1653
- Queensland Health Forensic and Scientific Services  
39 Kessels Road  
Coopers Plains QLD 4108  
Phone: +61 (0)7 3274 9111  
Fax: +61 (0)7 3274 9119

