enHealth Guidance on: Clandestine Drug Laboratories and Public Health Risks

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enHEALTH

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Information Paper Summary

In many western countries, especially the United States (US) and Australia there has generally been increasing numbers of clandestine laboratories (clan labs) being found.

Although police remove the bulk of chemicals and equipment used, contaminant residues remain on many surfaces and areas at these sites. As most clan labs are discovered in residential buildings, these residues place existing and future occupants at potential health risk.

To address this issue comprehensive national guidance has been developed in the form of the *Clandestine Drug Laboratory Remediation Guidelines – 2011* (Australian Crime Commission 2011). These Guidelines are increasingly being adapted and implemented across Australian jurisdictions taking account of local risk circumstances and regulatory systems to make them more effective and workable.

Illicit drug incidence data indicates that there has been a decline in clan lab detections nationally in recent years, and more markedly in Queensland and Western Australia. This may be the result of much easier access to illegally imported drugs, superimposed on jurisdictional differences. Although methylamphetamine labs remain the most common by far, there tends to be east to west differences in the main production methods.

The major sources of public risk from clan labs can be ascribed predominantly to methylamphetamine exposure (as a persistent production residue) and also from toxic or flammable gases when the labs are actively operating. Methylamphetamine and associated contaminants can spread widely at a site.

Children, possibly numbering hundreds per year, are likely to be the most at risk population exposed to contaminants associated with “discovered” clan labs. The number of children at risk in undiscovered labs may be ten-fold higher.

Based on contaminant level and exposure studies in Australia and New Zealand it is likely that a reasonable proportion of exposed children and adults will suffer at least minor behavioural, psychological or physiological health effects. The frequency and severity will increase with the nature, level and duration of such exposure.

Purpose

The purpose of this document is to highlight the potential public health risks associated with chemical contamination from clandestine laboratories (clan labs), in particular former clan labs. The potential risks from methylamphetamine labs are also relevant to contamination derived from the smoking of crystal methylamphetamine.

As clan lab assessment and management systems vary across Australia, for guidance in these regards please contact your State or Territory regulator as listed under Health Agency Information at the end of this document.

Background

Tighter restrictions on the transnational illicit drug trade have prompted growth in local clan lab manufacture operations particularly in Western countries. In this document, clan lab manufacture refers to the production of illicit drugs or precursors within an improvised laboratory environment (Newell 2008). It can include extraction, synthesis and/or tablet making operations.

The growth in clan labs in Australia is shown in Table 1 from the Australian Criminal Intelligence Commission (Australian Crime Commission 2015) peaking at 809 detections in 2011-2012. The decline in detections since then, most marked in Queensland and Western Australia, could be for local or more broad-based reasons. A key factor is likely to be the apparent substantial increase in the amount of imported illicit drugs, which might otherwise be manufactured locally. In any case, for the hundreds of detected labs, there will be many thousands more clan labs that may never be identified and will continue to operate until eventually abandoned.

Table 1: Number of clan lab detections, by State and Territory, 2002–03 to 2014–15

Year	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	Total
2002-03	47	19	171	34	36	2	3	2	**314**
2003-04	61	20	189	48	33	1	6	0	**358**
2004-05	45	31	209	25	44	3	21	3	**381**
2005-06	55	47	161	50	58	5	12	2	**390**
2006-07	49	72	132	51	37	9	1	5	**356**
2007-08	51	76	121	69	30	2	1	6	**356**
2008-09	67	84	148	65	78	0	7	0	**449**
2009-10	82	113	297	71	118	1	12	0	**694**
2010-11	87	63	293	75	171	11	2	1	**703**
2011-12	90	99	379	58	160	15	7	1	**809**
2012-13	105	113	330	56	136	9	8	0	**757**
2013-14	98	114	340	80	96	5	11	0	**744**
2014-15	99	161	236	71	84	5	10	1	**667**

Clan labs are subject to a range of legislation and strategies designed to take action against the misuse of drugs, and these have also identified the need to minimise risks to the public, especially children, who are incidentally associated with such labs (Australian Institute of Criminology 2007).

The police and forensic agencies typically remove clan lab bulk chemicals, containers and equipment as part of their investigation and management of illicit drug activities. However, a range of chemical residues may remain on-site posing a risk to occupants and others due to these improvised activities usually by untrained offenders who care little about the safe management of dangerous chemicals, generation of gases and the disposal of waste.

As the majority of clan labs are in residences (non-work place settings) (Australian Crime Commission 2015), any resulting risks are often subject to State or Territory public health legislation, in particular the habitability of a residence. If the clan lab is in a work place or affects the environment, then other setting-specific legislation will apply.

Some countries have recognised real and potential risks of such contamination and have published guidance material to help manage them. The US has done much in this area, having had a large problem for decades. More recently detailed guidance has been produced New Zealand (NZ) (Ministry of Health 2010) and also by Australia in the form of the Clandestine Drug Laboratory Remediation Guidelines (Guidelines) (Australian Crime Commission 2011).

These Guidelines also recognise that since there is variation across Australian jurisdictions in relation to illicit drug manufacturing processes, local practices and legal systems, the guidance would need to be customised by each authority into a form suitable for local application. Queensland, Victoria, New South Wales, South Australia and Western Australia have already released such guidance documents (see relevant web addresses in the Health Agency Information section).

To help further drive and focus the management process, enHealth has commissioned this paper to identify the nature and degree of potential public health risks associated with clan labs.

The paper does this by reviewing, for Australian circumstances (with reference to local data and overseas' experience), the likely character of clan lab contamination, the human exposures scenarios and the potential health effects associated with contaminant exposure, to try to arrive at an estimation of the real likely health effects.

Overview of Manufacture and Contamination

Clan Labs and Processes

There are a wide range of chemicals and therefore contaminants associated with clan labs, depending on the illicit drug involved, the production process, and the improvised materials used. Hundreds of different recipes may be used to manufacture common illegal drugs, resulting in an even greater number of possible chemical contaminants (Wright 2009). Contaminants may include precursor chemicals, process support chemicals, illicit drug products or by-products, and chemical production wastes.

The main illicit drugs made in Australia include amphetamine-type stimulants (ATS), 3,4-methylenedioxymethylamphetamine (MDMA or ecstasy) and pseudoephedrine (PSE)/ ephedrine extraction (for ATS manufacture). ATS production primarily consists of methylamphetamine, i.e. meth, speed or ice, but also covers other drugs such as amphetamine and phenethylamines including MDMA (unless specifically excluded as in this publication) (Australian Crime Commission 2015).

Table 2 provides a jurisdictional summary of the number of clan labs detected in Australia for 2014-2015 on the basis of the production method used (Australian Crime Commission 2015).

Table 2: Detected Clan Labs by Drug, Production Type and Jurisdiction 2014-15[#]

State/ Territory	ATS (excluding MDMA)					MDMA	Homebake Heroin	Other/ Unknown**	Total^
	Total	Hypo*	Red P*	Nazi/ Birch	P2P*				
NSW	74	65	3	1	4	10	0	14	**98**
VIC	74	56	7	3	5	4	1	79	**158**
QLD	80	71	6	0	3	2	1	155	**238**
SA	31	25	3	2	0	1	1	44	**77**
WA	67	5	4	58	0	0	11	12	**90**
TAS	5	3	1	1	0	0	0	0	**5**
NT	9	0	5	3	0	0	0	1	**10**
ACT	0	0	0	0	0	1	0	0	**1**
Total	**340**	**225**	**29**	**68**	**12**	**18**	**14**	**305**	**676**

Adapted from Australian Criminal Intelligence Commission (2016), noting discrepancies in its data

* Hypo = hypophosphorous method, Red P = red phosphorous method, P2P = phenyl-2-propanone method

** Other/unknown includes the manufacture of GHB/GBL, cannabis oil or pseudoephedrine extraction, presence of chemicals/glassware/equipment only and manufacture of other unknown illicit drugs or those awaiting analysis

^ Totals may be slightly inflated due to multiple methods used in some laboratories

Analysis of the Australian Criminal Intelligence Commission report plus other information provides the following relevant additional insights:

- The manufacture of ATS (i.e. methylamphetamine) still dominates clan lab detections in Australia, where the drug involved is known (82.5% for 2014-15). However, some uncertainty exists because of the increasingly high level of unknown methods associated with detections.

- The hypophosphorous and Nazi/Birch methods are the dominant methods of ATS manufacture in Australia, with the hypophosphorous method predominantly used in NSW, VIC, QLD and SA and the Nazi/Birch method predominantly used in WA.

- Detection trends with the less common illicit drugs or drug processes are hard to determine because there can be considerable annual and jurisdictional variation in these numbers.

- The laboratory size distribution was as follows: addict-based (smallest size, mainly for personal or close group use) 60.9%; other small scale 20.2%; medium size 12.9%; and industrial scale 5.9%. This represents a significant increase in addict-based labs from the previous year (from 51.6%), mainly at the expense of other small-scale and industrial scale labs.

- Large scale illicit drug production is more commonly associated with commercial/ industrial sites and primarily presents an occupational risk for incidental exposed groups. For these operations, there is the potential for the public to be exposed to waste that may be illegally dumped. In NSW about 50% of laboratories were categorised as medium to large scale.

- Most clan labs are either in or adjacent to domestic dwellings (68.4%). Other sites include vehicles (9.9%), public places (6.8%), rural areas (6.0%), commercial/ industrial buildings (4.2%), and other (4.7%). The main increases from the previous year were in public and rural places from 3.9% and 3.5% respectively, primarily at the expense of motor vehicles and other sites.

- A significant proportion of domestic dwellings involved may be part of public housing programs. See discussion below.

- Just over half the clan labs found related to stored or unused chemicals and equipment, with 25.7% of clan labs being associated with stored/used chemicals, 11.2% being a historical lab, and 11.5% being classified as an active lab.

- In domestic dwellings, wet areas (kitchens, laundries and/or bathrooms) are commonly used for manufacturing/cooking as they have hard surface work areas, a water and electricity supply, and sinks for disposal purposes. Other commonly used areas for manufacture include sheds and garages (Wright 2016).

- About 1 in 10 clan labs are thought to be detected in Australia, while others continue to operate until they are eventually abandoned or relocated (Newell 2008). The number may be higher than this as data from New Zealand indicates that 32% of frequent drug users in 2011 indicated that they cooked (or had an attempt at cooking) their own drugs (Wilkins et al. 2012).

Information available from the Western Australian Department of Health clan lab notification and management database system is also useful on a jurisdiction specific basis (Western Australian Department of Health, 2016). In the period from August 2012 to February 2016, 210 clan labs detections were reported, of which 65% were in residences (18% Government owned), approximately 30% were associated with bushland or vacant land; and about 5% were in industrial premises. In general agreement with the national data presented above, about 30% of labs found had or were associated with actual production at the site. The Nazi/Birch production method still dominated though the more recent appearance (2011-2012) of phosphorus methods continued to be observed in this data.

Of the clan labs reported in WA for the same period, 23% of all residential clan labs had children at the premises (average of 1.6 children in these premises) (consistent with observations reported by WA police (Wright 2016)) and about 3% of sites detected were related to fires or explosions.

Although WA has had a well-developed and enforceable clan lab notification and remediation system in place for 5 years, the level of remediation of the clan labs that are deemed to require remediation runs only at about 30-50%. For other parts of Australia which may not have comparable regulatory history or arrangements, the clean-up level may be much lower.

Therefore, although jurisdictions vary, the dominant type of clan lab in Australia consists of small scale methylamphetamine production in a residential setting using the hypophosphorous or Nazi/Birch methods.

NZ data from 2006 and 2008 (Fisher, Maxwell & Smithies 2011; Ministry of Health 2010; Newton 2007) reveals that: the majority (approximately 62%) of clan labs were methylamphetamine-related (where the production method was known); the phosphorus methods were most common with very few detected using the Nazi/Birch method; residential dwellings were most frequently used for manufacture, in particular rental properties; and approximately 33% of the labs detected had children resident. This indicates that clan lab similarities exist between New Zealand and Australia, particularly for methylamphetamine production processes and circumstances associated with the eastern Australian States.

Chemicals and Contamination Characteristics

Many of the multiple chemicals that can be used to make illicit drugs are toxic, flammable and/or corrosive. Wright (2009) has undertaken an assessment of illicit drug production in Australia, which provides part of the basis for the Guidelines. Wright (2009) has identified the main contaminants of concern as listed in Table 3, taking account of practical issues and toxicological factors. pH is included here to cover common corrosive materials such as sodium hydroxide and hydrochloric acid (also an airborne contaminant as hydrogen chloride).

Table 3: Clan Lab Key Chemical Contaminants (Wright 2009)

Methylamphetamine	Boron and compounds
MDMA	Mercury (inorganic)
Ephedrine and pseudoephedrine	Lithium
Ammonia	Benzaldehyde
Iodine	Phosphine
Bromide	Safrole and isosafrole
Phosphorous (acids) & red phosphorus	Chloroform
N-Methyl formamide	Dichloromethane
Methylamine	pH
Nitroethane	
Petroleum hydrocarbons Benzene, toluene, ethylbenzene, total xylenes, naphthalene, TPH# fractions	

#TPH=total petroleum hydrocarbon

Also NZ, which has similar clan lab-related issues to the eastern Australian States, has identified as key contaminants methylamphetamine, iodine, mercury (inorganic), phosphine, pH, benzene, toluene, xylenes, hydrogen chloride and lead (Ministry of Health 2010). The shortness of the list is based on the rationale that if these chemicals are remediated then other potential contaminants will also be removed.

A recent development in Western Australia (with no data available from other jurisdictions) was the detection of four labs of the total of 40 in 2015-2016, which were manufacturing N,N-Dimethyltryptamine (DMT) (Western Australian Department of Health, 2016). Risks associated with its production have not been evaluated yet because it was not captured in the national guidance (Wright 2009). However, since DMT is normally obtained by an extraction process from suitable plant material such as certain types of bark it may be less contaminating than a chemical reaction.

The most important contaminant in terms of public health risk and management is usually methylamphetamine. It is the most commonly produced illicit drug in Australia, can be detected using a range of sampling and analysis methods, is a persistent contaminant inside premises (Martyny, JW 2008b, 2008a), has the lowest derived clean-up threshold level in the Guidelines, and is also the main focus of clan lab remediation management efforts in the US and NZ.

The following points are important when determining the nature, in particular, of methylamphetamine contamination at an Australian clan lab site:

- Contamination often results from overheating chemical reactions, poorly managed extractions, and spills or dumping of chemicals (Newell 2013).

- The level of contamination depends on the processes and methods involved, scale and operational status of the lab, and duration and frequency of operation.

- The spread of contamination in a premises depends on the method of manufacture, the skill of the cook, internal layout of the premises and the use of ventilation fans and air conditioning systems (Wright 2016). Even after a single small “cook”, surfaces will be contaminated in both nearby and more distant areas, depending on the production method (Martyny, J 2007; Martyny, JW et al. 2007).

- For a given amount of drug produced there may be three to thirty times that quantity of chemical waste generated (Newell 2013). For methylamphetamine, the US Drug Enforcement Agency has estimated this to be five to seven times the amount of product (Horne 1997).

- Contamination can be transient or residual. Gases such as ammonia and phosphine are transient and only likely to be present in the air during or shortly after active drug production (Ministry of Health 2010). Vapours from liquids, such as solvents, can be retained in and be re-released to air from soft furnishings or surfaces for some time after clan lab operations cease (Australian Crime Commission 2011). With good ventilation, these vapours can be considered transient.

- Residues are more persistent and are usually in the form of surface deposits (salts), or liquids (methylamphetamine base oil or reagent chemicals) that remain on hard surfaces and have absorbed into porous surfaces or materials such as plaster board.

- During the manufacture of methylamphetamine using the hypophosphorous and Nazi/Birch methods the main chemicals of concern are airborne, specifically phosphine, hydrogen chloride, ammonia and methylamphetamine aerosols (Martyny, J 2007; Martyny, JW et al. 2007). Iodine may also be an issue for the red phosphorus production method.

- Methylamphetamine (including its salt) is usually the main contaminant after its production has ceased and can persist as a surface residue for months or years (Martyny, JW 2008a). It is generated as a reaction aerosol through the “salting

out" step (hydrogen chloride gas bubbling) commonly employed in the phosphorus and Nazi/Birch processes (Martyny, J 2007; Martyny, JW et al. 2007). These residues deposit onto all surfaces, both porous and non-porous. Contamination absorbed into porous materials, including gyprock walls, may desorb over time (Li 2014; Poppendieck, Morrison & Corsi 2015).

- Any gases or aerosols released are often likely to be initially contained in the building at high levels because the operators typically close-up the premises (i.e. limit ventilation) to avoid detection by escaped fugitive odours. However ventilation is commonly used to specifically vent localised production gases (sometimes into separate vessels) (Wright, Edwards & Walker 2016).

- Where ventilation fans and air conditioning systems are present these commonly have the highest levels of contamination. This can result in the ongoing spread of contamination throughout the premises (Wright 2016).

- Contamination may also be present in plumbing and septic systems resulting from the disposal of manufacturing waste

- For methylamphetamine production, the phosphorus reduction methods (hypophoshorous and red phosphorus) are generally substantially more contaminating than the Nazi/Birch method both to the air and on surfaces (Salocks, C, Golub & Kaufman 2009). This has generally been observed in data relevant to contamination levels in Australian homes, however, this does depend on the scale of methylamphetamine production (Wright 2016).

- Methylamphetamine contamination can also occur due to smoking ice, the drug's crystal form. Smoking involves heating (not burning) the drug to produce a vapour, which is inhaled. This results in the same mechanisms of methylamphetamine residue contamination as production (Martyny, JW et al. 2004b) and can cause methylamphetamine contamination in homes (Wright 2016).

- The extent and level contamination as a result of smoking ice is likely to increase with the general growth of methylamphetamine use in Australia (Australian Crime Commission 2015). Ice represents about 67% of methylamphetamine use, but the proportion smoked as compared to injected or snorted is uncertain (Australian Crime Commission 2015).

- Although contamination resulting from occasional ice smoking is not as "dirty" as production-related contamination, it adds to the contaminant loading, especially over time, and can affect other areas in the building.

- For other potential contaminants, limited data available from a controlled cook (Martyny, JW et al. 2004c) determined that metals were only present at very low levels and hydrocarbons were impractical to measure due to potential interference from household chemicals. In addition, methylamphetamine was considered a better indication of contamination risk than its starting materials, pseudoephedrine and ephedrine. The significance of these other chemicals is not well understood. However, intermediate products formed during the drug

synthesis, such as for the common hypophosphorous methods, where methylamphetamine hydro-iodide is a common contaminant from reflux reactions, include compounds such as iodine which may impact on endocrine function and have individual toxicity characteristics.

- For the less common MDMA clan labs, the contaminants of main concern (Wright 2009) include formamides and safrole/isosafrole during operations, and afterwards, residues of MDMA salts and safrole/isosafrole. The presence and persistence of these contaminants within an indoor environment is not known. For some processes liquid waste containing mercuric chloride can also present a significant hazard depending on where it ends up as the mercuric chloride settles out of the waste solution and persists as a finely divided powder like residue which is highly respirable if disturbed.

- Environmental contamination of water and soil can occur from the burning or dumping/burial of waste or through use of outdoor areas for production. Sodium hydroxide waste is one such hazard and since it is usually present as a solid it will tend to remain on the soil surface, though possibly infiltrating with rain water into soil over time.

- Fires and explosions within clan labs can result in dwelling and environmental contamination, and are commonly how many clan lab activities are initially discovered (Martyny, J 2007; Wright 2016; Wright, Edwards & Walker 2016).

Consequently, there will always be some contamination associated with a clan lab operation, and in most cases, it will persist in buildings as methylamphetamine residues. These residues will also be present from the smoking of ice, although normally to a much lesser extent. The remainder of this document will therefore focus on methylamphetamine as a source of public health risk. Other contamination concerns will also be addressed where appropriate.

Contaminant Levels

Information on the level of methylamphetamine contamination that remains in former clan labs is available for 100 homes in Australia (Wright 2016) that relate to the hypophosphorous, red phosphorous and Nazi/Birch methods. This only relates to those labs that had been operational at some stage, not simply storage sites. Data is also available from controlled cooks (i.e. simulated cooks inside homes) from Colorado and from suspected clan labs in the US. Table 4 presents a summary of the range of methylamphetamine concentrations reported in different areas of homes evaluated in these studies, while not specifying where the production was located if known.

The available data on the level of contamination that may remain in Australian homes used as a clan lab indicates the following (Wright 2016):

- The range of methylamphetamine surface residues reported in homes evaluated in Australia are generally consistent with the range reported in former clan labs and homes used for controlled cooks in the US.

Table 4: Summary of Methylamphetamine Surface Residues in Former Clan Labs

Location/Activity	Range of Methylamphetamine Surface Residue Reported (µg/100 cm^2) (note: HIL is 0.5 µg/100cm^2)	References
Data from Australian Premises (various methods commonly used in Australia, prior to remediation)		
Walls and surfaces within: kitchen including benches dining/family room lounge room bedrooms bathrooms entrance hall/foyer study/sun-room laundry upstairs (production on ground floor) shed/garage	 0.05 to 791 0.03 to 460 0.02 to 179 0.02 to 260 0.03 to 320 0.03 to 27.7 0.05 to 100 0.03 to 65 0.09 to 71 0.04 to 1400	(Wright 2016)
Ventilation and fans (including kitchen range hood)	0.13 to 5171	(Wright 2016)
Kitchen Appliances (microwaves, burners, ovens, refrigerators	0.25 to 180	(Wright 2016)
Roof space	0.2 to 12.8	(Wright 2016)
Neighbouring unit or house (not used for manufacture)	0.14 to 3.1 (<1% maximum in unit used for manufacture)	(Wright 2016)
Data from Seized and Suspected Laboratories (cook methods not specified)		
Walls and surfaces that include benches, tables, floors, indoor fans, appliances	0.1 to 6093 to 16000 after explosion	(Gaynor et al. 2007; Martyny, JW et al. 2004c; Martyny, JW et al. 2007; McKenzie, Miskelly & Butler 2013)
Ventilation and fans (including kitchen range hood)	0.2 to 450	(Martyny, JW et al. 2004c)
Kitchen Appliances (microwaves, burners, ovens, refrigerators	nd to 16000	(Martyny, JW et al. 2004c)
Data from Controlled Cooks - Red phosphorous, hypophosphorous and Nazi/Birch methods		
Various surfaces	0.08 to 860	(Martyny, JW et al. 2004a; Martyny, JW et al. 2004c; Martyny, JW et al. 2007; Martyny, JW et al. 2005a; Martyny, JW et al. 2005b; VanDyke et al. 2009)

nd = not detected (variable analytical limits or reporting)
HIL = Health Investigation Levels as presented in the Guidelines

- In general, the maximum concentrations reported from the hypophosphorous or red phosphorous methods are higher than for the Nazi/Birch methods, however this is property specific. The large-scale manufacture of methylamphetamine using the Nazi/Birch method can have contamination levels higher than small scale manufacture using the hypophosphorous method.

- There are number of areas where the range of methylamphetamine surface residues varies significantly, in some cases in the order of 10,000. This reflects

the highly individual nature and spread of contamination that is present in each of the properties.

- Where the location of manufacture was known (or suspected) this generally correlated with the location of highest contamination.

- The level and spread of contamination is specific to each individual property. However, it is noted that air conditioning or other room ventilation is associated with significant spread of contamination in a home.

The study by Martyny *et al* (Martyny, JW et al. 2004b) evaluated methylamphetamine contamination due to smoking the drug. The research found that after two "regular" smokes (simulated pipe, 100 mg dose, assumed 90% body absorption), the mean surface contamination of adjacent areas can be 0.07 μg/100cm^2. Even with multiple smokes these levels were considered likely to remain lower than for "cooks". Injection remains more common in Australia than smoking, at least for hard core methylamphetamine users (McKetin et al. 2012; Stafford & Breen 2016), however the prevalence of smoking may be changing. This is indicated by recent change in the preferred form of methylamphetamine from powder to crystal ("ice" which is usually smoked) (Australian Crime Commission 2015). The ease of obtaining ice has increased (Australian Crime Commission 2015) with record seizures of ice being reported, for instance 585 kg in Sydney in February 2013, accompanied by a significant reduction in heroin seizures.

The above results provide the best available indication of residual methylamphetamine contamination levels in former Australian clan labs. However, the level and spread of contamination in former clan labs will be variable and specific to the individual property.

Exposure Considerations

Contamination becomes a potential health risk when humans are exposed to hazardous contaminants. The nature, extent and duration of exposure will depend on a number of different factors as outlined below, including clan lab factors (status and location) as well as exposed groups involved.

Clan Lab Factors

Clan labs are likely to cause the highest levels of contaminant exposure to occupants when the cooking process is occurring, although this may be of a short duration compared to exposure to residues remaining after operations have ceased.

Clan labs that remain undetected continue to have this exposure profile. Once clan labs are detected the subsequent exposures will be dominated by exposure to residual surface contamination until remediation occurs.

The greater the clan lab scale, lifetime and frequency of operation, then the larger the potential for contamination and exposure. While such factors will vary, addiction based methylamphetamine clan labs (most common in Australia) normally produce no more than 3 grams of drug per production run. Based on this figure and common drug use

patterns (McKetin et al. 2012), many clan labs might operate on a weekly or fortnightly frequency.

Over time, contamination associated with any clan lab will decrease through dispersion, dilution and degradation, if not regenerated. However, if the initial contamination was high, contaminant levels of concern may potentially remain for many years. Published cases from Australia and the US have shown significant exposures and health effects occurring following exposure to residues that persisted for more than two to five years (New York Times 2009; Wright 2016; Wright et al. 2017).

Contamination levels, and hence exposure potential, have been shown to be greatest where the clan lab operations specifically took place (Wright 2016). This may be particularly important if it happens to coincide with a much used communal area. As indicated previously, wet areas are most common locations, especially kitchens (where there is also food preparation) that can result in even further potential for exposure.

The spread of contamination in a premises has also been demonstrated for a significant number of properties, which has the potential to result in exposures in all rooms and areas (Wright 2016).

Exposure from illicit drug processes conducted or materials spilt or disposed of in residential yards and public areas is very difficult to estimate because of the great variation in where, what and how this has occurred, as well as in the possible activity patterns of potentially exposed groups. The WA clan lab data previously discussed indicated that in recent time, about 30% of sites were bush or vacant land, and also 14% of sites were residential yards (WA Department of Health 2016). So, for WA during that period, the potential for environmental contamination and exposure frequently accompanied clan lab finds.

Exposure in such environmental situations would most likely be significant in the case of residential yards due to a greater opportunity for closer and prolonged personal contact. This exposure may more likely occur if visual indicators are not good or some bulk chemicals remain due to practical problems for their removal by police, for instance if mixed in with soil. Even so, exposure is likely to be less in most cases than for contamination within residences, where people spend much of their time and in an enclosed space (enHealth 2012a).

Another environmental exposure situation could be if the contaminant ends up in ground or surface water intended for human use. Again, this is hard to predict or estimate.

Exposed Groups

Clan lab operators or “cooks” are typically exposed to contamination, during and as a result of any manufacturing (Martyny, J 2007). Where “cooks” are also drug users, the intake of methylamphetamine during manufacture is reported to result in an enhanced high (Wright 2016).

A major population of concern are the other (non-cook) occupants of a clan lab dwelling used for manufacture. These people, usually family members and including children

and infants, may be less directly exposed to contaminants released during production but are exposed to some residual contamination. These occupants, especially the children, may not be exposed by their own volition.

US, Australian and NZ experiences indicate that about 20% to 33% of methylamphetamine lab detections have children associated with them, and in many cases there could be several children involved (AAP 2011; Martyny, J 2007; Ministry of Health 2010; WA Department of Health 2016; Wright 2016). Based on this, and the clan lab occurrence data presented earlier, each year there may be several hundred additional children found to be associated with detected clan labs in Australia and possibly several thousand children involved with undetected labs on an ongoing, if variable basis.

Children considered to be exposed the most are those in the six month to two year age group, due to their high contact time with the floor and level of hand/object-to- mouth (pica) behaviour (Salocks, C.B 2009). Toddlers are also likely to remain in the dwelling on a more continuous basis. This age group (0-2 years) represents about 20% of children (0-14 years) that may be present, extrapolating from Australian Bureau of Statistics data (ABS 2011). In addition where children are present in clan labs or the homes of drug users, they are exposed to significant risks from abuse, neglect and other adverse influences which may exacerbate any effects from contaminant exposure (Bratcher, Wright Clayton & Greeley 2007).

The number of potentially exposed adults will be even greater than that for children. Western Australian data for 2012-2016 indicates an average of 2.4 adults for each detected clan lab in a residence (WA Department of Health 2016).

If people move into a dwelling after clan lab operations cease they are most likely to be unaware of these previous illicit operations. These individuals may have family members who include infants and young children, are pregnant, elderly, frail or have compromised health, placing them at increased risk. Methylamphetamine contamination may persist for years on all surfaces in the home, including within the building materials. As a result, there is also the potential for exposures to occur during renovation activities. These exposures may occur in a dwelling that has not been remediated as well as a dwelling where remediation has only addressed contamination on accessible surfaces at the time of remediation.

Other groups that may be exposed to contamination are visitors to the clan lab site, and people involved in regulatory or remediation activities of detected labs. Visitors, such as friends, relatives, tradesmen and real-estate agents, are only likely to have transient incidental exposure. However, some higher exposure scenarios do exist such as tradesmen working in a contaminated confined area such as a roof space.

Although regulatory officers may be exposed to the contamination for a short time, they would be expected to take precautionary measures and wear appropriate personal protective equipment. Such exposure would be occupational rather than public health related.

Any exposure to neighbours is likely to be low except possibly from clan lab fires, explosions or occasional fugitive gases during operations, backyard chemical dumping, or in high density housing situations.

Exposure Routes

Common exposure routes of inhalation, skin contact and ingestion to clan lab contamination vary in importance with the operational circumstances (i.e. whether exposure occurs in an operational lab or a former clan lab), the nature of the contamination that remains, the level of contamination, risk population and situations, such as building layout and location.

Inhalation exposure can occur as a result of gas and aerosol release during and shortly after production. Methylamphetamine can also be regenerated as an aerosol hazard if its residues are disturbed the following day or beyond, particularly as a salt, or redistributed through domestic cleaning or professional remediation and use of contaminated ventilation systems. When generated during manufacture, methylamphetamine aerosols have been found to be less than 0.1 μm in median aerodynamic diameter and therefore these aerosols are able to penetrate deep into the lungs, from where it can be absorbed into the bloodstream (Martyny, JW et al. 2005a).

The main route of exposure is considered to be direct contact with residues on surfaces, through dermal contact (i.e. absorption through the skin) and to some extent contaminated hand/object-to-mouth behaviour especially for children (Salocks, C.B 2009). This is particularly relevant in former clan labs where remediation has been completed and it is assumed that inhalation exposures are of less significance (Salocks, C, Golub & Kaufman 2009).

Exposure Studies

A limited number of studies are available that specifically characterise exposures that occur within clan labs. The available data indicates the following:

- During controlled (simulated) “cooks” methylamphetamine levels ranging from 0.2 to 580 μg/100 cm^2 have been reported on the clothing or skin of individuals involved in the manufacturing process (Martyny, JW 2008b; Martyny, JW et al. 2004a; Martyny, JW et al. 2004c; Martyny, JW et al. 2007; Martyny, JW et al. 2005b).

- Following a “cook” in a home, levels of methylamphetamine reported on the clothing or skin of police, firefighters, children or a simulated crawling child range from 0.14 to 56 μg/100 cm^2 (Martyny, JW 2008b).
- Approximately 35% to 73% of biological samples, as urine and/or hair samples collected from children exposed to ATS in the home (from adult drug use or manufacture), reporting positive detections results are related to methylamphetamine, amphetamine, pseudoephedrine and/or ephedrine exposures (Bassindale 2012; Department of Justice 2002; Grant 2007; Grant et al. 2010; Keltner, Chervenak & Tsongas 2004; Mecham & Melini 2002; Messina et al. 2007; Oregon Department of Human Services 2003).

- Hair analysis of a child injured from the ingestion of caustic liquid (drain cleaner) in the US (where methylamphetamine was manufactured in the home) reported detections of methylamphetamine (1.7 ng/mg) and amphetamine (0.16 ng/mg)

(Farst et al. 2007).

- Hair analysis data from New Zealand (Bassindale 2012) from children removed from clandestine drug laboratories reported 73% detection of methylamphetamine in hair above 0.1 ng/mg, and low level detection (10%) of methylamphetamine determined to be present from external contamination/ deposition (i.e. in the hair wash). The levels of methylamphetamine reported in the hair of children ranged from 0.1 to 131 ng/mg, with higher concentrations reported in children under 5 years of age.
- Hair analysis of 2 young children, aged 7 and 8 years, exposed in a former clan lab in Australia for a period of approximately 18 months, with indoor surface methylamphetamine residue levels between 11.7 and 26 μg/100 cm^2, reported levels in hair of 0.33-0.46 ng/mg for methylamphetamine and 0.016 to 0.02 ng/mg for the major metabolite amphetamine (Wright 2016; Wright et al. 2017).

Therefore, given the numbers of detected and possible undetected clan labs in Australia, and their propensity for contamination, as well as evidence of personal contamination, it is likely that many people have been exposed to methylamphetamine and/or other hazardous chemicals to some extent over their lifetimes.

Potential Health Effects and Toxicity

There is now a reasonable body of information on the health effects of methylamphetamine in humans due to the fact that it has been a drug of abuse for many years and also used therapeutically for weight loss programs and to treat Attention Deficit/Hyperactivity Disorder (ADHD) in children. However, these do not fully cater for possible clan lab exposure scenarios such as longer term low level exposure to all subgroups of the relevant population. Health effects information on many of the other contaminants of concern derives from incidental exposures or animal studies.

Generally, children are considered more susceptible than adults to adverse effects from chemical toxicants due to their developing physiology, especially their central nervous systems. These developmental risk factors also apply in regard to pregnant women given that methylamphetamine will cross the placental barrier and adversely impact on the developing foetus (Ganapathy et al. 1999).

The most detailed and relevant Australian publication about the health effects and toxicity of clan lab contaminants is that of Wright (Wright 2009, 2016; Wright, Edwards & Walker 2016) which focuses on the contaminants listed in Table 3, and provides more specific information related to methylamphetamine exposures. Another very useful reference is the New Zealand Ministry of Health's Guidelines (Ministry of Health 2010). Wright et al (2016) identifies three temporal classes of health effects from clan lab operations, being immediate, acute and chronic.

Immediate Exposure Effects

Immediate exposure health effects can result from sudden releases of toxic material, explosions or fire which in some instances may pose an immediate threat to life or long term disability particularly from the respiratory effects of corrosive or poisonous gases or from large scale tissue damage. Up to 20% of clan labs in residences both in

Australia and the US may be identified as a result of an explosion or fire (Roper 2007).

Acute Exposure Effects

Acute exposure effects may result from short-term (for instance hours or days) high level exposure to toxic chemicals usually generated coincidentally due to poor safety practices during the production process. This is also likely to involve gases or aerosols and depending on the chemical, could produce a range of effects such as eye irritation and respiratory effects. In Australia, the main compounds of concern are methylamphetamine, phosphine, ammonia and hydrogen chloride as mentioned above.

Methylamphetamine aerosols can potentially produce physiological and psychological effects, especially for naïve exposure groups. Effects may include skin, eye and respiratory irritation as well as dizziness, headache and insomnia (Ministry of Health 2010; Wright 2016). Drug users involved in the manufacture of methylamphetamine commonly do not use protective equipment, to enable them to experience a drug high during the “cook” (Wright 2016).

Martyny (Martyny, J 2007) states that phosphine may cause severe pulmonary irritation resulting in pulmonary oedema and death. At lower levels it may cause nausea, vomiting, headache and chest tightness (Ministry of Health 2010).

Ammonia and hydrogen chloride are both corrosive gases which will affect the eyes and respiratory track with damage increasing with concentration, possibly resulting in pulmonary oedema and death.

Chronic Exposure Effects

Chronic exposure effects may be due to longer term exposure (weeks, months or years) to lower contaminant levels. Much of the information available on chronic exposures to methylamhetamine is derived from therapeutic and illegal drug use, not from environmental exposures.

Methylamphetamine, the most likely persistent residue in Australia, is a powerful stimulant which can produce central nervous system effects (Ministry of Health 2010). The most significant effects related to methylamphetamine exposure, based on data from drug use and therapeutic drug use, include (Wright, Edwards & Walker 2016): neurochemical changes in areas of the brain that are associated with learning, potentially affecting cognitive function, behaviour, motor activity and changes in avoidance responses; psychotic, physiological and behavioural/ developmental effects that include violent behaviour, depression, irritability, hallucinations, mood swings, paranoia, mood and sleep disorders. Prolonged exposure to methylamphetamine also causes cardiovascular effects including increased heart rate, blood pressure and at higher or sustained exposure, chest pain, hypertension and the risk of stroke (Ministry of Health 2010). Exposures to chemicals involved in the manufacture of methylamphetamine are associated with chronic health effects that include (Wright, Edwards & Walker 2016) cancer and effects on respiratory, renal, hepatic, neurological, developmental and reproductive systems.

For external disposal areas associated with clan labs, e.g. house yards, human exposure (acute or chronic) may also result from the dumped contaminants, either by direct contact *in situ* or through local water supplies if they become affected. Sodium hydroxide is such a chemical of health concern, as it is highly corrosive and can be hazardous by skin contact or incidental ingestion. Additionally, the dumping of mixed sodium hydroxide and ammonium sulphate wastes pose a risk from ammonia evolution if they become wet.

It is also probable that multiple chemical exposures may occur which may modify, in uncertain ways, the likely significant effects of dangerous gas and/or methylamphetamine exposure.

Level of Health Risk

Although it is widely agreed that clan lab contamination represents a public health risk that needs to be managed there is limited information on the health effects and level of risk. This may be due to the complexity of the issue as well as the legal, ethical and practical considerations associated with obtaining this data.

It is worth noting that even where the exposed population does present with physiological or psychological conditions, these may be the result of some other cause and cannot be readily ascribed specifically to clan lab-related exposures especially for low contaminant levels. However, some data is available that provides evidence of exposure and a range of health effects which have been consistent with those associated with exposures in former clan labs.

Health Evidence

Clan Lab Operation

In the US, New Zealand and Australia, it has been reported that many people, especially cooks, have been killed or severely injured as a result of clan lab explosions (Caldicott et al. 2005; Martyny, J 2007; Ministry of Health 2010).

Acute effects during clan lab operation are not well documented probably due to the unwillingness of affected people to seek medical aid or reveal the cause. Australian and US hospital data shows frequent cases of chemical and thermal burns as well as acute inhalation injuries, particularly among operators, many of whom require higher levels and longer duration of treatment when compared to other burn injuries (Wright, Edwards & Walker 2016).

Nearly a quarter of all clan lab detections were associated with human injuries, again often associated with chemical as well as thermal burns. Simulated cooks have shown ammonia, hydrogen chloride and phosphine air levels up to three times those that may pose an immediate risk to life (Martyny, JW et al. 2004a; Martyny, JW et al. 2007; Martyny, JW et al. 2005b; NIOSH 1995; VanDyke et al. 2009).

Data from the Environmental Protection Information Centre National Clandestine Laboratory System database indicates that 700 children out of 2028 found at clan labs in the US in 2001 had tested positive for toxic levels of chemicals, with no further detail

provided (Caldicott et al. 2005).

The most common acute adverse health effects reported by first responders attending methylamphetamine laboratories include: chemical burns; collapse; abdominal pain; headache; respiratory irritation and effects (including breathlessness, bronchitis, cough, emphysema, pneumonia and wheezing, and decreased lung capacity); skin irritation; central nervous system effects and mood swings (Wright, Edwards & Walker 2016). However, first responders would be exposed to lower levels than the operators and many of the occupants due to the responders' less direct exposures and likely use of safe practices.

Children removed from homes where methylamphetamine has been manufactured have been reported (Wright, Edwards & Walker 2016) to display a range of behavioural issues, allowing for their socio-economic circumstances, including academic difficulties, developmental delay, a higher incidence and risk of externalising (acting out) problems, aggressive behaviour, post-traumatic or dissociative symptoms and internalising problems. In addition, children in environments where methylamphetamine is used or manufactured can also be exposed to a wider range of other chemicals, neglect, criminal behaviour, abuse (emotional, physical and sexual) that place these children at risk of developmental, behavioural and other mental health problems (Wright, Edwards & Walker 2016).

Exposures in Former Clan Labs

There have been reports of people, including children, exposed to/living in un-remediated labs with throat irritations, skin irritation and burns, nausea, respiratory difficulties and headaches (New York Times 2009; Wright, Edwards & Walker 2016).

Case studies related to individuals and families exposed to environmental methamphetamine contamination from former clan labs have consistently reported (Wright 2016) respiratory issues and behavioural changes, particularly in children. Other effects commonly reported include skin rashes, sore and watering eyes (potentially associated with respiratory problems and increased susceptibility to infections), sleep disturbance, headaches and dizziness (Wright 2016).

One of these case studies (Wright 2016; Wright et al. 2017) provides co-located data related to environmental contamination levels in a home that was a former clan lab, levels of methylamphetamine and amphetamine in the hair of all family members exposed in the home, and adverse health effects reported. While these data are limited the data show the following (Wright 2016; Wright et al. 2017):

- The level of methylamphetamine reported in the hair of children aged 7 and 8 years of age indicate a significant level of intake from the home, approximately 330 to 8000 times higher than the acceptable intake (discussed below).

- These intakes were associated with respiratory and behavioural issues, particularly for the youngest child. Other effects reported by the family included skin and eye irritation, sleep disturbance and dizziness.

- Surface residue data collected from the home reported methylamphetamine levels that ranged from 11.7 to 26 μg/100 cm^2 approximately 23 to 52 times higher than

the guideline, based on meeting the acceptable intake.

The above health effects are consistent with those reported in other case studies (Wright 2016) where environmental methylamphetamine residue levels were reported in the range 0.02 to 42 μg/100 cm^2.

While these data are limited they suggest the higher levels of methylamphetamine intake than would be calculated on the basis of the exposure assumptions used in the derivation of the Australian remediation criteria (Wright 2009). The following section provides further discussion on the toxicity data considered in the derivation of the Australian remediation criteria.

Non-Effect Levels

In the absence of adequate data as to what level of clan lab contamination will produce a health effect, authorities in the US, Australia and NZ have developed clan lab contamination criteria for a range of chemicals, below which a health effect is unlikely.

Most of this work has been done on methylamphetamine, although Wright (2009) has also derived these criteria, termed Health Investigation Levels (HILs) for the chemicals listed in Table 3. HILs have also been derived for a range of exposure routes and different clan lab situations, e.g. occupational and environmental settings.

Only the data on methylamphetamine contamination in conjunction with its surface HIL allows for some risk estimates to be made, primarily for longer term exposure. In this way methylamphetamine is used as a surrogate in managing risks of other clan lab contaminants because of its low threshold for effects and its predominance as a clan lab contaminant (Ministry of Health 2010; Queensland Department of Health 2012; Victoria Health 2012; WA Health 2012; Wright 2015).

In the US, the methylamphetamine clean-up criteria varies amongst States from 0.05 to 1.5 μg/100cm^2 for surface contamination, with 0.1 μg/100cm^2 being the most common (USEPA 2013). Most of these are feasibility and not risk-based. The value of 0.1 μg/100cm^2 was chosen because it is still analytically measurable but low enough to ensure health effects will not occur despite the uncertainties.

Salocks (Salocks, C, Golub & Kaufman 2009; Salocks, C.B 2009) and Wright (2009) have used standard proven health-based risk assessment methodologies, for California and Australia respectively, in deriving HILs for surface methylamphetamine contamination for clan labs.

As a first step Salocks et al (2009) developed a prolonged exposure (four month) reference dose (or tolerable daily intake) of 0.3 μg/kg/day. This was based on the lowest exposure level producing an adverse side-effect from sub-chronic studies associated with therapeutic use, and then dividing it by a composite 300 uncertainty factor related to influences such as variation in individual susceptibility (10 fold), extrapolation from low to no effect level (10 fold) and for a limited data set (3 fold). This intake is significantly lower than that associated with illegal drug use (typically ranging from 15 to 150 mg/day depending on tolerance and route of administration) and therapeutic drug use (typically in the range 10 to 40 mg/day).

There are limitations associated with the use of data from therapeutic drug use, which may or may not be relevant where the data is used to address effects in all members of the population (i.e. individuals not requiring any therapeutic use or effects).

The reference dose was considered relevant to sub-chronic exposures, not chronic exposures, based on the assumption that remediation has been completed and residual levels will continue to decline such that the duration of exposure is limited. A sub-chronic exposure assumes exposures occur up to 10% of a person's lifetime. Such an assumption may not be appropriate in dwellings where high levels of contamination remain and no remediation has been undertaken. For these properties, methylamphetamine residues have been found to remain for a number of years.

Subsequently, Salocks (Salocks, C.B 2009) determined the HIL for methylamphetamine to be 1.5 µg/100cm^2 based on the most susceptible exposed population being six months to two year old children. Despite the risk basis methodology for this level, there has been some criticism that some of its assumptions may have led to a higher figure (Ministry of Health 2010). The HIL methodology assumed that remediation would be undertaken resulting in no ongoing reservoirs of contamination, and therefore that no exposure greater than four months or exposure to re-suspended methylamphetamine particulate material would occur.

Wright's (2009) value was 0.5 µg/100 cm^2 using the same toxicology data and general approach but with a more conservative exposure model, which is described as a "Reasonable Maximum Exposure" scenario. This value was adopted in the Australian Guidelines. The Guidelines adopted the tolerable daily intake of 0.3 µg/kg/day described above as well as the assumption that inhalation indoors is not a significant exposure pathway. NZ has also adopted 0.5 µg/100cm^2 as its clean-up level (Ministry of Health 2010).

Ideally a guideline that is protective of the health of all members of the public should have a sufficient level of safety such that minor exceedances of the guideline should not give rise to adverse health effects (enHealth 2012b; NEPC 1999 amended 2013). Rather an exceedance should be considered to be a trigger for further, more specific/detailed, evaluation of risk (enHealth 2012b; Renwick & Walker 1993). In practice the HIL is used invariably in Australia as a remediation standard because it is much easier and cheaper than conducting a detailed risk evaluation.

Since the development of the Australian guidelines, more information is now available in relation to the intake of methylamphetamine by children in un-remediated former clan labs (Wright 2016; Wright et al. 2017) and the dermal transfer and absorption of methylamphetamine residues (Salocks, C. B. et al. 2014; Salocks, C. B. et al. 2012; Van Dyke, Martyny & Serrano 2014). No new or additional toxicity studies are available that relate to environmental exposures, however the assumption about intake as a result of sub-chronic exposures in un-remediated or undetected clan labs may require further review.

Contaminant and Effect Levels

The level at which methylamphetamine contamination will produce a health consequence is not known and will likely vary based on circumstances. However, the higher the level the greater the likelihood and potential severity of health effects.

As stated above, contaminant levels and the spread of contamination throughout a property, while present to some degree in all clan labs, vary considerably and are situation dependent.

Health effects have been associated with environmental exposures in former (un-remediated) clan labs in Australia and New Zealand where methylamphetamine surface residues reported range from 0.01 to 42 μg/100cm^2 (Wright 2016). Average methylamphetamine surface residue levels in the individual homes where adverse health effects have been reported ranged from 5.8 to 18.6 μg/100cm^2 (Wright 2016). These contamination levels are between approximately 10 and 40 times higher than the Australian guideline. These exceedances are within the uncertainty (or safety) factors incorporated into the acceptable intake adopted in the development of the guideline (which is 300-fold). However data from hair analysis, for children exposed in one of these homes, suggests actual intakes may be 330 to 800 times higher than the acceptable intake (Wright 2016; Wright et al. 2017), which is greater than the uncertainty factors incorporated into the acceptable intake. These intakes exceed the lowest adverse effects levels seen in small exposure studies for certain human populations, namely weight loss for some pregnant women (0.08 mg/kg/day) and sleep disturbance for some children (0.2 mg/kg/day) (Salocks, C, Golub & Kaufman 2009).

Data on contamination levels in former clan labs in Australia indicates the average methylamphetamine levels in individual homes is 8.5 μg/100cm^2 where the Nazi/Birch method was used, 53.4 μg/100cm^2 where the hypophosphorous or red phosphorous method has been used and 555 μg/100cm^2 where the P2P method has been used. The maximum level of methylamphetamine contamination in these homes ranges from 0.1 to 5171 μg/100cm^2, with an average maximum level reported from each home of 208 μg/100cm^2. These contamination levels are, on average, substantially higher than those noted above where adverse health effects are expected to be observed.

For higher levels of contamination there is potential for greater frequency and severity of these effects and also other adverse effects to emerge, such as to the central nervous and cardiovascular systems. Hence where there are exposures to un-remediated clan labs there is the potential of populations being exposed to levels where adverse health effects are likely.

Adverse health effects have also been associated with exposures in a formerly remediated clan lab, where contamination was disturbed through renovation activities (Wright 2016). Where remediation involves only treating surface contamination, including the repainting of surfaces, renovation activities can result in remobilisation of contamination to a level that exceeds the current Australian guideline where adverse health effects can occur.

In the case of the much greater number of **undetected** clan labs the risks to occupants and others visiting the residence will be substantially higher because prolonged exposure at resulting higher levels is expected to occur and also can involve the

harmful gases associated with the manufacturing process. Furthermore, bulk chemicals may still be present on-site. People associated with undetected clan labs may be subject to two or more times the duration/ dose exposure level than would be found with people from “busted” labs, taking account of the above considerations especially clan lab operational timeframes (e.g. on average, a bust may halve these time frames).

In the case of environmental contamination, especially from dumped chemicals, the level of contamination *in situ* is likely to be well above effect levels at least for acute acting chemicals like sodium hydroxide.

Health Risk Estimation

As previously stated it is likely that many hundreds of children (about 10% toddlers) have/are being exposed to clan lab contamination and this is likely to be in terms of thousands if undetected clan labs are included (assuming a 1:10 ratio). The corresponding numbers of adults including other sensitive groups are likely to be even higher.

As many people may be exposed to methylamphetamine greatly above the HIL level, and often above levels recently associated with adverse effects (Wright 2016), it is likely that significant proportions of them may be suffering some health effects ranging from subtle to more severe. These effects are likely to be greatest for groups associated with undetected labs, followed by un-remediated ones. However, this data will be largely unrecognised and unreported.

It is worth noting that the usually more contaminating phosphorus-related methylamphetamine production methods (average methylamphetamine level 53.4 $\mu g/100cm^2$) which predominate in QLD, NSW, VIC and SA clan labs suggest that their exposed populations may be at a more likely and greater risk than those in WA where the Nazi/Birch reduction method is dominant (average methylamphetamine level $8.5\mu g/100cm^2$). However similar health risks are present for Nazi/Birch methods where larger (quite rare), long-term labs may be present. From 2010-2011 to 2014-2015, use of the phosphorus-related methods grew from approximately 50% to 75% of the total ATS (excluding MDMA) clan labs detected.

Although other inter-jurisdictional clan lab differences exist, these are often on the margins of the available data and reliability can vary from year to year (for instance the production of MDMA, and also of methylamphetamine by the P-2-P method) (Australian Crime Commission 2015).

Table 5 shows some speculative population sizes associated with clan lab activity and the possible corresponding level of risk. This is in terms of occupants of residences that have been used as clan labs, being the situation of most public health concern. It makes use of the clan lab quantitative data outlined earlier in the document, is for a one year period and assumes an average of three people per residence, and that about one third had contaminating operations at some time. Numbers will obviously grow with time. The level of uncertainty in the risk ratings will be greatest for the undetected clan labs.

Table 5: Exposure Group Possible Risk Ratings

Exposure Group	Potential Population Size	Risk Rating*
Detected clan labs		
Remediated, post-operation#	About 200	1 to 2**
Un-remediated, post operation#	About 600	3 to 4***
Operational phase	About 800	5
Undetected clan labs		
Operational phase	Up to10,000	5
Post-operational	Up to10,000	4
Methylamphetamine contaminated home (smoking use)		
Un-remediated##	10,000s	2 to 3

* Risk is simply rated in order 1 (low i.e. even minor effects to susceptible groups unlikely) to 5 (highest i.e. minor or major health effects possible even for healthy adults)

** Range of risk based on the level of remediation undertaken. Remediation that only addresses surface contamination may leave contamination that can be remobilised during renovations

*** Range of risk based on the method of manufacture and scale of operations

Assumes the current low level of remediation activity in Australia (taken to be around 25%)

No properties assumed to be remediated as there are no programs in Australia to identify and address these properties

It is worth noting that up to one third of each population may be children. Also, some groups may be involved in more than one exposure scenario.

The emphasis of this paper has focused on methylamphetamine production and exposure as a source of risk and primarily relates to typical situations in non-workplace settings. The risks associated with other clan lab manufacturing methods and chemicals and possibly more severe circumstances are much harder to estimate but likely to be less common. Potential occupational and environmental exposures are considered to be a lesser concern as they are less likely to result in significant exposure when they occur.

However, it is apparent that thousands of Australians are at some level of incidental public health risk, and likely many are already suffering effects, from the illicit operations of clan labs, and this continues to increase. It is also likely that tens of thousands of non-users in premises where ice has been smoked are also at some level of incidental public health risk.

Health Agency Information

For NSW, Local Government has the role of regulator for clan lab contamination.

ACT Health Directorate, Health Protection Service

Phone: 02 62051700 Email: HPS@act.gov.au

New South Wales Health

Phone: 02 9391 9000

NSW Division of Local Government

Phone: 02 44284100 Email: dlg@dlg.nsw.gov.au

Website or link:
http://www.dlg.nsw.gov.au/dlg/dlghome/dlg_index.asp

Clandestine laboratory guidance

Website or link:
http://www.health.nsw.gov.au/environment/hazard/Documents/clan-lab-guidelines.pdf

Northern Territory Department of Health, Environmental Health Branch

Phone: 1800 095646

Website or link:
www.nt.gov.au/health/envirohealth

Queensland Department of Health, Environmental Hazards, Hazard Protection Unit

Phone: 07 33289310 Email: environmentalhazards@health.qld.gov.au

Website or link:
http://www.health.qld.gov.au/ph/documents/ehu/fs-illicit-drug-lab.pdf

South Australian Department of Health, Public Health Services

Phone: 08 82267100 Email: public.health@health.sa.gov.au

Tasmanian Department of Health and HumanServices, Public and Environmental Health

Phone: 1800 671738 Email :public.health@dhhs.tas.gov.au

Website or link:
http://www.dhhs.tas.gov.au/peh

Victorian Department of Health and Human Services, Environmental Public Health

Phone: 1300 761874 Email: environmental.healthunit@health.vic.gov.au

Website or link:
https://www2.health.vic.gov.au/public-health/environmental-health/environmental-health-professionals/clandestine-laboratory-remediation

Western Australian Department of Health, Environmental Health Directorate

Phone: 08 93884999 Email: clanlab@health.wa.gov.au

Website or link:
http://www.public.health.wa.gov.au/3/1653/2/clandestine_drug_laboratories.pm

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