Appendix I - Current Position of Human Health Risks from Lead (Pb) Exposure in Australia

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1. Abstract

- While historical lead paint and petrol remain a concern for older urban cities in Australia, the most significant lead hot spots and most robust monitoring and intervention programs are near current or historical lead smelters (Port Pirie and Lake Macquarie), lead mines (Mount Isa and Broken Hill), and ore transport regions (Goulburn and Esperance).
- From the early 1970s to late 1990s, Australia enacted legislation that banned lead in consumer products, paint, petrol, and plumbing and strengthened occupational worker health protections.
- The average BLL levels of Pb in Australia are estimated to be under 5 μg/dL (the screening level for lead in blood in Australia), and it is uncommon for levels to be above 10 μg/g or to cause severe health effects. There is no national routine BLL monitoring to provide conclusive results.
- The National Health and Medical Resource Council (NHMRC) undertook a comprehensive review of national lead exposure in 2015 that updates health practitioners on best-practice protocols for addressing elevated BLLs in children. The same report concluded that Australia would not benefit from universal BLL screening.
- Rather than at the national level, monitoring is conducted in regional hot spots. The most prominent programs are Port Pirie, Broken Hill, and Mount Isa.

2. Introduction

Lead particles from historical lead paint and petrol in Australia can increase residential soil contamination in older urban cities, but the primary national lead concern is the exposure of communities near lead smelting and mining operations. Australia has been the world's leading producer and exporter of lead since the 1880s, and while it is a key contributor to the national economy, it also increases blood lead levels (BLLs) in mining towns. The federal government has established national screening levels and recently undertook a comprehensive review of lead exposure in 2015 that updates health practitioners on protocols for addressing elevated BLLs (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). Outside of these national measures, robust monitoring and interventions are found in mining regions such as Mount Isa and Broken Hill, and smelting/processing regions such as Port Pirie. This report explores Australia's lead sources, exposure pathways, health risks, and regional monitoring programs to provide an international model for what can be done, or done differently, to address lead contamination at a national level. This report aims to provide insight into how one national management style is working and what can be learned from it in New Zealand.

3. Lead Sources, Sinks, and Exposure Pathways

The source of lead contamination in Australia is primarily historical and current mining and smelting emissions, historical lead paint, and historical lead gasoline. Through wet and dry deposition, these sources of lead contaminate soil, air, and water reservoirs. Lead contamination in these reservoirs becomes a concern through ingestion and inhalation, as lead particles are moved from these lead sinks into the human body. The primary sources, sinks, and exposure pathways for Australia are detailed below.

2.1 Soil and Dust Contamination

Soil and dust contamination in Australia can be attributed to (1) mining/smelting, (2) lead paint, and (3) lead gasoline/petrol. Mining and smelting regions experience the highest Pb contamination rates, making this exposure route a focus for Australian monitoring. Legacy lead paint and lead gasoline also contribute to current contamination concerns in older urban residences, though the magnitude from these sources is smaller than with mining operations.

Mining is a major contributor to Australia's national economy; it accounts for 10.4% of Australia's GDP and 62% of its export revenue. Mining serves as a significant employer and is a key driver of Australia's economic growth ("Trade and Investment," 2024). Today, Australia is the world's leading producer and exporter of lead; 11% of Australian mines are lead mines (Moon & Buteyn, 2021). Below are the locations of lead and zinc producing mines and deposits (Geoscience Australia, 2025)(Figure 1).

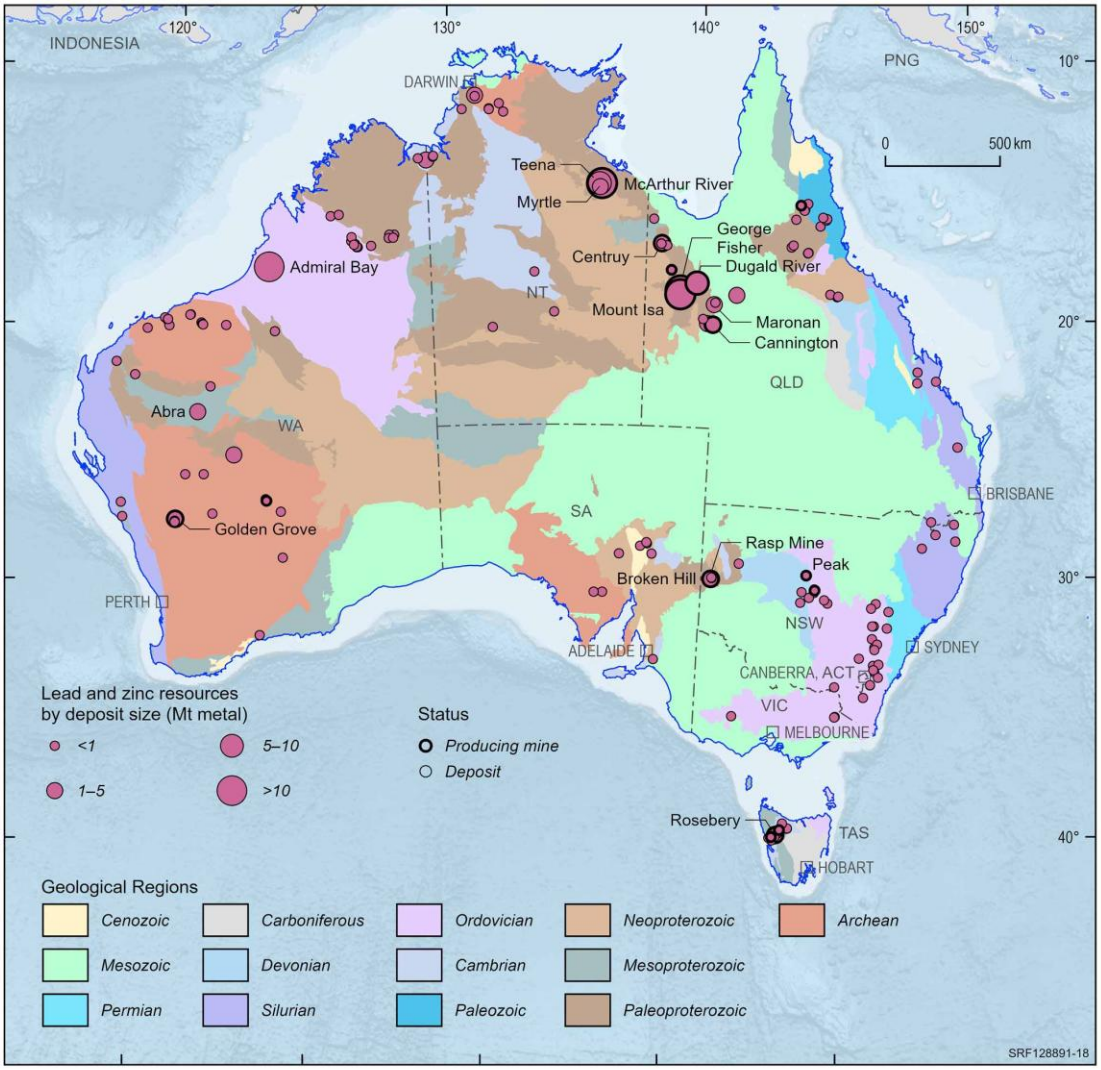

Figure 1: *Locations of lead and zinc resources by deposit site and distributed by geological regions (Geoscience Australia, 2025).*

While mining has contributed greatly to Australia's economy, it is also a key source of lead in the environment. Industrial emissions of lead particles end up in residential soil through dry deposition, when atmospheric pollutants are transferred from the air to the Earth's surface without the involvement of precipitation. Exposure to lead has been documented in communities near current or historical lead smelters, including Port Pirie (South Australia) and Lake Macquarie (New South Wales), lead mines, including Mount Isa (Queensland) and Broken Hill (New South Wales), and ore transport regions, including Goulburn (New South Wales) and Esperance (Western Australia) (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). These contaminated soil particles are then ingested or inhaled, posing a human health risk. Studies have shown that mining towns in Australia have higher median BLLs than non-mining towns (Figure 2). It is also in these communities where blood lead monitoring and public health initiatives are often concentrated (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

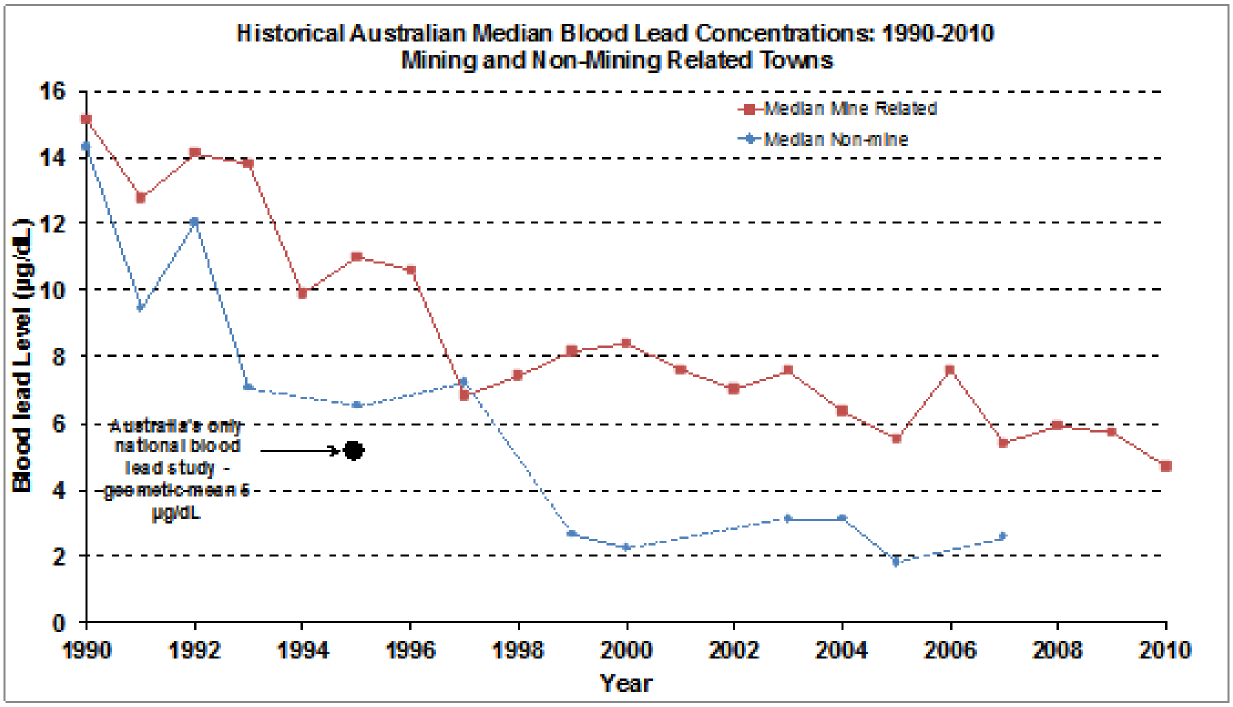

Figure 2: *BLL Concentrations from 1990-2010 of Mine-Related vs Non-Mine Related Towns in Australia (M. Taylor & Winder, 2013).*

Additionally, not only mining towns are affected by mining operations. Towns, such as Esperance and Goulburn, have historically experienced higher levels of lead due to their role in the transport of lead ore. For instance, Esperance is a port town that began in 2005 to export finely ground lead carbonate concentrate. It is a windy region, and the material was finely ground and thus in a very bioavailable form. In 2007, thousands of birds died in the town, and an investigation, led by Michelle Crisp, showed that the cause was lead poisoning. The bird testing then shifted to drinking water testing, which revealed that water tanks near the port had been contaminated, and blood lead testing (the largest blood lead survey ever conducted in Western Australia by the Department of Health), which revealed elevated levels among children living close to the port. In response, the state government spent $25 million to test 2,320 homes and commercial properties, and then cleaned the roofs, gutters, carpets, rainwater tanks, and external surfaces of 1,775 properties. This was the largest blood lead survey and clean-up operation of its kind ever undertaken in Australia (McCafferty et al., 2013). The mining company, Magellan Metals, also had to pay $9 million towards the cleanup and establish a $1 million community fund (Trenwith, 2012). The problem has been deemed resolved, and there is no longer any regular monitoring.

A second key source of lead in soils and dust is lead paint. The Australian government considers houses built before 1980 to contain lead-based paint, and if built before 1965, it is likely that the paint may contain up to 50% lead (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). Though lead paint was phased out in Australia between 1965 and 1997, the disturbance of lead paint through peeling, renovation, sanding, and other activities may cause the lead to be remobilized into the soil or air (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). The Australian government has prepared a six-step guide to home painting that is intended to reduce the risk of exposure and recontamination (Australian Government Department of the Environment, 2016).

Lead contamination can also be attributed to historical lead gasoline. While unleaded gasoline was introduced in Australia in 1985 and lead in gasoline was banned in 2002, the consequences of historical lead gasoline have been significant. A national assessment of petrol lead emissions found that 3,842 tons of lead were emitted in 1976, and 2,388 tons were emitted in 1985 (M. Taylor & Winder, 2013). As a result, in areas with a high history of traffic flow, such as larger inner cities, there are often higher levels of lead in the roadside soil (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

2.2 Air Pollution

Air contamination attributed to petrol-gasoline using vehicles has been decreasing since its phase out began in 1986 and ultimate elimination/banning in 2002 (Figure 3). By 1994, ambient air quality monitoring in Australian cities showed air contamination levels under the Australian screening guideline of 0.5 $\mu g/m^3$ (National Environment Protection (Ambient Air Quality) Measure, 2001). The average lead air concentration in Australia is now generally low, meeting the national 0.5 μg/m^3 standard. Some areas, particularly with mining and smelting, can still experience higher concentrations (*Outdoor Air Quality | Australia State of the Environment 2021*, 2021).

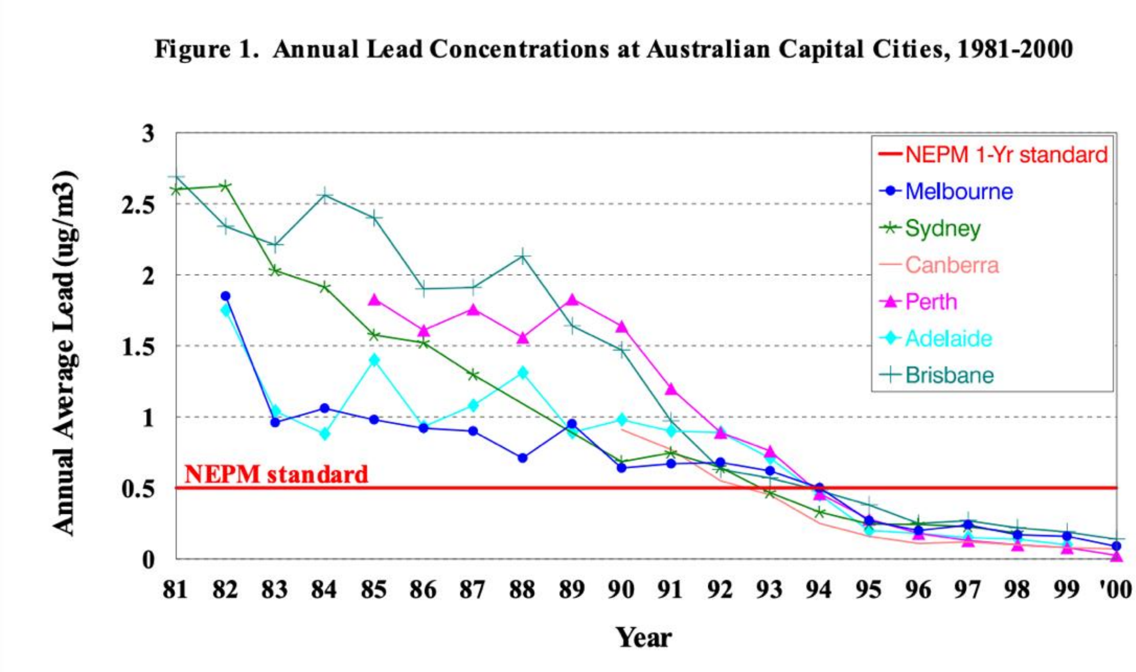

Figure 3: *The Annual Average BLL in Australian Capital Cities from 1981-2000. Phase out began in 1986 (National Environment Protection (Ambient Air Quality) Measure, 2001).*

Recent research has also introduced the idea of wildfire-caused lead particle resuspension in the air. High temperatures during wildfires cause natural lead from soils and vegetation, and anthropogenic historical deposits from lead gasoline to be volatilized and released into the air. Lower temperatures then cause the remobilized lead to be concentrated in ash. This phenomenon has been documented in Australia as well as North America, South America, and Europe. While this is an emerging field of research, the effect of remobilized lead during wildfires does not appear to alter Australian atmospheric lead concentrations measurably (Kristensen et al., 2017).

2.3 Water Contamination

Contaminated drinking water does not pose a large health concern for Australia, for water in Australia typically has less than the 0.005 mg/L national screening level for Pb (Lead | Australian Drinking Water Guidelines, 2025). Drinking water may have small amounts of Pb in older buildings due to contact with lead in solder fittings of pipes. The highest reported level of lead in water found in Australia is 0.162 mg/L (Lead | Australian Drinking Water Guidelines, 2025).

In 1989, Australia established a ban on lead-based solders in domestic plumbing. The Plumbing Code of Australia now requires lead-free piping systems, and a three-year transition (beginning in May 2023) is now underway to accomplish this goal (*Australia's Transition to Lead Free Tapware*, 2025).

The current guideline for lead in drinking water is 0.005 mg/L. This number was derived using a dose-response analysis that assumed that 20% of the total lead intake can be attributed to water. From there, Australian scientists used the IEUBK model assumptions to obtain the health guideline of 0.005 mg/dL, which is protective of the general population, including sensitive populations such as pregnant people (Lead | Australian Drinking Water Guidelines, 2025). New Zealand's lead in drinking water standard is 0.01 mg/L in comparison.

2.4 Other Sources, Sinks, and Exposure Pathways

Other routes of exposure to lead in Australia include occupational exposure, consumer products, and some hobbies. Occupational exposure rules are set by Safe Work Australia, including in contexts where workers are restoring or demolishing buildings with lead paint, or people are working in lead-related industries. Imported consumer products may also contain lead. Hobbies such as restoring boats, soldering, and firing pottery have also been shown, in rare cases, to result in lead exposure (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

2.5 Blood Lead Levels (BLL) in Australia

At the national stage, lead poisoning is not considered a significant or widespread priority. National regulatory bodies have established screening levels for blood lead levels (5 μg/dL), but there is no national routine BLL monitoring (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). This inaction is likely due to the rarity of lead poisoning in most of Australia. The average BLL levels of Pb in Australia are estimated to be under 5 μg/dL, the screening level for lead in blood in Australia. It is uncommon for levels to be above 10 μg/g, and severe health effects are infrequent in Australia (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). It is important to note that the World Health Organization (WHO) maintains that there is no safe level of lead exposure; any amount of Pb in the body can be harmful (World Health Organization, 2025).

While the national government does not conduct routine monitoring, it does recommend BLL testing based on an individual's "risk profile." A risk profile considers factors such as life stage, current health status, exposure to other family members (such as in an occupational context), the local environment (including the age of the house, mining location, and traffic density), and whether pica behavior is present. If a child's risk profile points to probable lead exposure, the national government recommends venous blood testing (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). The national government puts the responsibility for noticing symptoms or conducting risk profiles on the health practitioner, and recommends that health practitioners conduct routine environmental history and family history questioning to improve targeted risk assessment (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

While nationally, high blood lead levels are not a priority, the elevated lead emissions in mining/smelting regions of Australia is still an ongoing problem. Monitoring and interventions are mostly at the state/territory level (see section 4).

4. Management of Lead in Australia

3.1 National Lead Management in Australia

Lead management in Australia is mostly concentrated at the state and territory level, but there have been some key national initiatives that have reduced and even eliminated exposure pathways in Australia.

The earliest actions to reduce lead exposure in Australia related to consumer products. *The Customs Regulations (1956), Trade Practices Act (1974),* and other trade regulations have restricted or prevented the use of lead in consumer goods such as toys, cosmetics, ceramics, water pipes, medicines, and other imported products containing lead (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

A series of regulatory changes and amendments to the *Australian Uniform Paint Standard* limited the amount of lead in house paints to 1% (1965), 0.25% (1992), and 0.1% (1997). The current limit for lead in most paints (according to the *Australian Uniform Paint Standard* in 2021) is 0.009%. Anti-corrosive and anti-fouling paints still have a slightly higher limit of 0.1%. These percentages are extremely low compared to the mid-1960s, which had up to 50% lead in its paint (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

Australia has also acted to eliminate lead in petrol. Australia used leaded petrol for 70 years, which left 240,000 tons of lead emitted across the continent, often concentrated in Australia's densely populated capital cities of Sydney, Melbourne, Brisbane, and Adelaide. Leaded petrol emissions peaked in 1974 and then began to decline with city regulations in the 1970s in Sydney, Melbourne, and Hobart that limited the maximum allowable concentration of lead in petrol. The introduction of unleaded gasoline in 1985 and then a series of phase-outs in the 1990s—culminating with the *Fuel Quality Standards Act of 2000,* which completely banned lead in petrol—further contributed to the decline (Figure 4). These regulations have proven effective in reducing lead concentrations in air below the guideline of 0.5 $\mu g/m^3$ and in reducing the mean BLL (Kristensen et al., 2017).

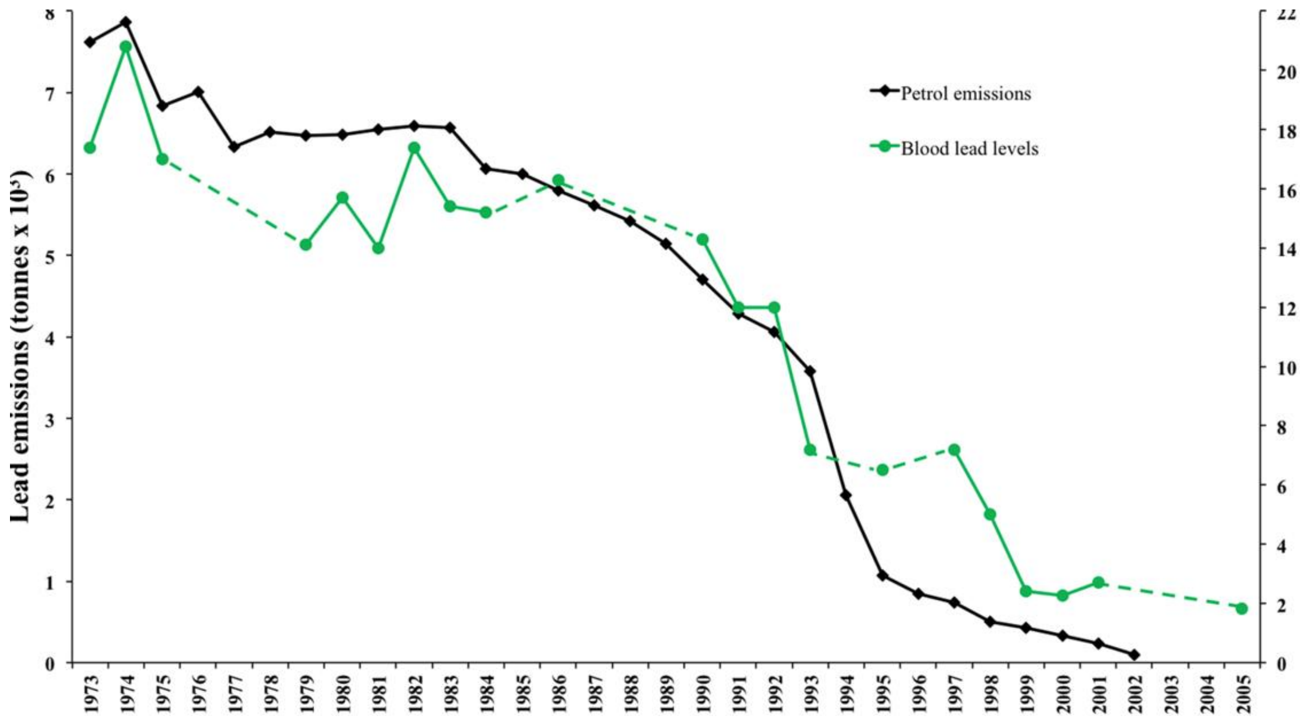

Figure 4: *Declining BLL in children and petrol emissions (Kristensen et al., 2017).*

With the phase out of lead in petrol, elevated lead emissions in Australia are almost exclusively linked to mining and smelting. The surge of Australia's lead industry occurred when one of the world's largest lead-zinc ore bodies was discovered at Broken Hill, New South Wales, in 1884. Mining and smelting operations initially occurred on-site, and then smelting was relocated to Port Pirie. The effects of mining and smelting in these two areas, as well as Mount Isa, Port Kembla, Esperance, Karumba, Boolaroo, and Townsville, are felt both locally and globally (Figure 5). Isotopic composition differences in ice cores in Antarctica can be attributed to industrial lead emissions in Broken Hill (Kristensen et al., 2017).

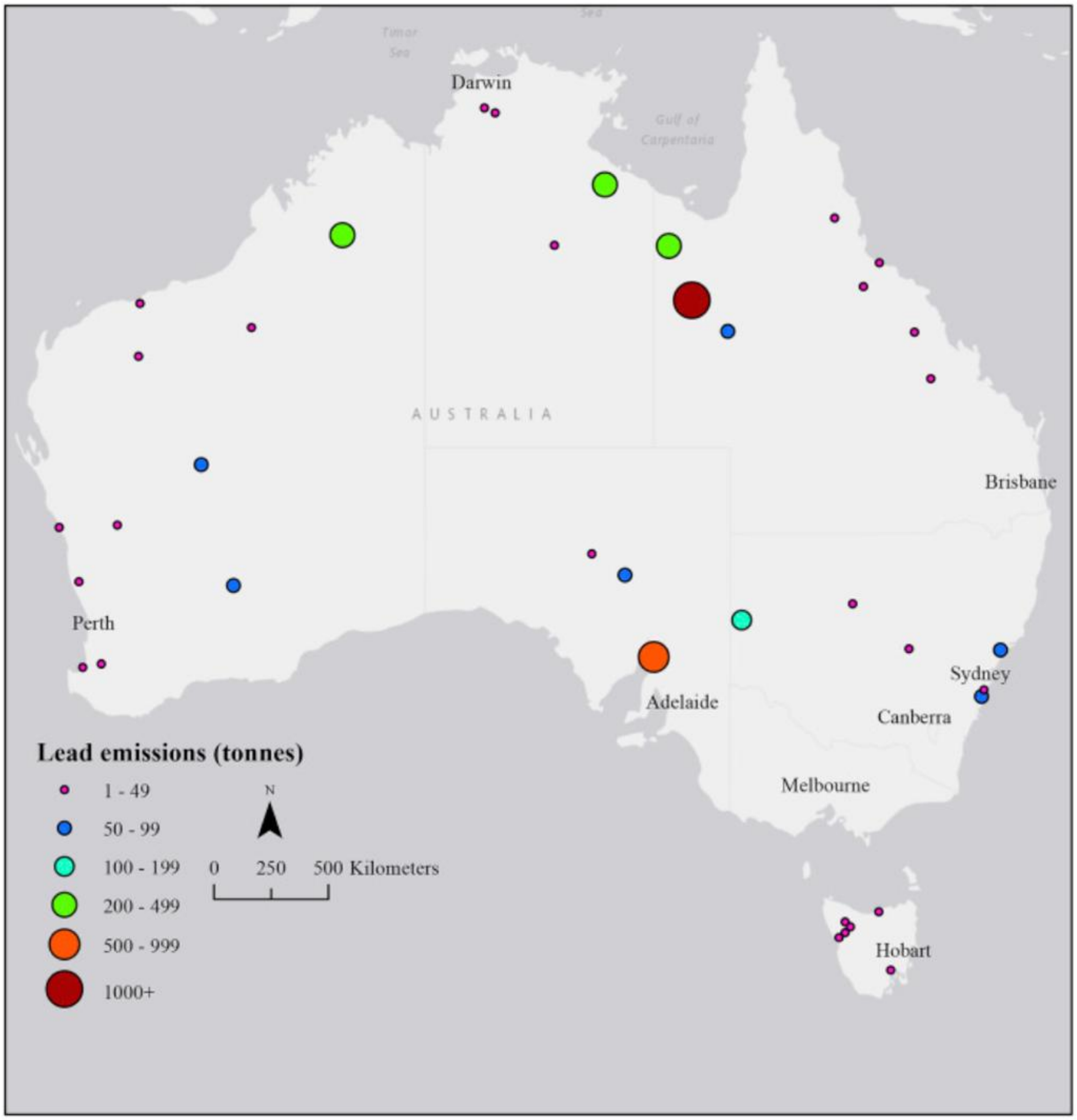

Figure 5: *Distribution of Australia's largest point-source lead emissions from 2000-2014 according to the National Pollution Inventory (Kristensen et al., 2017).*

Since the early years of mining, Australia has modernized its smelting activities through regulations, remediation, and new technology. National regulations focus particularly on reducing worker exposure through establishing lead level thresholds and enhanced monitoring and control measures. *The Mining and Quarrying Safety and Health Act of 1999* established a legislative framework to protect the safety and health of persons at mines. This act was recently updated in 2023 to improve risk control of lead and lead health surveillance, and lower allowable

BLLs in workers (*Mining and Quarrying Safety and Health (Lead) Amendment Regulation 2023 Explanatory Note*, 2023).

Currently, the National Health and Medical Research Council provides standards for managing individual exposure to lead. These include 4361.1: Guideline to Lead Paint Management in Industrial Applications (1995) and 4361.2 Guide to Lead Paint Management: Part 2 Residential and Commercial Buildings (1998), which were updated by the Hazardous Paint Compliance Plan in 2017 (a.k.a. AS/NZS 4361.1:2017 and AS/NZS 4361.2:2017). These guidelines apply both to Australia and New Zealand and outline lead renovation, management, and safety precaution best practices. These guidelines are primarily for contractors, property owners/managers, and safety and health practitioners, but they can also help "do-it-yourself" home renovators as well ("Lead Paint, Lead Dust, Inspection Sampling and Testing by Occupational Hygienists," 2024). None of these guidelines—including testing—are legally required, but they may inform the implementation of Work Health and Safety regulations that may hold legal requirements related to lead exposure in the workplace (Standards Australia / Standards New Zealand, 2017).

National regulatory bodies have also established screening levels for air, drinking water, and soil (Table 1). Outside of the guidelines and screening levels, the national government takes a hands-off approach to monitoring and intervention. It does not explicitly conduct BLL monitoring or cleanup of hazardous sites (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). Instead, action is delegated to the state/territory level.

Table 1: *National Guideline Values for Lead in Australia.*

Sink / Source	Regulatory Body	Standard	Citation
AIR	National Environment Protection Measure	0.5 $\mu g/m^3$	(*National Environment Protection (Ambient Air Quality) Measure*, 2000)
DRINKING WATER	Australian Drinking Water Guidelines	0.005 mg/dL	(*Lead | Australian Drinking Water Guidelines*, 2025)
SOIL	The National Environment	Residential w/ gardens or	(Department of Climate Change, Energy, the

	Protection Council (2013)	accessible soil: 300 mg/k	Environment and Water, 2013)
		Recreation Areas: 600 mg/kg	
DUST	Australian Standard AS 4361.2 Guide to Lead Paint Management Part 2: Residential and Commercial Buildings	Interior floors: 1 mg/m^2	(Standards New Zealand, 2017)
		Interior windowsills: 5 mg/m^2	
		Exterior surfaces: 8 mg/m^2	

3.2 State/Territory Lead Management in Australia

State and territory action is sporadic and inconsistent across jurisdictions (Kristensen et al., 2017). Some states/territories have a long legacy of BLL monitoring and/or air quality monitoring, require public health office notification if a BLL test is higher than 5 µg/dL, and have established a follow-up protocol for cases of elevated BLL. New South Wales, Queensland, Tasmania, and Victoria have some/all of these programs in place (Figure 6). Other states/territories (ACT, the Northern Territory, and South Australia) have none of these requirements (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015).

State/ territory	Notifier	Legislation	Notification level/ additional details
NSW	Laboratories on diagnosis	Public Health Act 1991	Venous blood lead level of ≥5μg/dL http://www.health.nsw.gov.au/Infectious/controlguideline/Pages/lead.aspx
Queensland	Laboratories on diagnosis	Public Health Regulations 2005	Notifiable ≥5μg/dL in any person http://disease-control.health.qld.gov.au/Condition/720/lead-exposure
Tasmania	Laboratories	Public Health Act 1997	Notifiable >5μg/dL http://www.dhhs.tas.gov.au/peh/communicable_diseases_prevention_unit/?a=53319
Victoria	Laboratories and medical practitioners on diagnosis	Public Health and Wellbeing Act 2008	Notifiable >5 μg/dL http://docs.health.vic.gov.au/docs/doc/Notifiable-Conditions-Form
Western Australia	Medical practitioners after diagnosis of lead poisoning	Health Act 1911 Health (Notification of Lead Poisoning) Regulations 1985	Notifiable ≥5μg/dL high-risk groups and ≥10 μg/dL for everyone else http://www.public.health.wa.gov.au/3/507/2/lead_poisoning_notifications.pm

Note: elevated blood lead levels are not currently notifiable conditions in South Australia, ACT and Northern Territory. Health authorities in these jurisdictions can follow up cases of lead exposure should a referral be made. The notification requirements change over time — local state/territory or regional public health authorities can advise on current requirements.

Figure 6: *State/territorial requirements for notification of elevated BLL result (NHMRC Information Paper. Evidence on the Effects of Lead on Human Health, 2015).*

Some prominent state-level action include the (1) *Lead Smart Guidelines* from the Port Pirie Environmental Health Center, which provides information for property owners on lead harm reduction strategies (SA Health, 2025), and (2) the *New South Wales (NSW) Lead Paint Policy* which requires Homes NSW to act immediately if lead paint is in a form that could be directly ingested by children (NSW, 2024). Some states/territories and cities have also established BLL monitoring programs. These programs are described in more detail in section four.

5. Monitoring Programs and Intervention

4.1 National Intervention Strategies

Australian national intervention strategies surrounding health, medicine, and research on lead are spearheaded by the National Health and Medical Research Council (NHMRC). This governing body was established under the *National Health and Medical Research Council Act (1992).* In the NHMRC Strategic Plan of 2013-2015, the NHMRC identified environmental hazards—including lead—as a primary health issue to be targeted through its research. One of the outputs of this Strategic Plan is the NHMRC Information Paper: Evidence on the Effects of Lead on Human Health (2015). The creation of this paper is a way for the NHMRC to "advise the community," one of its responsibilities under Section 7(1)(a) of the *NHMRC Act 1992*. Additionally, this paper replaces the *2009 NHMRC Blood lead levels for Australians*: *An information paper for practitioners and policy makers* report, which was written with the assumption that exposure should be minimized to be no greater than 10 µg/dL. A review of this paper was called for due to emerging evidence that pointed to health effects under 10 µg/dL (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). The 2015 paper presents Australia's most updated primary lead national intervention strategy (Table 2). The NHMRC also has a fact sheet that answers the most frequently asked questions (National Health and Medical Research Council, 2015).

Table 2: *Guidelines for recommended interventions for clinicians based on BLL test results* (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015)

BLL Test Result	Health Practitioner Intervention
<5 mg/g	• No particular action or treatment is needed • May be worthwhile to investigate further for pregnant people if BLL is over 4 mg/g
5-10 mg/g	• Create a Management Plan (MP). This plan should include: ○ Collaboration between health practitioner and state health officials. ○ An individual risk profile and a detailed patient history

	○ A proportionate and holistic plan to address the health risk • Advise on behavioral and environmental abatement strategies. This should include consideration on the potential source of exposure (advice can be obtained from local health agencies) • Follow up BLL test six months later • Consider testing other family members • Education on how to limit exposure
10-20 mg/g	• Everything in column above AND… • Consult with state and territory health authorities about remediation and sources of exposure
20-44 mg/g	• Everything in columns above AND… • Perform a pediatrician clinical evaluation • Conduct an environmental intervention* including an exposure evaluation, environmental investigation, risk assessment • Manage the exposure source in consultation with state and territory health authorities.
45-69 mg/g	• Everything in columns above AND… • Provide health care within 48 hours • Chelation therapy for children
>70 mg/g	• Everything in columns above AND… • Hospitalize IMMEDIATELY and begin chelation therapy (children and adults) *MEDICAL EMEGENCY*
Note: * The environmental intervention should prioritize the removal of lead. If this is not possible, exposure minimization and behavior modification are the next steps. These actions can include separating the person of concern from the lead source, isolating the source, educating the person of concern on risk reduction, and avoiding lead-containing products.	

Outside of health practitioner intervention guidance, national intervention is limited. Monitoring and intervention are instead delegated to state/territory offices for action.

4.2 Monitoring Programs

At the national level, the National Environment Protection Measure for Ambient Air Quality monitors ambient air quality. But due to the low levels of air pollution, the monitoring is limited, even in urban areas (*National Environment Protection (Ambient Air Quality) Measure*, 2001) The other monitoring program run by the national government is the National Pollutant Inventory (NPI). The NPI requires industries to monitor and report their industrial emissions. This data is available on their website. (Department of Climate Change, Energy, the Environment and Water, 2025). Neither soil nor water have mandatory or routine lead testing. Instead, these contamination issues are picked up in contaminated site investigations.

There are no national BLL Screening programs in Australia. The World Health Organization (WHO) set criteria to assess whether implementing a national screening program would be effective in a country (World Health Organization et al., 1968). NHMRC concluded that Australia does not fulfill the criteria for several reasons, including:

- The proportion of people exposed to additional sources of lead is small.
- There is no acceptable treatment for people exposed to lead with no signs or symptoms.
- The reduction in BLL achieved by a national screening program would be very small.
- The cost for national screening would be too high to justify when considered against the benefit of reducing the burden of disease in Australia.

Instead of a national screening program, BLL screening in Australia has been established in areas where there is a high risk of lead exposure due to lead smelting and mining: Mount Isa, Port Pirie, and Broken Hill (NHMRC Information Paper: Evidence on the Effects of Lead on Human Health, 2015). This screening is variable across jurisdictions, including when the programs started and their scope. These programs are described in more detail below.

4.2.1 Regional Monitoring Programs

Regional monitoring in Australia is centered in (1) Port Pirie, (2) Broken Hill, and (3) Mount Isa. These areas are key mining areas; Port Pirie is one of the world's largest lead smelters, and both Broken Hill and Mount Isa are centers for Australian mining.

The Port Pirie (South Australia) has a long history of BLL screening. The Port Pirie Lead Investigation Group was started in 1984 to write health reports on lead and collect BLL data (Port Pirie Blood Lead Levels, 2024). Port Pirie was a prime location for this level of attention because it has one of the world's largest primary lead smelters, continuously operating since 1889 (Port Pirie Blood Lead Levels, 2024). This investigation group helped develop the *Port Pirie Targeted Lead Abatement Program (TLAP)*. *TLAP* has invested $28 million to lower lead emissions in the area (Government of South Australia Energy & Mining, 2021). TLAP also drives key initiatives such as the *Port Pirie Lead Implementation Program* and *Port Pirie's Homes and Houses Program*.

The Port Pirie Lead Implementation Program focuses on upgrading smelter technology, reducing children's BLLs, assisting the community in creating lead exposure safeguards, and ensuring the sustainability and feasibility of the smelter and the Port. It also offers free BLL testing to residents, explicitly recommending tests for pregnant people, young children, new residents, and home or garden renovators (Port Pirie Blood Lead Levels, 2024). As of 2024, 68.4% of children screened had a BLL over 5 μg/dL, with 38.6% of the children testing between 5-10ug/dL, 18.5% testing between 10- 15 μg/dL, and 8.2% testing between 15-20 μg/dL (Port Pirie Blood Lead Levels, 2024). A second facet of *TLAP* is *Port Pirie's Homes and Houses Program*. This program offers free services that help people reduce lead exposure in their homes. These services include free property and business lead exposure assessments and a greening program that uses plants to extract lead from the soil ("TLAP About Us," 2024).

The second regional screening program in Australia is in Broken Hill (New South Wales). Mining has occurred in Broken Hill for the past 140 years, resulting in high levels of lead deposition (*Broken Hill Lead Program Annual Report 2023_Final.Pdf*, 2023). Awareness of the problem became clear after people noticed that dogs were being poisoned, and then an ABC television report in 1991 triggered *The Lead Program* in 1991 (Howartin, 2012). An initial survey in 1991-1993 showed that 91% of children had BLLs over 10 μg/dL. Interestingly, Broken Hill sends much of its mined lead to the smelter in Port Pirie. The problem of lead contamination in Broken Hill may have been recognized sooner if officials had made the connection that exposure concerns in Port Pirie (which were noticed and addressed earlier) would likely be an issue in Broken Hill as well (Howartin, 2012).

The Lead Program now includes both the *Lead Surveillance Program* and the *Lead Abatement Program.* The *Lead Surveillance Program* aims to test all kids under five, screening child BLLs every six months until they are two, and then every year until they are six. As of 2023, participation is at 84%. 2024 results showed that 76% of Aboriginals and 43% of non-Aboriginals tested above 5 μg/dL. (*Broken Hill Lead Program Annual Report 2023_Final.Pdf*, 2023) *The Lead Abatement Program* remediates 15-25 homes annually, including replacing or capping contaminated soil, encapsulating lead-based paint, and sealing internal ceiling joints. Since this program began, there has been a reduction in BLLs. In addition to these two programs, legislation requires the regular monitoring of workers who may be exposed to lead in the area (*Broken Hill Lead Program Annual Report 2023_Final.Pdf*, 2023).

The final regional screening program in Mount Isa has a much shorter history. The Mount Isa (Queensland) BLL screening program began in 2009 after community concerns about lead exposure in 2006 prompted Queensland Health to conduct a blood lead screening program for kids one to four years old (Mount Isa Community Lead Screening Program, 2010). This study in 2006-2007 led Queensland Health to decide to continue routine monitoring in addition to increasing education, collaborating with the Living with Lead Alliance to develop lead mitigation strategies, and committing to a follow-up study.

The follow-up study was conducted in 2010 and showed that the geometric mean BLL for children in Mount Isa was 4.27 to 4.97 μg/dL. Indigenous children in the study had significantly higher BLLs (Mount Isa Community Lead Screening Program, 2010). After the 2010 study, follow-up protocols were put in place by Queensland Health. If there is a BLL exceedance result, Queensland Health is responsible for follow-up, including an environmental audit (soil, dust, and paint sampling), advice on home modification, dietary advice, additional BLL testing, and a referral to a health specialist if needed.

4.3 Academic Research

Research surrounding lead in Australia is present in many contexts. Following the search criteria: ((TS=("lead")) AND ALL=("Pb")) AND ALL=("Australia"), 364 results were found on the Web of Science from the period 2023-2025. Many of these results focus on the geochemical characteristics of Pb as it relates to bedrock and the geological crust. To further stratify for studies on health exposure, I refined the search terms to be: ((TS=("lead")) AND ALL=("Pb")) AND ALL=("Australia") AND ALL=("Health").

This search criteria resulted in 87 sources. Some results of this search (hand-filtered for relevance) are included in the table below. Interestingly, many studies seem to focus on the health of birds and non-human mammals (Nzabanita et al., 2024; Saaristo et al., 2024); these were not included. Given the small number of relevant sources, I then used a new search term designed to specify the residential setting but with no specified the date range: ((((TS=("Lead")) AND ALL=("Pb")) AND ALL=("Health")) AND ALL=("Australia")) AND ALL=("Residential"). This query resulted in 37 documents, 19 of which were relevant. These studies tended to focus on data from the VegeSafe Program (Sydney) or from mining regions (Broken Hill and Mount Isa).

Table 3: Recent national and regional lead surveys in Australia, 2023-2025

Title	Study Location	Year	Reference
Human Health risk assessment of metal-contaminated soils in Sydney estuary catchment (Australia)	Sydney	2024	(Birch et al., 2024)
A cross-regional ecological assessment of contaminants in soils intended for agri-food initiatives on Indigenous Peoples' lands in Australia and Canada	New South Wales, Queensland.	2024	(Moriarty et al., 2024)
Sources, pathways and concentrations of potentially toxic trace metals in home environments	Sydney	2023	(Rivero et al., 2023)
Opportunities and Challenges Associated with Bioavailability-Based Remediation Strategies for Lead-Contaminated Soil with Arsenic as a Co-Contaminant-A Critical Review	Review	2023	(Kastury et al., 2023)
Review on distribution, fate, and management of potentially toxic elements in incinerated medical wastes	Review	2023	(Bolan et al., 2023)
Cognitive performance and lifetime occupational exposures in a regional	Hunter Valley Region of New South Wales	2025	(Peter G Knott et al., 2025)

Australian population: a distributed lag mixtures approach			
A 25-year record of childhood blood lead exposure and its relationship to environmental sources	Broken Hill	2020	(Dong et al., 2020)
The effects of contemporary mine emissions on children's blood lead levels	Broken Hill	2019	(Dong et al., 2019)
Household dust metal levels in the Syndey metropolitan areas	Sydney	2003	(Chattopadhyay et al., 2003)
VegSafe: A community science program measuring soil-metal contamination, evaluating risk and providing advice for safe gardening	Sydney	2017	(Rouillon et al., 2017)
Spatial distribution and composition of mine dispersed trace metals in residential soil and house dust: Implications for exposure assessment and human health	Broken Hill	2022	(Gillings et al., 2022)
Heavy metal distribution, bioaccessibility, and phytoavailability in long-term contaminated soils from Lake Macquarie, Australia	Lake Macquarie	2009	(Kim et al., 2009)
Quantifying factors related to urban metal contamination in vegetable garden soils of the west and north of Melbourne, Australia	Melbourne	2019	(Kandic et al., 2019)
Provenance of lead (Pb) in soils in the Mt Isa urban area	Mount Isa	2018	(Wilson, 2018)
Estimates of potential childhood lead exposure from contaminated soil using the USEPA IEUBK model in Melbourne, Australia	Melbourne	2018	(Laidlaw, Gordon, et al., 2018)
Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia	New South Wales, Australia	2006	(Kachenko & Singh, 2006)

Lead poisoning of backyard chickens: Implications for urban gardening and food production	Sydney	2022	(Yazdanparast et al., 2022)
Human exposure and risk associated with trace element concentrations in indoor dust from Australian homes	Sydney	2019	(Doyi et al., 2019)
A citizen science approach to identifying trace metal contamination risks in urban gardens	National	2021	(M. P. Taylor et al., 2021)
Cadmium, lead and mercury exposure in nonsmoking pregnant women	Western Australia	2013	(Hinwood et al., 2013)
Assessment of soil metal concentrations in residential and community vegetable gardens in Melbourne, Australia	Melbourne	2018	(Laidlaw, Alankarage, et al., 2018)
VegeSafe: A community science program generating a national residential garden soil metal(loid) database	National	2018	(Harvey et al., 2018)
Identifying factors influencing trace metal concentrations in urban residential soil using an optimal parameter-based geographical detector model	Sydney	2025	(Liu et al., 2025)
Solid Cd, Cu., Pb, and Zn contaminants around Mount Isa city, Queensland, Australia: Potential sources and risks to human health	Mount Isa	2010	(M. P. Taylor et al., 2010)
Identification of lead sources in residential environments: Sydney Australia	Sydney	2014	(Laidlaw et al., 2014)

6. References

Australian Government Department of the Environment. (2016). *Lead Alert: The six step guide to painting your home*. *5*, 1–44.

Australia's Transition to Lead Free Tapware. (2025, February 27). https://oliveri.com.au/about-us/stop-press/australias-transition-to-lead-free-tapware/

Birch, G., Wang, X., & Liu, E. (2024). Human health risk assessment of metal-contaminated soils in Sydney estuary catchment (Australia). *Environmental Geochemistry and Health*, *46*(4), 125. https://doi.org/10.1007/s10653-024-01898-4

Bolan, S., Padhye, L. P., Kumar, M., Antoniadis, V., Sridharan, S., Tang, Y., Singh, N., Hewawasam, C., Vithanage, M., Singh, L., Rinklebe, J., Song, H., Kirkham, M. B., Wang, H., & Bolan, N. (2023). Review on distribution, fate, and management of potentially toxic elements in incinerated medical wastes. *Environmental Pollution*, *321*, 121080. https://doi.org/10.1016/j.envpol.2023.121080

Broken Hill Lead Program Annual Report 2023_Final.pdf. (n.d.). Retrieved June 26, 2025, from https://www.nsw.gov.au/sites/default/files/noindex/2024-07/Broken%20Hill%20Lead%20Program%20Annual%20Report%202023_Final.pdf

Chattopadhyay, G., Lin, K. C.-P., & Feitz, A. J. (2003). Household dust metal levels in the Sydney metropolitan area. *Environmental Research*, *93*(3), 301–307. https://doi.org/10.1016/S0013-9351(03)00058-6

Department of Climate Change, Energy, the Environment and Water. (2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999*. Federal Register of Legislation. https://www.legislation.gov.au/F2008B00713/latest

Department of Climate Change, Energy, the Environment and Water. (2025). *National Pollutant Inventory—DCCEEW*. https://www.dcceew.gov.au/environment/protection/npi

Dong, C., Taylor, M. P., & Gulson, B. (2020). A 25-year record of childhood blood lead exposure and its relationship to environmental sources. *Environmental Research*, *186*, 109357. https://doi.org/10.1016/j.envres.2020.109357

Dong, C., Taylor, M. P., & Zahran, S. (2019). The effect of contemporary mine emissions on children's blood lead levels. *Environment International*, *122*, 91–103. https://doi.org/10.1016/j.envint.2018.09.023

Doyi, I. N. Y., Isley, C. F., Soltani, N. S., & Taylor, M. P. (2019). Human exposure and risk associated with trace element concentrations in indoor dust from Australian homes. *ENVIRONMENT INTERNATIONAL*, *133*, 105125. https://doi.org/10.1016/j.envint.2019.105125

Geoscience Australia. (2025, May 14). *Lead* (Australia) [Text]. Geoscience Australia. https://www.ga.gov.au/education/minerals-energy/australian-mineral-facts/lead

Gillings, M. M., Fry, K. L., Morrison, A. L., & Taylor, M. P. (2022). Spatial distribution and composition of mine dispersed trace metals in residential soil and house dust: Implications for exposure assessment and human health. *Environmental Pollution*, *293*, 118462. https://doi.org/10.1016/j.envpol.2021.118462

Government of South Australia Energy & Mining. (2021, December 2). *United plan to reduce lead levels in Port Pirie* (South Australia) [Text]. United Plan to Reduce Lead Levels in Port Pirie. https://www.energymining.sa.gov.au/home/news/generic-images/2021/united-plan-to-reduce-lead-levels-in-port-pirie

Hampton, J. O., Lohr, M. T., Specht, A. J., Nzabanita, D., Hufschmid, J., Berger, L., McGinnis, K., Melville, J., Bennett, E., & Pay, J. M. (2023). Lead exposure of mainland Australia's top avian predator. *Environmental Pollution*, *332*, 122004. https://doi.org/10.1016/j.envpol.2023.122004

Harvey, P. J., Peterson, P. G., & Taylor, M. P. (2018). VegeSafe: A community science program generating a national residential garden soil metal(loid) database. *ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH*, *25*(33), 33745–33754. https://doi.org/10.1007/s11356-018-3293-3

Hinwood, A. L., Callan, A. C., Ramalingam, M., Boyce, M., Heyworth, J., McCafferty, P., & Odland, J. O. (2013). Cadmium, lead and mercury exposure in non smoking pregnant women. *ENVIRONMENTAL RESEARCH*, *126*, 118–124. https://doi.org/10.1016/j.envres.2013.07.005

Howartin, D. A. (2012). *Lead exposure Implications for general practices* [Text"]. Australian Family Physician; The Royal Australian College of general Practitioners. https://www.racgp.org.au/afp/2012/may/lead-exposure

Kachenko, A., & Singh, B. (2006). Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. *WATER AIR AND SOIL POLLUTION*, *169*(1–4), 101–123. https://doi.org/10.1007/s11270-006-2027-1

Kandic, S., Tepe, S. J., Blanch, E. W., De Silva, S., Mikkonen, H. G., & Reichman, S. M. (2019). Quantifying factors related to urban metal contamination in vegetable garden soils of the west and north of Melbourne, Australia. *Environmental Pollution*, *251*, 193–202. https://doi.org/10.1016/j.envpol.2019.04.031

Kastury, F., Li, H., Karna, R., Betts, A., Scheckel, K. G., Ma, L. Q., Sowers, T. D., Bradham, K. D., Hettiarachchi, G. M., & Juhasz, A. L. (2023). Opportunities and Challenges Associated with Bioavailability-Based Remediation Strategies for Lead-Contaminated Soil with Arsenic as a Co-Contaminant—A Critical Review. *Current Pollution Reports*, *9*(2), 213–225. https://doi.org/10.1007/s40726-023-00252-z

Kim, K.-R., Owens, G., & Naidu, R. (2009). Heavy metal distribution, bioaccessibility, and phytoavailability in long-term contaminated soils from Lake Macquarie, Australia. *AUSTRALIAN JOURNAL OF SOIL RESEARCH*, *47*(2), 166–176. https://doi.org/10.1071/SR08054

Kristensen, L. J., Taylor, M. P., & Flegal, A. R. (2017). An odyssey of environmental pollution: The rise, fall and remobilisation of industrial lead in Australia. *Applied Geochemistry*, *83*, 3–13. https://doi.org/10.1016/j.apgeochem.2017.02.007

Laidlaw, M. A. S., Alankarage, D. H., Reichman, S. M., Taylor, M. P., & Ball, A. S. (2018). Assessment of soil metal concentrations in residential and community vegetable gardens in Melbourne, Australia. *Chemosphere*, *199*, 303–311. https://doi.org/10.1016/j.chemosphere.2018.02.044

Laidlaw, M. A. S., Gordon, C., Taylor, M. P., & Ball, A. S. (2018). Estimates of potential childhood lead exposure from contaminated soil using the USEPA IEUBK model in Melbourne, Australia. *ENVIRONMENTAL GEOCHEMISTRY AND HEALTH*, *40*(6), 2785–2793. https://doi.org/10.1007/s10653-018-0144-6

Laidlaw, M. A. S., Zahran, S., Pingitore, N., Clague, J., Devlin, G., & Taylor, M. P. (2014). Identification of lead sources in residential environments: Sydney Australia. *ENVIRONMENTAL POLLUTION*, *184*, 238–246. https://doi.org/10.1016/j.envpol.2013.09.003

Lead | Australian Drinking Water Guidelines. (2025, June 23). https://guidelines.nhmrc.gov.au/australian-drinking-water-guidelines/part-5/physical-chemical-characteristics/lead

Lead Paint, Lead Dust, Inspection Sampling and Testing by Occupational Hygienists. (n.d.). *Health Safety Consultants*. Retrieved June 27, 2025, from https://www.healthsafetyconsultants.com.au/lead-paint-lead-dust-testing/

Liu, X., Taylor, M. P., Song, Y., & Aelion, C. M. (2025). Identifying factors influencing trace metal concentrations in urban residential soil using an optimal parameter-based geographical detector model. *Environmental Research*, *283*, 122045. https://doi.org/10.1016/j.envres.2025.122045

McCafferty, P. B., Devenish, M., Burton, H. M., Jackson, M., North, M., & Winchester, W. (2013). Assessment and Remediation of Lead Contamination in Esperance, Western Australia. *E3S Web of Conferences*, *1*, 10002. https://doi.org/10.1051/e3sconf/20130110002

Mining and Quarrying Safety and Health (Lead) Amendment Regulation 2023 explanatory note. (2023).

Moon, J. W., & Buteyn, S. (2021). The Mineral Industry of Australia. *USGS 2020-2021 MINERALS YEARBOOK*, 1–31.

Moriarty, R., Wilton, M., Tsuji, L., Sarkar, A., & Liberda, E. (2024). A cross-regional ecological assessment of contaminants in soils intended for agri-food initiatives on Indigenous Peoples' lands in Australia and Canada. *Environmental Monitoring and Assessment*, *196*(12). https://doi.org/10.1007/s10661-024-13424-1

Mount Isa Community Lead Screening Program (pp. 1–32). (2010). Queensland Government.

National Environment Protection (Ambient Air Quality) Measure. (n.d.). Retrieved June 27, 2025, from https://www.nepc.gov.au/sites/default/files/2022-09/aaqprctp09leadmonitoring200105final.pdf

National Health and Medical Research Council. (2015). *Frequently Asked Questions: NHMRC Information Paper: Evidence on the Effects of Lead on Human Health*. Australian Government National Health and Medical Research Council.

NHMRC Information Paper: Evidence on the Effects of Lead on Human Health. (2015). Australian Government National Health and Medical Research Council.

NSW, H. (2024, November 19). *Lead paint policy—Homes NSW | NSW Government* [Resource]. NSW Government. https://www.nsw.gov.au/departments-and-agencies/homes-nsw/social-housing-resources/lead-paint-policy

Nzabanita, D., Mulder, R. A., Lettoof, D. C., Grist, S., Hampton, J. O., Hufschmid, J., & Nugegoda, D. (2024). Interactions Between Heavy Metal Exposure and Blood Biochemistry in an Urban Population of the Black Swan (Cygnus atratus) in Australia. *Archives of Environmental Contamination and Toxicology*, *86*(2), 178–186. https://doi.org/10.1007/s00244-024-01055-z

Outdoor air quality | Australia state of the environment 2021. (2021). https://soe.dcceew.gov.au/air-quality/environment/outdoor-air-quality

Peter G Knott, Erin Nolan, Christopher Oldmeadow, John Attiaa, Peter Schofield, Genza Benke, & Mark McEvoy. (2025). Cognitive performance and lifetime occupational exposures in a regional Australian population: A distributed lag mixtures approach. *International Journal of Environmental Health Research*. https://www.tandfonline.com/doi/abs/10.1080/09603123.2025.2520897

Port Pirie Blood Lead Levels. (2024).

Rivero, C. I.-D., Fry, K. L., Gillings, M. M., Barlow, C. F., Aelion, M., & Taylor, M. P. (2023). Sources, pathways and concentrations of potentially toxic trace metals in home environments. *Environmental Research*, *220*, 115173. https://doi.org/10.1016/j.envres.2022.115173

Rouillon, M., Harvey, P. J., Kristensen, L. J., George, S. G., & Taylor, M. P. (2017). VegeSafe: A community science program measuring soil-metal contamination, evaluating risk and providing advice for safe gardening. *Environmental Pollution*, *222*, 557–566. https://doi.org/10.1016/j.envpol.2016.11.024

SA Health. (2025). *Port Pirie Environmental Health Centre* [Text]. scheme=AGLSTERMS.AglsAgent; corporateName=Department for Health and Wellbeing; address=11 Hindmarsh Square, Adelaide, SA, 5000; contact=+61 8 8226 6000. https://www.sahealth.sa.gov.au/wps/wcm/connect/Public+Content/SA+Health+Internet/Services/Regional+Health+Services/Port+Pirie+Environmental+Health+Centre/Port+Pirie+Environmental+Health+Centre

Saaristo, M., Johnstone, C. P., Mikkonen, A., Lewis, P., Sardiña, P., & Taylor, M. P. (2024). Trace elements in liver and muscle tissues from wild waterfowls in Australia: Risk associated with human consumption in a global context. *Environmental Pollution*, *362*, 124949. https://doi.org/10.1016/j.envpol.2024.124949

Standards Australia / Standards New Zealand. (2017). *AS/NZS 4361.1 Guide to hazardous paint management*. https://www.thenbs.com/PublicationIndex/documents/details?Pub=SA%2FSNZ&DocId=326183

Standards New Zealand. (2017). *AS/NZS 4361.1:2017*. https://www.standards.govt.nz/shop/ASNZS-4361-12017

Taylor, M. P., Isley, C. F., Fry, K. L., Liu, X., Gillings, M. M., Rouillon, M., Soltani, N. S., Gore, D. B., & Filippelli, G. M. (2021). A citizen science approach to identifying trace metal contamination risks in urban gardens. *ENVIRONMENT INTERNATIONAL*, *155*, 106582. https://doi.org/10.1016/j.envint.2021.106582

Taylor, M. P., Mackay, A. K., Hudson-Edwards, K. A., & Holz, E. (2010). Soil Cd, Cu, Pb and Zn contaminants around Mount Isa city, Queensland, Australia: Potential sources and risks to human health. *APPLIED GEOCHEMISTRY*, *25*(6), 841–855. https://doi.org/10.1016/j.apgeochem.2010.03.003

Taylor, M., & Winder, C. (2013). The full story: The only safe level of lead exposure is zero. *The Journal of The LEAD (Lead Education and Abatement Design) Group*, *14*(1). https://doi.org/10.1056/NEJM199205073261916

TLAP About Us. (2024). *TLAP - Targeted Lead Abatement Program*. https://tlap.com.au/about/

Trade and Investment. (2024). *Minerals Council of Australia*. https://minerals.org.au/policies/trade-and-investment/

Trenwith, C. (2012, May 31). *Esperance's lead poisoning disaster finally cleaned up*. WAtoday. https://www.watoday.com.au/national/western-australia/esperances-lead-poisoning-disaster-finally-cleaned-up-20120531-1zkwg.html

Wilson, I. H. (2018). Provenance of lead (Pb) in soils in the Mt Isa urban area. *APPLIED GEOCHEMISTRY*, *93*, 113–128. https://doi.org/10.1016/j.apgeochem.2018.04.007

World Health Organization. (2025). *Lead poisoning*. https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

World Health Organization, Wilson, J. M. G., & Jungner, G. (1968). *The principles and practice of screening for disease*. World Health Organization.

Yazdanparast, T., Strezov, V., Wieland, P., Lai, Y.-J., Jacob, D. E., & Taylor, M. P. (2022). Lead poisoning of backyard chickens: Implications for urban gardening and food production. *ENVIRONMENTAL POLLUTION*, *310*, 119798. https://doi.org/10.1016/j.envpol.2022.119798