Appendix E - Available Residential Soil, Household Dust, Blood, and Other Lead Data in New Zealand

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1. Overview

This paper is intended to complement the history of lead in NZ appendix by providing an overview of existing New Zealand data on soil-associated lead concentrations and blood lead-levels relevant to residential lead exposure.

There have been no systematic surveys of lead concentrations in residential soils, and methods used for sample collection vary between studies. However, two studies provide a comprehensive collation of soil lead concentrations in residential soils in New Zealand following general standardized protocols (Kah & Sharp 2024, KOHC 2024). These studies broadly show that very high concentrations of lead are still found in New Zealand residential soils, with concentrations up to 32,000 mg/kg reported in KOHC 2024, and that housing age has a strong influence on lead concentrations with higher concentrations observed in houses built prior to 1950s. Studies undertaken during the 1980's provide a more specific evaluation of the influence of housing age and proximity to roadways on residential soil lead concentrations. Sample collections varies among these studies. Some research papers focused on a small number of properties (6-10 sites), while most conducted a broader survey (30-40 sites). Most researchers chose to limit the number of samples at each site to 2-10 samples, allowing for a broad geospatial analysis of Pb across (usually) one New Zealand city. Two studies took a different approach, focusing on identifying backyard and indoor hotspots at a small number of residential properties. These researchers took around 30 samples per site, but at a smaller number of sites (Jordan and Hogan, 1975; Kennedy, 1988).

Similarly, sample collection varies studies on household dust with concentrations ranging from 10 mg/kg to 1,200 mg/kg. Household lead dust concentrations have also been shown to increase in older homes. Street dust was reported as an important contributor to house dust in the mid-1980s with Fergusson and Schroder 1985 estimating the contribution of different street dust in house dust in non-lead-painted houses to be (40-70%) with aerosol contributing 30-50% and soil being lo-15%. In areas with older housing and with lead paint, approximately 45% of the lead in the house dust comes from lead paint and 50% from petrol lead (street dust and aerosol). However, there are no contemporary studies on the relative contribution of

different sources to lead in house dust (e.g. inside sources vs soil), although the significance of lead in petrol has diminished.

The most detailed studies in New Zealand to characterise sources of exposure of children to lead was a series of studies undertaken on Auckland pre-school children over the late 1970's to late 1980's (Kjellstrom et al 1978, Reeves et al 1982 and Kennedy et al 1988). Over a similar period, a series of studies by the Christchurch Lead Research Group (including Hinton et al 1986, Malpress & Hinton 1998, Walmsley et al 1988, 1995) provided some of the most comprehensive data on lead exposure in the wider population in Christchurch. These studies show a significant drop in blood lead levels over 1981-1984, preceding the removal of lead from petrol, and has been attributed to the removal of lead in solder of tin cans (Hinton et al 1986, Walmsley et al 1995). The most recent and broad survey is that of Mannatje et al. 2020, which provides an assessment of population level exposure to lead and shows continuing decrease in blood lead concentrations in non-occupationally exposed adults and children. The Dunedin Multidisciplinary Health and Development Study which has tracked the outcomes of a cohort of children born over 1972/1973 measured blood lead levels of a subset of participants at age 11 and 21. Linking these results with adult personality traits, mental health and socio-economic status later in life found that childhood lead exposure was associated with lower cognitive function and socioeconomic status at age 38 years and with declines in IQ and downward social mobility (Reuben et al 2017), and with greater psychopathology across the life course and difficult adult personality traits (Reuben et al 2019).

Finally, and in a different context four papers investigated Pb in birds in urban environments. One study demonstrated elevated lead concentrations in the blood and eggs of backyard laying hens from 30 properties in Auckland (Cowie and Gartrell, 2018), highlighting the potential for consumption of Pb accumulated in eggs in NZ residential properties. Concentrations of lead in blood were higher in hens from properties with homes built before 1941 than between 1941–1960, and in hens from properties with weatherboard homes than brick homes. Three other studies investigated lead exposure of an urban population of the North Island Kaka, an endemic native parrot, kaka to lead in Wellington (Sriram 2017, Sriram et al 2018, 2022), and demonstrate that lead in urban environments goes beyond human exposure. These studies found an association between elevated lead and reduced body condition in adult Kaka, with behavioral changes present in one individual with

the highest recorded blood lead concentration (Sriram 2017, Sriram et al 2018). Isotopic analysis suggested that roof-derived rainwater was a plausible source of lead. Elevated lead in nestling Kaka arising from parental feeding and maternal transfer was identified although no measurable neurological or physiological deficits were associated with this lead exposure (Sriram et al 2022).

The following tables report the available data on lead in multiple residential contexts, including in soil, street and house dust, and blood (Tables 1-4). Additional information from the sources are included in the Appendix (Fig A1-14).

2. Available Data on Lead Concentrations in Residential Contexts in NZ

Table 1: Studies Reporting Pb Concentrations in Residential Soil in New Zealand

Location	Housing Year	# of samples	# of Sites	Arithmetic Mean (mg/kg)	Median or Geometric mean (mg/kg)	Range (mg/kg)	Study description[1]	Reference
National	All houses	4,624	1,003 homes		~160 pre-1940 homes ~50 for houses <1940s[1]	Max: ~ 1,150	Understanding community soil values and mapping lead and other metals in home garden soils Samples self-collected from depth of 5-10 cm following standardized protocol and sent to laboratory for analysis	(Kah & Sharp, 2024)
Kainga Ora Properties (national)	1940s-1980s (a limited number of pre-WW2 houses also included)	12,000+	1,000+ properties	147	57	2.7-32,000	Soils collected from non-HAIL residential sites, including the halo zone around houses and front and back yards. Soils collected from 0 to 0.1 m bgl. Characterising soil contamination in KOHC residential properties.	(Kainga Ora, 2024)
Urban residential regions (Fig A1)	All houses	176 (total)	47 total, 1-20 for individual urban areas	149	12-108 range in urban area medians	4-2982	Samples collected from selected urban residential areas: Auckland (17), Wellington (6), Tasman (2), Christchurch (20), Invercargill (1) and Cromwell (1) 3-4 samples collected to 15 cm depth from unpaved areas in residential properties.	(Freeman, 2021)

Auckland (Figure A2)	1968 to early 1980s	73	12 to 25 in each of 4 suburbs		36-68 at 3 test suburbs; 16 control suburbs	NR	Characterising lead exposure among Auckland pre-school children in four areas with different traffic intensity (Mangere 12000 vehicles/day, Glenfield 15000 v/day, Clover park 32000 v/day and Clendon Park (control, 5550 v/day) Garden soils collected to 2 cm depth.	Kennedy et al 1988
Auckland (Figure A2)	1890-1900 (FB-GL) 1920-1940 (R) 1950-1960 (GI) 1980s (G)	NR	56 (FB-GL) 39 (R) 32 (GI) 33 (G)		842 (FB-GL) 592 (R) 155 (GI) 24 (G)	NR	Lead exposure among Auckland pre-school children in four areas with different housing ages. Lead in exterior paint, soil, and house dust from where the children lived was also measured. Freemans Bay- Grey Lynn (FB-GL) Remuera (R) Glenn Innes (GI) Glenfield (G)	Reeves et al 1982
Auckland (Fig A4)	1890-1920s (GL) Pre 1980s (O, MW) >1960 (L)		104		1250 (GL) 351 (O) 105 (MW) 42 (L)	10-1,7000	Lead exposure and effects among Auckland pre-school children from three areas expected to have high lead exposure (lead paint exposure -Grey Lynn (GL), lead smelting exposure -Onehunga (O), traffic exposure (motorway, MW)), and one site with low exposure (Lynfield, L) Blood lead levels from pre-schoolers, soil	(Kjellstrom et al., 1978;)

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							from a part of a garden they played in, and within 5 m of motorway (motorway subset only), and house paint.	
Auckland regional background	Mixed land uses including urban, rural farmland, native forest	112	112	NR	27 (O) 23.2 (A)	4.5-367 (O) 2.8-223.3 (A)	Grid-based sampling (4 km, with 2km grid for Auckland city) across the Auckland region with samples collected from a variety of land uses. At each site, samples were collected from the O horizon (0-0.02m) and A horizon (0.02 -0.1 m) with 5 samples collected from a 20m plot were composited together in the field.	Martin et al. (2023)
Lower Hutt	Mixed (30-80 years old)	55	3 areas		175-273 (area means)	175-273 (area means)	5cm deep samples in garden lawn.	Kennedy 1988 (Table 15)
Wellington regional baseline	All sites	151	NR	NR	28.7 (O) 27.2 (A)	5-776 (O) 5-702 (A)	Region wide study of trace elements in soil. Lead data from 0 horizon presented in table. Data is for all landuses. <2 mm. Grid-based sampling (4 km, with 2km grid for Auckland city) across the Auckland region with samples collected from a variety of land uses. Sampling as described for Martin et al 2023	Rogers et al. 2025.
Christchurch	Gardens in Red Zone	313	8	158 (all), 74 (transect)	71 (all), 35 (transect) 129 (targeted)	<5 - 3,289	Unpublished Thesis. Heavy metals in the Christchurch residential red zone and	(Kim, 2021)

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				226 (targeted)			implications for community gardens Portable XRF assessment of soil lead concentration in the Christchurch residential red zone. Systematic and targeted sampling.	
Christchurch (Fig A1)	All years	Residential Up to 186 (~6 per garden)	Residential (URB + RUR) = 31 sites	RURAL 18.8 URBAN 137	RURAL 15.7 URBAN 123	RURAL 7.96-77.6 URBAN 22.6-2615	Sampling of gardens in rural areas and suburban Christchurch as well potentially contaminated sites. Garden soil collected from the top 10 cm.	(Ashrafzadeh et al., 2017)
		HAIL 396 (4 per site)	99	40.4	36	8.6-380		
Christchurch (Fig A2)	Late 1800s-1975	33137	-	~1,200	NR	30-15,500	Survey of lead in Christchurch garden soils collected as close as possible to the house.	(Jordan and Hogan, 1975)
Christchurch	<1980s	12 soil	6 sites	202	NR	35-1395	Study of trace elements in soil and dust in Christchurch. Garden samples	(Fergusson et al., 1986)
Palmerston North (Fig A3)	<1945	316	34	642	158.8	11.5-9,571	Composite of 7-12 0-0.1 m samples from curtilage plus samples collected 2m grid from 3 properties (100 samples each property).	(Blunden, 2020)
Dunedin, regional background	All sites	465	113	135	47.8	1.5-2,499	City wide sampling includes different land uses, no residential properties	(Turnbull et al., 2019)

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	Urban	83	83	NR	153	3.5-2,534		

[1] all samples <2mm fraction, [2]estimated from graph

Table 2: Studies Reporting Pb Concentrations in House Dust in New Zealand

Location	Housing Year	Sample Size	# of Sites	Mean (mg/kg)	Median or geometric mean(mg/kg)	Range (mg/kg)	Study description	Reference
National (Fig A5, A6)	<1970s	186	NA	379	88	9-10,092	Study of heavy metals in New Zealand house dust. Vacuum cleaner dust data. Measured via portable-XRF.	(Fisher, 2023).
National (Fig A6)	All houses	33	47	194	79	13-1660	NZ data part of international data review on residential indoor dust. Home vacuum cleaner dust samples, sieved to <0.25 mm, measured by portable-XRF.	(Isley et al., 2021)
Auckland (Fig A9)	Age 5-19 years.	56	5	GM 1,093-2,564 AM	343-827 (locations) and 250 (Motoroa Isl.)	106-1944 (all data) and 90-567 (Motoroa Isl.)	Environmental lead and lead in primary and pre-school children's blood in Auckland, NZ. Provided swab and vacuum cleaner dust data.	(Kennedy et al. , 1988)

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				1,256-2,772				
Christchurch	1900-1950	NR	NR	457 – 5580 (range in NZ studies)	NR	~300-1,200 all 600-1200 Pre-1950 300-500 Post-1950	Review of studies on sources and speciation of trace elements in street and house dusts. Data from Figure 4 housing age, and Table 5 for NZ studies.	(Fergusson and Kim, 1991)
Christchurch	All Houses <1993	120	NR	724	573	101-3,510	House dust in Christchurch. Vacuum cleaner dust	(Kim and Fergusson, 1993)
Christchurch	<1980s	12	6	734	NR	287-1408	Vacuum sample from carpet ($0.25m^2$) from houses in Christchurch	(Fergusson et al., 1986)
Christchurch (Fig A7)	<1950	66	6 areas	830	NR	361 -1059 (range in mean in different areas)	Vacuum sample from carpet ($0.25m^2$) from 10-12 houses in 6 areas in Christchurch. Data from Table 4.	(Fergusson and Shroeder, 1985)
	>1950			460	NR			

Auckland (Fig A9)	Age 5-19 years.	56	5	GM 1,093-2,564 AM 1,256-2,772	343-827 (locations) and 250 (Motoroa Isl.)	106-1944 (all data) and 90-567 (Motoroa Isl.)	Environmental lead and lead in primary and pre-school children's blood in Auckland, NZ. Provided swab and vacuum cleaner dust data.	(Kennedy et al. , 1988)

New Zealand	1980	2790	200-7840	Christchurch, inner city	40
	1983	6340	1780–12910	Busy intersection	36,38
	1984		887–10700	Christchurch	37
	1986	1223	175–2794	Christchurch	35

Table 3: Studies Reporting Pb Concentrations in Street particulates in New Zealand

Location	Sample Size	# of Sites	Mean (mg/kg)	Median or geometric mean(mg/kg)	Range (mg/kg)	Title of Study	Reference
Auckland	56	6	1,256-2,772	1,093- 2,564	636-10642 (all data)	Roadside gutter dust (<36µm) from 6 suburbs in Auckland. Samples obtained by sweeping 5 m of gutter and passing through fine mesh. Data from Table 11.	(Kennedy et al. , 1988)
Auckland		38	NR	169 (<2 mm) 276 (<0.063 mm)	28.2-695 (<2 mm)	Cross street surface vacuum samples (<2 and <0.063 mm) from Waitakere City (Auckland).	Kennedy & Gadd 2003

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					151-559 (<0.063 mm)		
Wellington	94	12 locations		888-6421 locations	207-30,842	Wide range of land uses (res-industrial), collected by brush. <2 mm particles.	(Kennedy 2003)
Christchurch	NA	NA	1223-6340	NR	175-12910	Review of sources and speciation of trace elements in street and house dusts. NZ street dust data reported in Table 4	(Fergusson and Kim, 1991)
Christchurch	NR	6	1223	NR	175-2794	Street dust from 6 areas in Christchurch.	(Fergusson et al., 1986)
Christchurch	60	30	62.4	-	13.2-593.8	Samples collected across a range of land-uses from gutter using vacuum cleaner. < 2 mm samples. Summer and winter samples collected.	Sampson 2017

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Table 4: Studies Reporting Blood Lead Levels in New Zealand

Location	Sample Year	Sample Size	Mean	Median or Geometric mean ug/dL	Range	Study description	Reference
National	2014-2016	Adult 304	1.5	1.3	2.9 (95th percentile)	A national biomonitoring survey to determine current blood lead levels (BLL) in New Zealand children and adults and identify determinants of BLL.	(Mannetje et al., 2020, 2018)
		Child 191	0.9	0.85	1.6 (95th percentile		
Auckland (A10)	1983-1984	43 (control) 79 (MW) 10 (old painted rural)	7.8 (control) 7.9-11.4 (MW) 15.8 (OPR)	NR	NR	See Table 1 for study description. Results originally reported in ug/L.	Kennedy et al 1988 (Table 23)
Auckland	1980	72 (FB-GL) 48 (R) 38 (GI) 37 (G)	NR	18.6 (FB-GL) 14.5 (R) 15.1 (GI) 11.8 (G)	NR	See Table 1 for study description. Results originally reported in umol/L	Reeves et al 1982 (Table 1)
Auckland	1977-1978	104	NR	7.5 (L) 20.7 (O) 16.1 (GL) 18 (MW)	NR	See Table 1 for study description Results originally reported in umol/L	Kjellstom et al 1978 as reported in Kennedy et al 1998
Wellington	1995	143	6.2	5.0	1.5 - 37	To examine blood lead levels in children (12-23 months)	Bates et al 1995

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						living in old housing areas of Wellington and to investigate risk factors for high lead levels. Original results reported in umol/L	
South Island (Fig A11)	1984-1988	2,832	0.60-1.10 ug/dL	NR	NR	Characterizing lead exposure of the family, including pets with their immediate environment. Samples from Infants, Children, Adults, Dogs, and Cats. Original results reported in umol/L	(Hinton, 1988)
Christchurch	1974-1994	1138 Males 2344 Females	0.28 (male) 0.19 (female) 1994	NR	NR	Annual surveys of up to 200 Christchurch adults who had no known exposure to lead. Original results reported in umol/L	Walmsley et al 1995, Walmsely et al 1988
Christchurch (Fig A12)	1980-1986	22-69 (3 study periods)	NR	10.35 – 20.7	51	Environmental Lead and its Absorption – Human and Animal. Original results reported in umol/L	(Malpress and Hinton, 1988)
Christchurch (Fig A14)	1974-1981 Annual thereafter to 1985	230-640 (depending on the survey year)	14 to 7.9	13.5 reducing to 7.5 in pre-school children in 1985 17 (11.4) to	NR	Assessing population exposure in non-occupationally exposed people Original results in umol/L	(Hinton et al., 1986)

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Dunedin	1993/1994	949	5.6	4.5 to 9.7 (6.4) in adult males (females)	0.4 to 56	Dunedin Multidisciplinary Health and Development Study (DMDS) cohort of children of children born 1 April 1972 to 31 March 1973. Bloods taken when participants were 21. 480 participants also had their lead measured at age 11 (Silva et al 1988). Decline with age was greater in females.	Fawcett et al 1996
		480	NR	4.8	NR		
Dunedin	1983/1984	579	11.08	10.2	4 to 50	DMHDS study, lead in blood taken from children when aged 11 (Silva et al 1988), which was associated with childhood lead exposure was associated with lower cognitive function and socioeconomic status at age 38 years and with declines in IQ and downward social mobility in Reuben et al 2017, and with greater psychopathology across the life course and difficult adult personality traits in Reuben et al 2019).	(Reuben et al., 2017, 2019, Silva et al 1988)

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3. Appendix

4.1 Soil Appendix

Figure A1: *Pb soil concentrations by urban region (Freeman, 2021).*

Table 3. 5 – Statistical summary for lead by region in the <2 mm soil fraction. Soil Contaminant standard is 210 mg/kg

Region	Min.	Max.	Mean	Rank*	Geomean	Median	Sd.	RB	% results >SCS
Auckland	4	826	81	4	39	39	138	<1.5 - 65	14
Wellington	12	1672	249	1	92	81	411	4.5 - 180	26
Tasman	14	229	117	3	89	108	69	26.4	36
Christchurch	7	2982	183	2	62	42	415	20.2	22
Cromwell	11	13	12	6	12	12	1	20 - 347	N/A
Invercargill	36	89	63	5	59	64	26	20 - 347	N/A

N/A – No soil samples exceeded the SCS. * - Ranked based on mean. RB – Regional Background.

Figure A2: *Study areas tested for Pb contamination in Auckland* (Kjellstrom et al., 1978; Reeves et al., 1982, *Reported in: Kennedy et al. , 1988).*

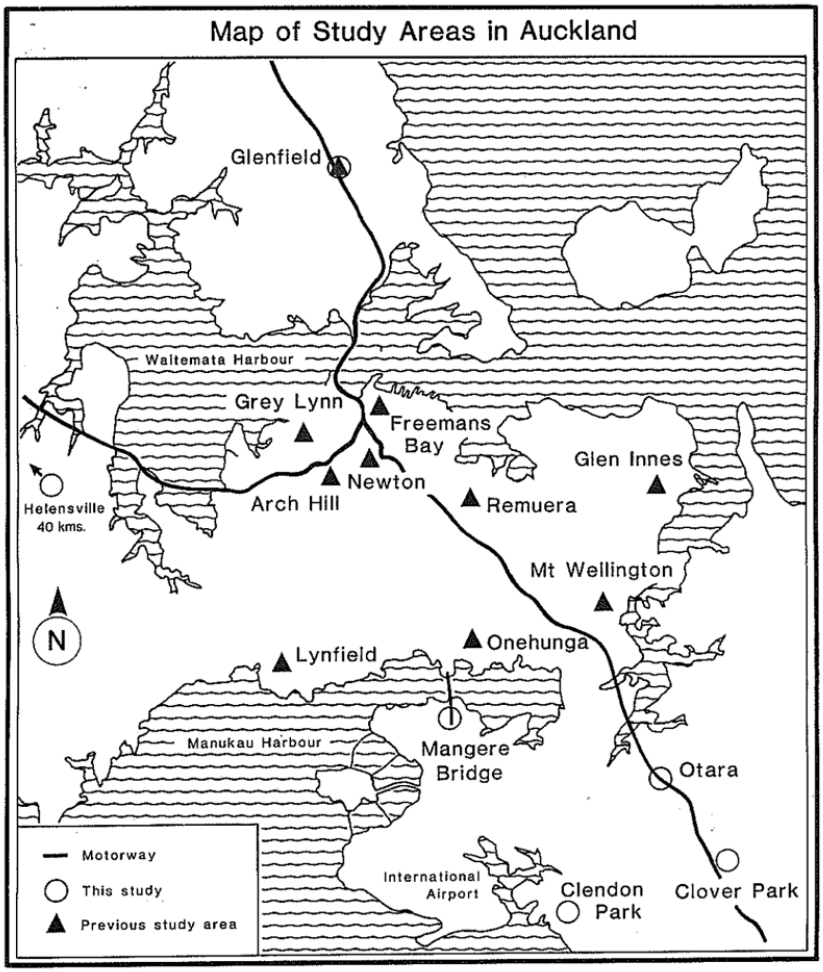


Fig. 2 Location of the study sites from this project and comparative study areas from Reeves et al. (1982) and Kjellstrom et al. (1978)

***Figure A3**: Mean soil lead concentration by sample site and housing age (Jordan and Hogan, 1975).*

TABLE 2—Average soil lead values (in mg/kg dry soil) by age and type of construction

Year house built	No. of houses	Average soil lead	Range of soil lead
Wooden construction			
Before 1890	5	664	420– 7000
1890–1909	21	2407	350–15 500
1910–1929	52	1732	50– 6000
1930–1949	31	829	140– 2500
1950–	42	277	30– 2200
Permanent-material construction			
Before 1890	2	30	30– 30
1890–1909	4	925	100– 2000
1910–1929	11	436	30– 1000
1930–1949	15	199	70– 550
1950–	148	96	10– 500

Figure A4: *Summary of available data on garden soils provided in* Kennedy et al 1988.

Table 15. Available data for the lead concentration of urban garden soils in New Zealand (all results µg/g)

Study Area	Mean		n	Housing age years	Housing type
Jordan & Hogan (1975), 0-10 cm sample close to house wall					
Christchurch	2407	A*	21	70-90	wood
Christchurch	1732	A	52	50-70	wood
Christchurch	925	A	4	70-90	permanent
Christchurch	829	A	31	30-50	wood
Christchurch	664	A	5	>90	wood
Christchurch	436	A	11	50-70	permanent
Christchurch	277	A	42	<30	wood
Christchurch	199	A	15	30-50	permanent
Christchurch	96	A	48	<30	permanent
Christchurch	30	A	12	>90	permanent
Kjellstrom et al. (1978); Reeves et al., (1982) 0-5 cm sample close to house wall					
Auckland, Arch Hill	1250	G	39	60-90	wood
Auckland, Newton **	1287	G*	14	80	wood
Auckland, Grey Lynn **	744	G	17	58	wood
Auckland, Freemans Bay **	692	G	25	76	wood
Auckland, Remuera	592	G	39	58	wood
Auckland, Onehunga	351	G	43	50	mixed
Auckland, Glenn Innes	155	G	32	25	wood
Auckland, Glenfield A***	114	G	8	12	wood
Auckland, Mt Wellington	105	G	46	-	mixed
Auckland, Lynfield	42	G	45	-	wood
Auckland, Glenfield B***	17	G	23	13	mixed
Kennedy, unpubl. 5 cm deep soil samples from garden lawn					
Lower Hutt, S. Petone	273	A	26	30-80	mixed
Lower Hutt, N. Petone	209	A	23	30-80	mixed
Lower Hutt, Waione st	175	A	6	30-80	mixed

* A,G Arithmetic and Geometric means respectively.
** Subdivisions of Freemans Bay-Grey Lynn in Reeves et al. (1982).
*** A = Wairau Rd. B = houses adjacent to the motorway prior to opening.
n = number of samples.

4.2 House Dust Appendix

Figure A5: *Heavy metal concentrations in household dust across New Zealand (Fisher, 2023).*

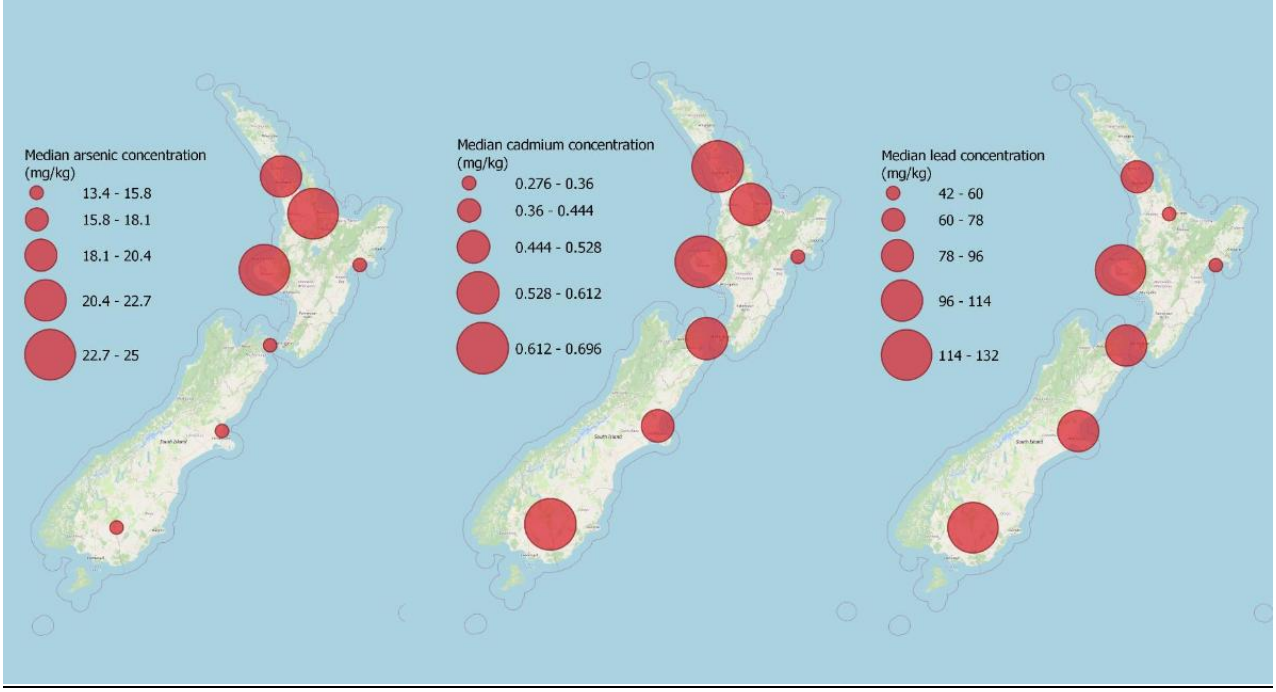


Figure A6: Reported median concentrations of select heavy metals with New Zealand data (Fisher, 2023).

Table 1.2: Reported median concentrations of select heavy metals from studies with New Zealand data.

Author	Location	As	Cd	Cr	Cu	Mn	Ni	Pb	Zn
Isley et al. (2021)	International study	13.3	0.76	86	176	257	39	94	1110
Isley et al. (2021)	**New Zealand-specific data**	39	B.D.	131	172	293	32	79	1070
Kim and Fergusson (1993)	Christchurch, New Zealand	N/A	1.2*	N/A	209*	N/A	N/A	424*	10700*
Fergusson et al. (1986)	Christchurch, New Zealand	15.8*	N/A	103*	B.D.L (<230)	207*	N/A	734	845

*Only mean heavy metal concentration reported.

B.D.L – Below detection limit, N/A – not measured in this study

***Figure A7**: Dust lead levels in house dust in 1981 and 1984 (Fergusson and Shroeder, 1985).*

TABLE 4
LEAD LEVELS 1981 AND 1984

Area[a]		1981			1984		
		Dust ($mg\ m^{-2}$)	Lead ($\mu g\ m^{-2}$)	Lead ($\mu g\ g^{-1}$)	Dust ($mg\ m^{-2}$)	Lead ($\mu g\ m^{-2}$)	Lead ($\mu g\ g^{-1}$)
1. Avonhead	$\bar{x}$	717	247	448	576	199	361
($n = 4$)	s	504	111	130	658	242	53
2. Riccarton	$\bar{x}$	1390	560	432	1367	1497	872
($n = 4$)	s	842	323	63	1367	1949	304
3. Hornby/Sockburn	$\bar{x}$	1060	367	368	1613	647	352
($n = 4$)	s	924	307	103	2442	1034	61
4. Richmond/Shirley	$\bar{x}$	1404	1110	692	932	988	1059
($n = 2$)	s	974	1225	575	144	266	153
5. Woolston/Opawa	$\bar{x}$	855	447	558	432	341	805
($n = 4$)	s	196	108	186	146	228	589
6. Spreydon	$\bar{x}$	591	823	959	419	334	779
($n = 4$)	s	371	946	626	394	364	183
Brick	$\bar{x}$	1050	373	398	1212	528	487
($n = 7$)	s	692	226	102	1850	758	255
Wood	$\bar{x}$	927	625	644	734	690	759
($n = 15$)	s	654	639	398	794	1086	387
Total	$\bar{x}$	966	545	566	886	638	672
($n = 22$)	s	652	549	350	1204	978	367

[a] $\bar{x}$ = mean; s = standard deviation.

4.2 Road Dust Appendix

Figure A9: *Concentrations of lead in <36um fraction of gutter dusts examined in the Auckland area (Kennedy et al., 1988).*

SITE	GEOM MEAN	STANDARD DEVIATION	ARITH MEAN	STANDARD DEVIATION	RANGE	n
Auckland (all residential)						
Freemans Bay	1975	2.14	2772	3233	991 - 10642	8
Remuera	1708	2.40	2180	1255	285 - 3982	8
Clover Park	2564	1.32	2644	705	1674 - 3725	6
Glenfield	2072	1.74	2379	1448	853 - 5534	8
Clendon Park	1504	1.66	1676	788	674 - 2863	10
Mangere	1093	1.73	1256	746	636 - 2481	8
Wellington (Kennedy and Chee unpublished)						
Lower Hutt (C)	4474	1.09	4488	407	4101 - 5053	4
Karori (C)	4135	1.27	4213	990	3264 - 5240	3
Karori (R)	1926	1.81	2215	1127	550 - 4247	11
Taita (R)	1266	1.69	1410	633	748 - 2157	8
Seaview (I)	1475	1.73	1643	691	527 - 2350	7

C = Commercial, R = Residential, I = Industrial area

4.3 Blood Lead Level Appendix

Figure A10: *Time trend in adult and children blood lead levels in New Zealand (Mannatje et al 2020).*

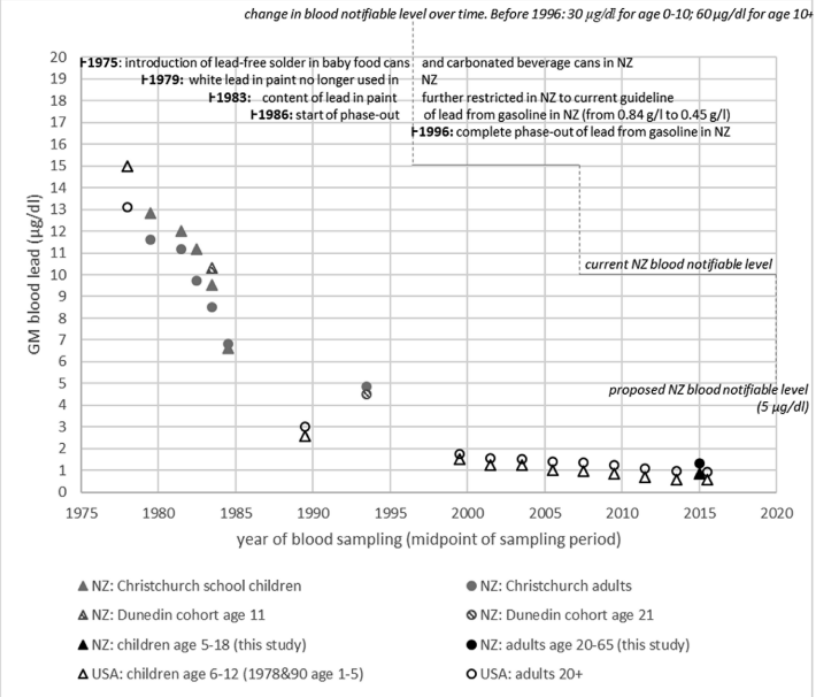


Fig. 2. Time trend of adults' (circles) and children's (triangles) mean blood lead levels for New Zealand (filled markers) and the USA (empty markers).

Figure A10: *Summary estimates for Air, paint, dust, soil, and blood contamination in sites across Auckland (Kennedy et al., 1988).*

Table 29. Summary of estimated average environmental and blood lead levels for different Auckland areas in 1984. Blood lead for children aged about 3-5 years. Data assembled from the different chapters of this report

Area	Air µg/m^3	Wall paint µg/g	Vacuum cleaner dust µg/g	Backyard soil µg/g	Blood µg/g
Clendon Park, (C)	0.1-0.2	40	300	16	74
Helensville, (C)	0.02***	0	ND	ND	90
Clover Park, (MW)	0.4-0.8	400	700	36	100
Mangere, (MW)	0.4-0.8	1700	1000	52	106
Otara, (MW)	0.4-0.8***	0	500	18	114
Helensville, paint*	0.02***	82000	ND	ND	158
Freemans Bay and Newton, Inner city (Reeves et al., 1982)**	0.9	36000	ND	800	190

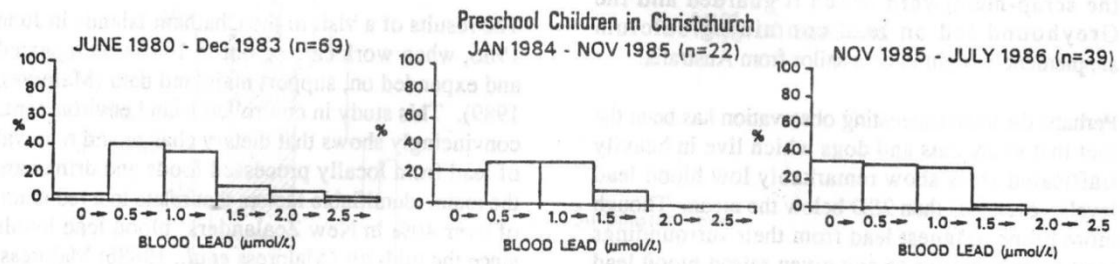
* data from 1982, younger children.
** data from 1979, younger children.
*** estimate.
ND = no data available.
C = control, MW = motorway.

Fig A11: *Red Cell Lead Concentrations of South Island Individuals (Hinton, 1988).*

Table 2. Current (1984-1988) levels of 'usual range' for RCL for South Island individuals

Species	"Usual Range" of Red Cell Lead µmol/l n=	mean	2 standard deviations
Infant 0-4 mths	41	0.60	0.40
Infant 4-9 mths	49	0.92	0.55
Preschool child	100	1.05	0.75
School child	195	1.00	0.78
Woman >16 yr	677	0.90	0.60
Man >16 yr	1090	1.10	0.58
Dog	578	0.70	0.60
Cat	102	0.90	0.60

Fig A12: Blood lead levels for preschool children between 1980-1986 in Christchurch (Malpress and Hinton, 1988).


Preschool Children in Christchurch
JUNE 1980 - Dec 1983 (n=69)
JAN 1984 - NOV 1985 (n=22)
NOV 1985 - JULY 1986 (n=39)
%
100
80
60
40
20
0
0 0.5 1.0 1.5 2.0 2.5
BLOOD LEAD (µmol/L)