

Blood Lead Screening in North Lake Macquarie, 2015

Abstract

Following concerns being raised about residual lead contamination in towns surrounding a former lead smelter site in Boolaroo, a blood lead screening clinic was conducted over three weeks in June/July 2015 for children under five years of age and pregnant women using the Lead Care II 'point of care' testing device. The last screening program, conducted in 2005/06, found that 7% and 32% of children under five years of age had blood lead levels of $\geq 10 \mu\text{g/dL}$ and $\geq 5 \mu\text{g/dL}$ respectively which confirmed a rapid decline in blood lead levels following the closure of the smelter in 2003. Seventy two children participated in the screening program in June/July 2015 and all blood lead levels were $\leq 5 \mu\text{g/dL}$ with 88% below the Lead Care II's lowest level of detection of $3.3 \mu\text{g/dL}$. Eight pregnant women were tested and all had blood lead levels $\leq 5 \mu\text{g/dL}$. The screening survey confirms the downward trend observed in 2005/06 and that the risk of children accumulating excess lead in the area has remained low since the closure of the smelter. Children's blood lead levels in the past were likely driven by recent smelter emissions with high mobility and bioavailability.

Background

In NSW, a lead smelter operated in the suburb of Boolaroo from 1897 to 2003. Annual surveys of blood lead levels in children from 1991 found elevated levels that decreased over time in conjunction with decreases in lead-in-air levels. After the closure of the smelter in September 2003, the average blood lead levels in children less than five years of age steadily declined from $9.6 \mu\text{g/dL}$ in 2003/04 to $6.8 \mu\text{g/dL}$ in 2004/05 and to $4.5 \mu\text{g/dL}$ in 2005/06. The proportion of children in this age range with lead levels $\geq 10 \mu\text{g/dL}$ has also declined from 40% in 1997 to 26% in 2004, 17% in 2005 and 7% in 2006. Maps of blood lead and soil lead spatial distributions can be found in the appendix.

In November 2014, Environmental Science students from Macquarie University tested soil samples from both private and public land finding that multiple samples had lead concentrations greater than the NEPM Health Investigation Level.¹ There was intense media coverage of the issue and concern in the community. While the previous reduction in blood lead levels suggested that soil levels were not driving blood lead levels in North Lake Macquarie, it was important to respond to new community concerns about the potential risk of residual lead in soils in the area by offering blood lead testing.

Methods

Blood lead screening clinic

Between 29 June and 17 July 2015, Hunter New England Health invited North Lake Macquarie residents of Boolaroo, Argenton and Speers Point to participate in a survey to

assess blood lead levels in children aged six months to less than five years and pregnant women.

The machine used to test lead levels was the Lead Care II 'point-of-care' testing device. This device uses the capillary method which is less invasive than venous testing and can provide a result within three minutes. The Lead Care II can detect blood lead levels as low as 3.3 µg/dL. Levels below 3.3 µg/dL display as 'low'. The device was calibrated on a daily basis and with the opening of each new test kit as required under the manufacturer's instructions.

After receiving their test results, families and/or pregnant women were seen by an Environmental Health Officer who provided a standard fact sheet on lead and relevant advice on prevention of lead exposure.

Blood lead levels were entered into the patient record using CHIME (Community Health Information Management Enterprise) and analysed using Excel.

Promotion of the clinic

To promote the clinic and maximise access we used a range of strategies including multiple media releases and alerts resulting in local television stories, extensive radio coverage across local commercial, community and public stations, and newspaper reports including in a free weekly newspaper delivered to all households in the area.

A letter box drop announcing the clinic was made to all households and businesses in the main street of the target suburbs (1700 letters) the week before the clinic commenced. Flyers were left at the local preschool, the library, pharmacies, doctors' offices, the local supermarket point of sale counters and other businesses with high customer traffic. Medical practices were asked to hand the flyer to parents of children from the area and in particular identify any children with behavioural problems or pica that would predispose to lead exposure.

A door knocking campaign was conducted two weeks after the letter box drop which focused on the streets that were closest to the smelter where children historically had the highest blood lead levels. Parents that were home were advised of the clinic and flyers were left where residents were not in attendance. The clinic was also promoted on a community administered "Lead Lowdown" Facebook page, on the local Council's website and in online posts by Lead Community Reference Group Chair, Mr Greg Piper, independent Member of Parliament representing Lake Macquarie.

The clinic was open Mondays from 1pm until 7 pm and each Tuesday to Friday from 9 am until 1 pm. Gift vouchers valued at \$20 were provided by the Lead Community Reference Group and funded by the Environment Protection Authority as a token of appreciation for participation in blood lead screening.

Results

There were 72 children tested who were between six months and less than five years of age and resident in one of three above mentioned suburbs. Seventeen were from Argenton, 18 were from Boolaroo and 37 were from Speers Point. Sixty-nine of the 72 children lived in the target area for at least the prior six months. None of the 72 children had a blood lead level above 5 µg/dL (Table 1).

Table 1. Blood lead levels of children aged six months to less than five years of age in North Lake Macquarie, 29 June - 17 July 2015.

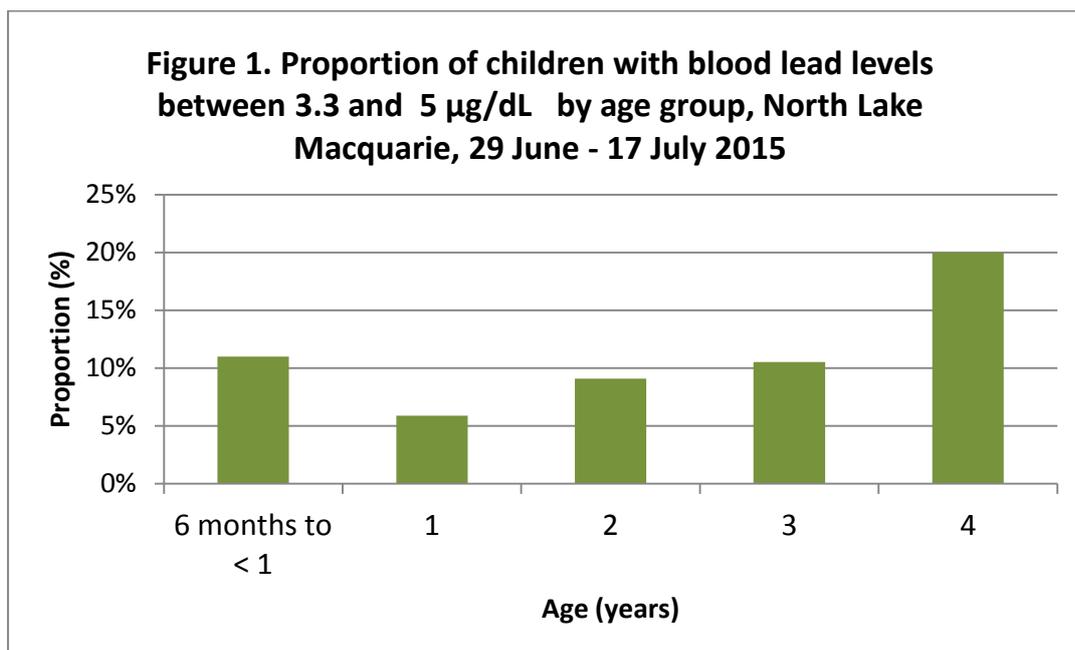
Age	<3.3 µg/dL	3.3 to ≤ 5 µg/dL	>5 µg/dL	Total
6 months - 11 months	9	2	0	11
1 year - 23 months	18	1	0	19
2 years - 35 months	10	1	0	11
3 years – 47 months	17	2	0	19
4 years - 59 months	9	3	0	12
Total	63 (88%)	9 (12%)	0	72 (100%)

In addition to the children reported in Table 1, 13 children aged six months to less than five years who resided outside of the target suburbs were tested for a range of reasons including parental concern for children living in adjacent suburbs or a physical connection with one of the suburbs such as attending preschool or their parent’s workplace. This group of children had a higher proportion of lead levels in the 3.3 to ≤ 5 µg/dL (30.8%) compared with those residing in North Lake Macquarie (12.5%) (Table 2).

Table 2. Blood lead levels of children aged six months to less than five years comparing children from North Lake Macquarie to non-resident children attending the clinic, 29 June- 17 July, 2015

Area	Blood lead level					
	<3.3 µg/dL		3.3 to ≤ 5 µg/dL		Total	
	n	%	n	%	n	%
North Lake Macquarie	63	87.5%	9	12.5%	72	100.0%
Non-North Lake Macquarie	9	69.2%	4	30.8%	13	100.0%
Total	72	84.7%	13	15.3%	85	100.0%

A further breakdown of blood lead levels, age group and suburb can be found in appendix A. While the numbers are small, there is no suggestion of the typical peak in blood lead levels around two to three years of age seen in other settings and in North Lake Macquarie prior to the smelter closure (Figure 1).



A total of eight pregnant women attended the clinic. All were from the North Lake Macquarie area and all had a blood level $\leq 5 \mu\text{g/dL}$.

The estimated participation rate for children 6 months to less than 5 years of age in the June/July clinic was 22%. For the suburb of Boolaroo, which was historically most affected by lead smelter emissions, the estimated participation rate was 35% (Table 7).

Table 7. Proportion of all North Lake Macquarie children aged six months to less than five years of age tested, by suburb, June/July 2015

Suburb	Children tested aged six months to less than five years*	
	n	%
Argenton	17	23%
Boolaroo	18	35%
Speers Point	37	19%
Total	72	22%

*removing ½ of 0-1 year olds from 2011 Census

Previous surveys targeted the same group of children aged under five years old and living in one of the three North Lake Macquarie suburbs. Our recent sample size is comparable to past screening programs with 24% (69 of 289) of under five year olds participating in screening over the entire 12 month period of the 2004/05 program and 45% (130 of 289) participating in the entire 12 months of screening including the July clinic in 2005/06. A mapping exercise (not published here for privacy reasons) showed that children who attended our blood lead screening service currently reside in what are known to be the areas affected by lead-in-soil contamination historically (see Appendix B) and where, in 2002, children had experienced elevated blood lead levels (see Appendix C).

Discussion

It has been nine years since the last lead screening program in North Lake Macquarie. Previous blood lead screening reports were based on monthly clinics with a heavily promoted annual clinic in July each year.

This is the first cohort of children to be screened who have grown up in the area since the closure of the smelter in 2003. The results of this survey are reassuring with no blood lead levels recorded above 5 µg/dL. In May 2015, the National Health and Medical Research Council (NHMRC) released their review on the effects of lead on human health. This review concluded that adverse health effects of lead in children can occur in blood lead levels greater than 10 µg/dL, but the evidence is insufficient and unclear to determine whether health effects occur at levels greater than 5 µg/dL but less than 10 µg/dL .

The results of the survey confirm the previous downward trend of blood lead levels in young children. As the Lead Care II cannot detect levels below 3.3 µg/dL and instead gives a reading of 'low', we were not able to calculate mean lead levels to compare to previous survey results. While the Lead Care II is not as accurate as clinical laboratory testing, it does have a high correlation with laboratory testing at a population level. The Lead Care II may be subject to falsely elevated readings if the specimen is contaminated with lead either through inadequate hand washing or by contact with lead at some point in the testing process. Two children who had initial results above 5 µg/dL with the Lead Care II, returned levels between 3.3 and ≤ 5 µg/dL on a repeat test after further hand washing. Two staff members that had initial blood lead levels between 3.3 and ≤ 5 µg/dL returned levels below 3.3 µg/dL on repeat testing (confirmed with laboratory testing of venous samples). If there is a systematic bias due to the use of the Lead Care II, it is likely that it overestimates blood lead levels due to sporadic contamination.

HNE Population Health has reminded local GPs servicing the North Lake Macquarie area annually to continue to check blood lead levels of children less than five years of age with risk factors for lead exposure such as behavioural disorders, developmental delay, exposure to renovation, or pica. From 2009 to 2014 of 18 children tested by GPs in the area only three returned a blood lead between 5 and 9 µg/dL, the remainder were ≤ 5 µg/dL.

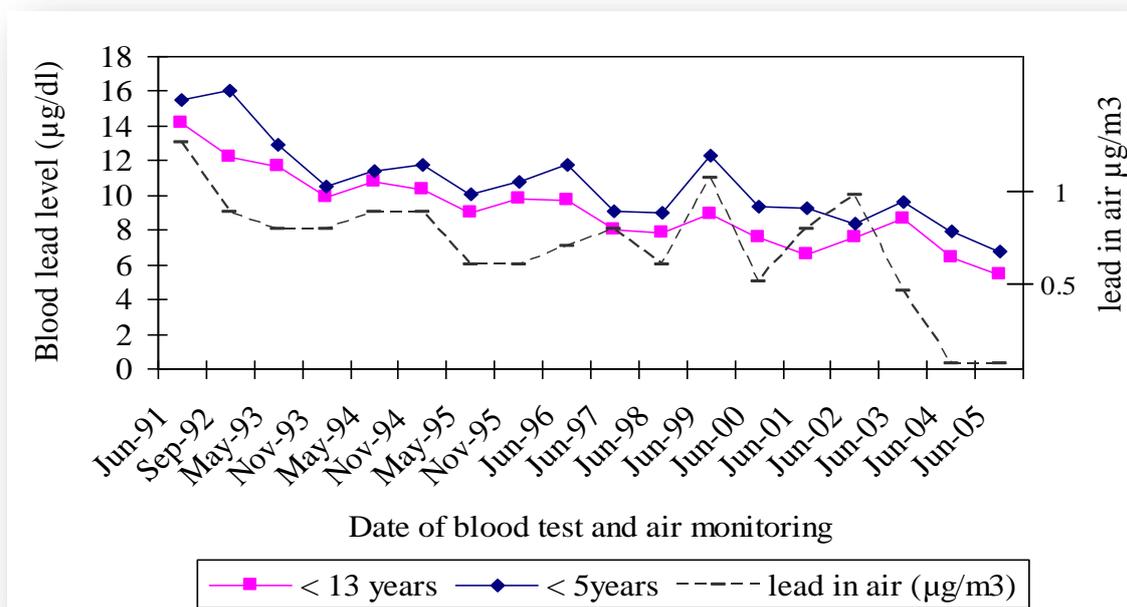
While these findings are reassuring, enhanced surveillance will continue. Paediatricians have been asked to maintain a low threshold for recommending testing and the antenatal service at John Hunter Hospital will offer blood lead testing to pregnant women from the North Lake Macquarie post code of 2284. Point of care testing using the Lead Care II will be available for those who missed out on recent screening, at monthly clinics in Warners Bay until February 2016.

While factors other than fresh smelter emissions may have contributed to a decrease in lead exposure, the closure of the smelter resulted in a more than 80% reduction in the lead in air levels between 2002 and 2004 (North Lake Macquarie Environment Health Centre, 2004, unpublished data), (Refer Figure 1). Reductions in lead exposure due to the phasing

out of lead in paint from the 1970's and phasing out of lead in petrol from 1985 to 2002 are unlikely to have contributed significantly to the subsequent rapid decline in blood lead levels (or lead in air levels) following the closure of the smelter in September 2003 (Refer Figure 1). A similar reduction in blood lead levels occurred among children aged 6-60 months living in Trail, Canada when the lead smelter was replaced with a lower emission smelter technology decreasing the average lead in air from 1.1 $\mu\text{g}/\text{m}^3$ in 1996 compared with 0.28 $\mu\text{g}/\text{m}^3$ in 1997.² Blood leads in Trail halved over 3 years without any change or enhancement to remediation programs.

Reductions of approximately 50% were observed in lead loadings and concentrations in outdoor dustfall, street dust and indoor dustfall after smelter emissions were reduced in Trail, Canada.² Slight reductions were observed in carpet dust and soil lead concentrations. The authors noted these finding challenged prevailing theories about the contribution of soil lead levels and concluded that increased attention should be paid to the importance of active sources of highly bioavailable and mobile lead bearing dusts. This finding parallels the reduction in average blood lead levels in the USA associated with the reduction in lead in air levels from phasing out of leaded gasoline without any significant remediation of historically contaminated soils.³

Figure 1. Blood lead levels of children < 5 years and < 13 years and lead in air levels, North Lake Macquarie, 1991-2006. Source: Hunter New England Population Health



Lead remediation in the North Lake Macquarie area has been limited since the closure of the smelter. Residential soil assessment for the Lead Abatement Strategy (LAS) that followed the closure of the smelter was offered to 1,969 eligible properties in the area. Of those, 1,238 accepted the offer of testing and after exclusions (vacant land, non-residential property, previously owned by Pasmenco, owners retracting the offer) 1,226 properties were sampled. Of those, abatement work was recommended for 437 properties and work was completed on 359 of those (after some owners withdrew from the strategy). The abatement

strategy excluded areas contaminated with slag and public lands. The LAS was less comprehensive than the prior remediation programs conducted in the area which appeared to have little impact on children's blood lead levels – as blood leads did not drop following the intervention and younger siblings often followed the same blood lead trajectory as their older counterparts. Hence the Lead Abatement Strategy likely had a limited impact on total lead exposure in the area.

While there have been interventions such as the Final Whistle and the Lead Safe Blitz to remind the community of lead control interventions, informal discussions with parents at the clinic did not indicate that parents were applying the often extensive lead control activities practiced while the smelter was in operation. Therefore it is unlikely the decrease in blood lead levels can be explained by behavioural modification.

The recent results are reassuring and confirm the downward trend of blood lead levels in young children. However it is important parents and pregnant women are aware of other potential sources of lead including pre-1970 paint, which may pose a risk, particularly during home renovations.

Conclusion

The results of this blood lead screening survey confirm the downward trend observed in 2005-06 and that the risk of children accumulating excess lead in the area has remained low since the closure of the smelter in 2003. Children's blood lead levels in the past appear to have been driven by exposure to fresh smelter emissions more so than lead contaminated soils.

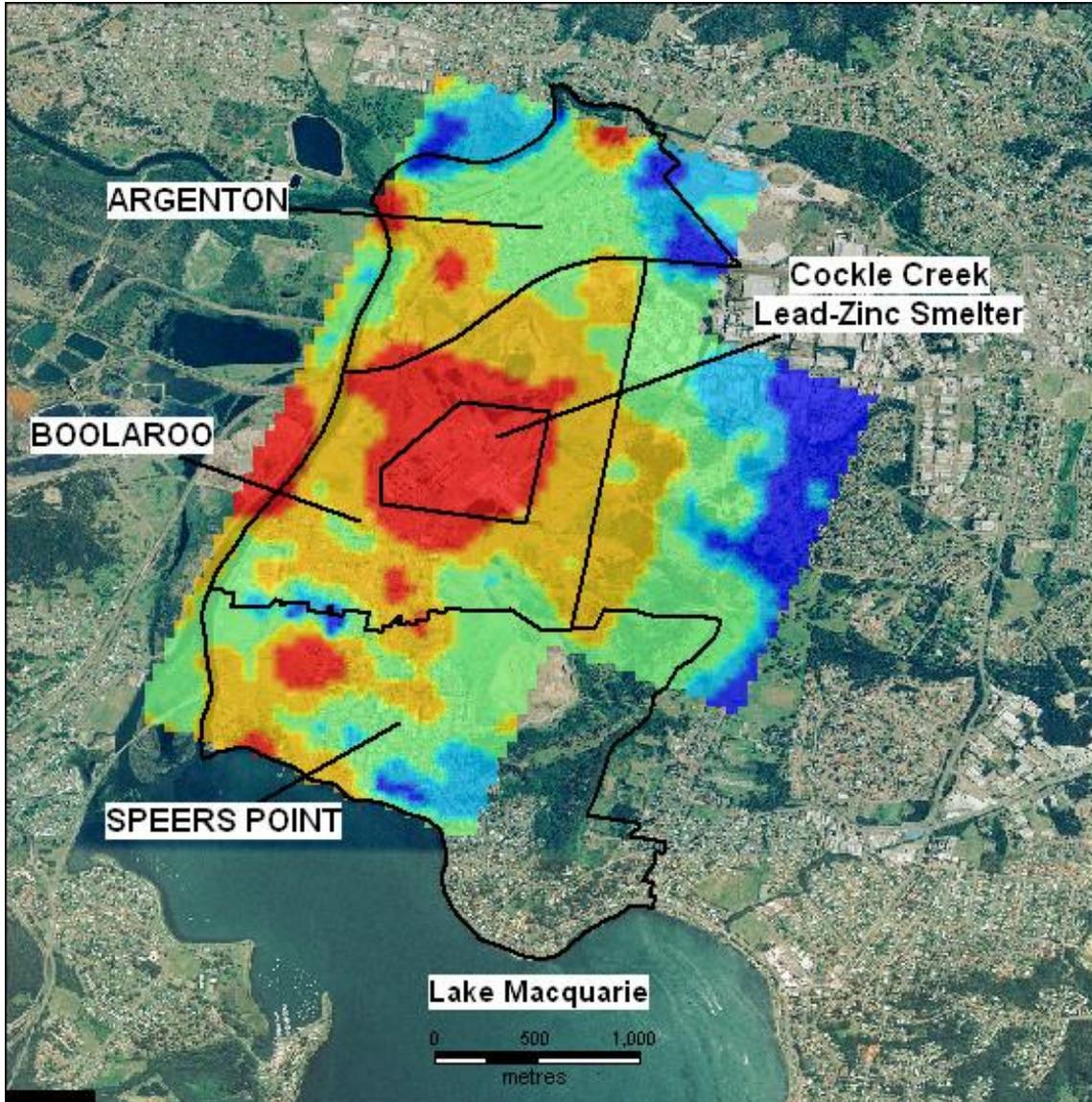
Appendix A

Blood lead levels of children aged six months to less than five years of age, by age, blood lead level and suburb in North Lake Macquarie, 29 June - 17 July 2015.

		Blood lead levels			
	Age (years)	<3.3 µg/dL	3.3 to ≤5 µg/dL	>5 µg/dL	Total
Suburb					
Argenton					
	6 months to <1	2	0	0	2
	1	5	1	0	6
	2	0	1	0	1
	3	5	0	0	5
	4	2	1	0	3
	Total	14	3	0	17
Boolaroo					
	6 months to <1	1	0	0	1
	1	4	0	0	4
	2	3	0	0	3
	3	5	2	0	7
	4	3	0	0	3
	Total	16	2	0	18
Speers Point					
	6 months to <1	6	2	0	8
	1	9	0	0	9
	2	7	0	0	7
	3	7	0	0	7
	4	4	2	0	6
	Total	33	4	0	37
Total		63	9	0	72

Appendix B

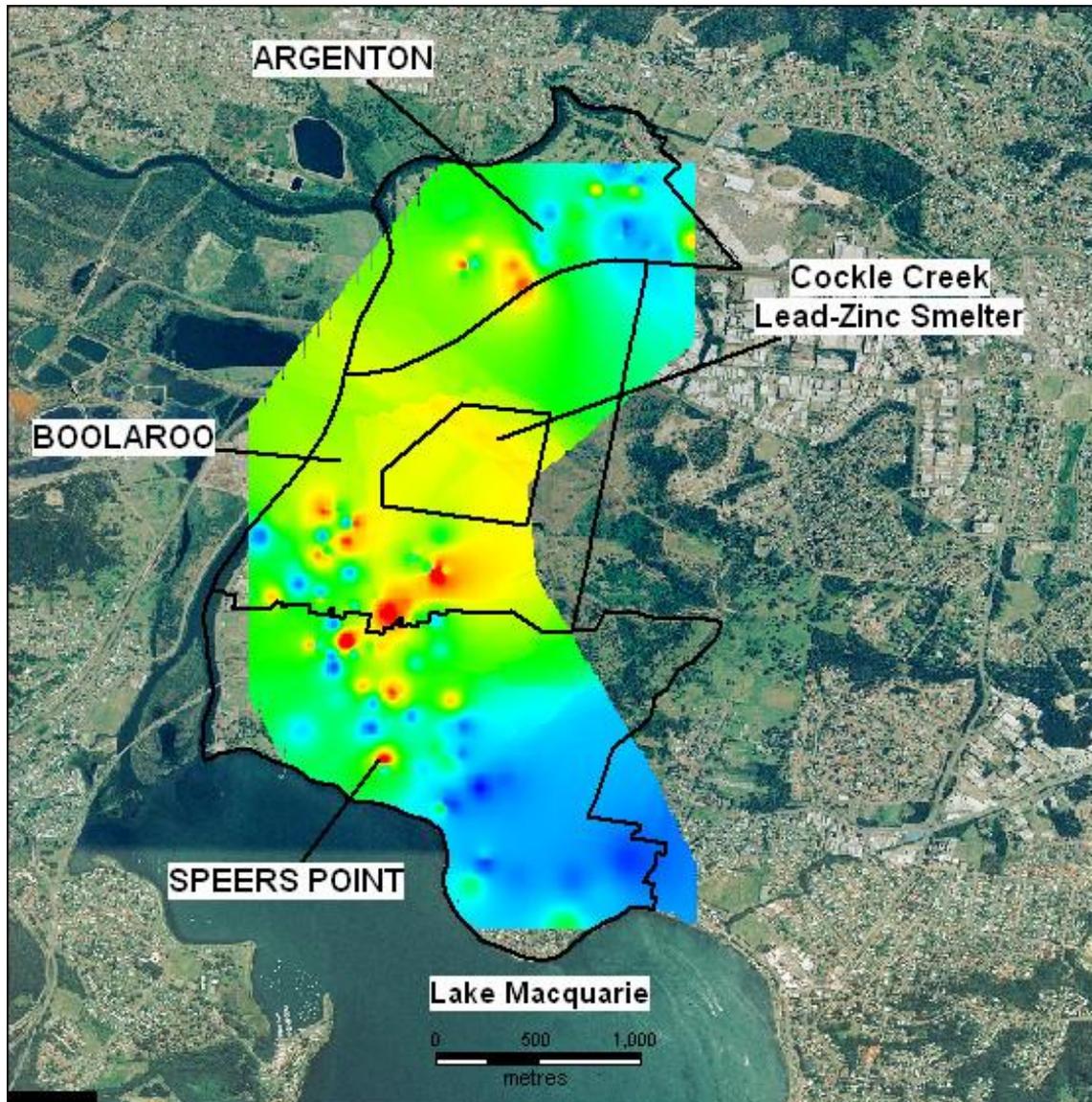
Soil lead concentrations in suburbs near a lead smelter in North Lake Macquarie 1992



Soil lead: Gridded and imaged 1992 soil lead concentration in the suburbs surrounding the Cockle Creek lead-zinc smelter, North Lake Macquarie, NSW, Australia. Navy: soil lead < 150 ppm, Turquoise: 150 ppm – < 300 ppm, Green: 300 ppm – < 1000 ppm, Orange: 1000 ppm – < 4000 ppm, Red: ≥ 4000 ppm

Source: Willmore A, Sladden T, Bates L, Dalton C. Use of geometric information system to track smelter-related lead exposures in children: North Lake Macquarie, Australia, 1991-2002, *International Journal of Health Geographics* 2006 **5**:30 doi:10.1186/1476-072X-5-30. Available at <http://www.ij-healthgeographics.com/content/5/1/30>

Appendix C Blood lead levels in children in suburbs near a lead smelter in North Lake Macquarie in 2002



Blood lead: Gridded and imaged 2002 blood lead levels of child residents in the suburbs surrounding the Cockle Creek lead-zinc smelter, North Lake Macquarie, NSW, Australia. Navy: BLL < 5.5 µg/dL, Turquoise: 5.5 µg/dL – < 7.5 µg/dL, Green: 7.5 µg/dL – < 10 µg/dL, Yellow: 10 µg/dL (the NHMRC national level of concern)- < 15 µg/dL, Red: ≥ 15 µg/dL. Source: Willmore A, Sladden T, Bates L, Dalton C. Use of geometric information system to track smelter-related lead exposures in children: North Lake Macquarie, Australia, 1991-2002, *International Journal of Health Geographics* 2006 **5**:30 doi:10.1186/1476-072X-5-30. Available at <http://www.ij-healthgeographics.com/content/5/1/30>

1. Harvey PJ, Taylor MP, Kristensen LJ, Grant-Vest S, Rouillon M, Wu L, Handley HK. Evaluation and assessment of the efficacy of an abatement strategy in a former lead smelter community, Boolaroo, Australia. *Environ Geochem Health*. November 2015. DOI:10.1007/s10653-015-9779-8.
2. Hilts SR. Effect of smelter emission reductions on children's blood lead levels, *Science of the Total Environment*, vol. 303, no. 1-2, pp. 51–58, 2003.
3. Pirkle JL, Brody DJ, Gunter EW, et al. The decline in blood lead levels in the United States: the National Health and Nutrition Examination Surveys (NHANES). *JAMA* . 1994;272(4):284–291