



TRAIL LEAD PROGRAM

Sentinel Homes Project - Summary of 1994-98 Results

Primary Project Objective

To measure changes in environmental conditions which result from smelter emissions improvements and other lead remediation efforts.

Secondary Project Objective

To enhance the Task Force's understanding of seasonal variability in lead exposure and the means by which lead is transferred into houses.

Project Description

Environmental data are collected quarterly from a network of 35 homes at consistent locations over a period of 5-6 years. Samples of carpet surface dust and indoor dustfall are collected at each home during each quarter. Street dust is sampled during snow-free quarters. Outdoor dustfall is collected monthly at each home, or at a location within one block of each Sentinel Home.

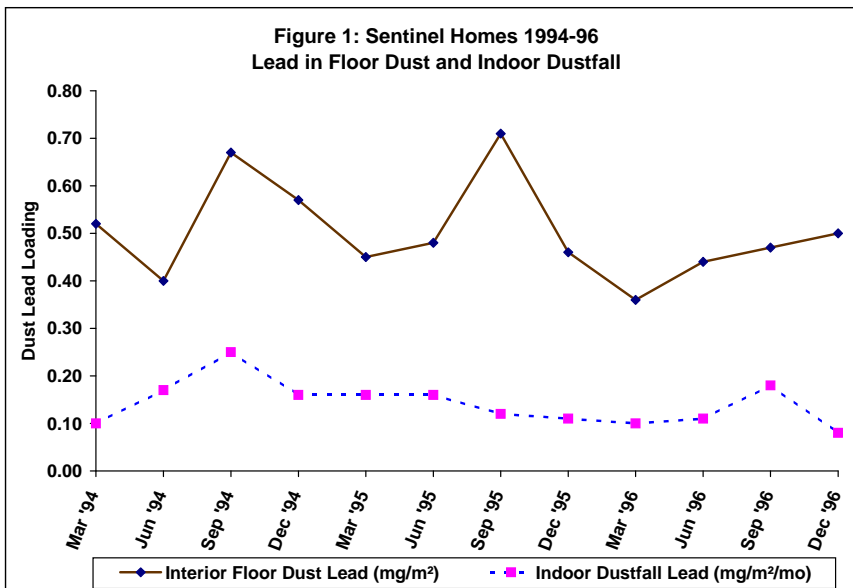
In 1995, we also began collecting soil and HEPA vacuum bag samples during the 3rd quarter of each year.

On each visit, we also note percent ground cover in each yard, use of door mats, whether renovations have been made to the house during the preceding quarter and whether new carpets have been installed.

1994 - 1996 Results

The 1994-96 period provides three complete years worth of baseline data from before the new lead smelter began operation. We also conducted

several specific assessments of lead dust movement using Sentinel Homes data collected in 1994.

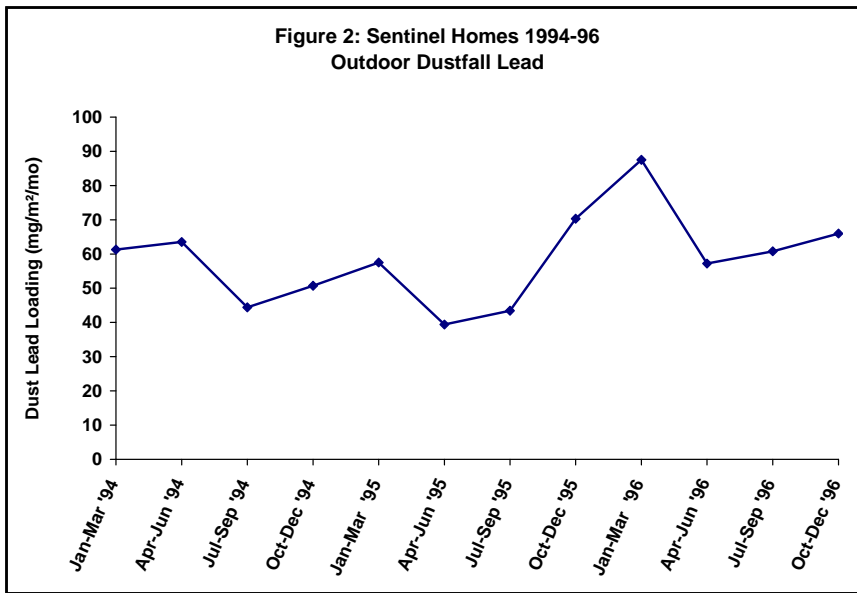


Seasonality

We expected lead levels indoors might be highest at the end of summer, after homes had been open to the outdoors more, and when the ground in the community was snow-free and dry. There was a tendency for indoor lead levels to be higher in September, but the seasonal trend was not consistent.

Figure 1 shows that average floor dust lead loadings did peak in September of 1994 and 1995, but not in 1996.

Indoor dustfall lead peaked in September 1994 and 1996, but not in 1995.

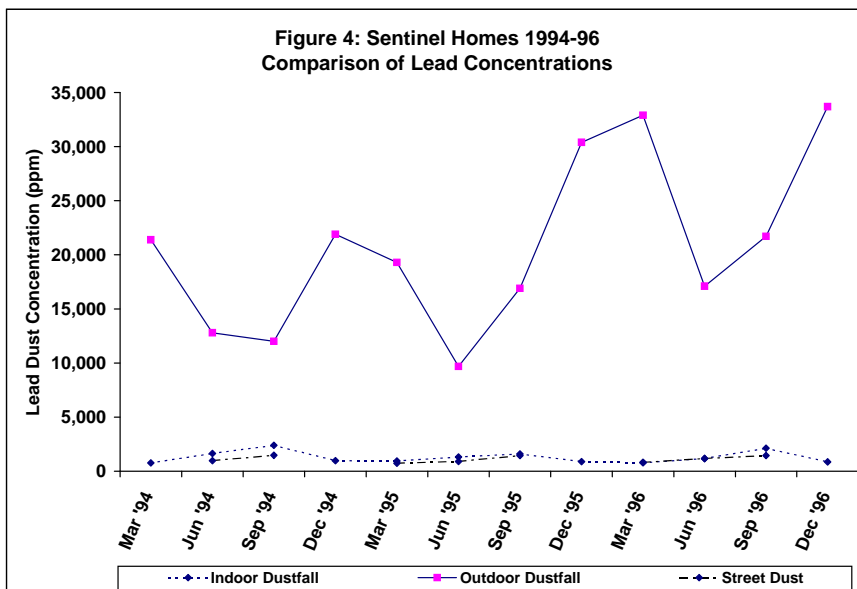
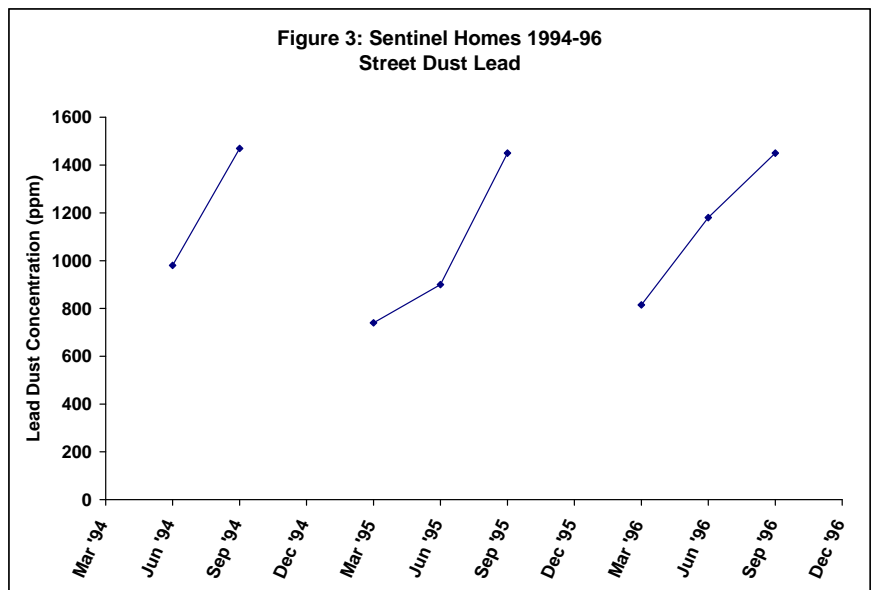


Many years of monitoring outdoor dustfall at Cominco and Ministry of Environment stations has shown that outdoor dustfall lead loadings peak during winter months, when smelter emissions are more poorly dispersed (winds are lighter and temperature inversions are more common in winter).

Figure 2 shows that average outdoor dustfall lead levels near the Sentinel Homes also peaked during winter months from 1994-96.

Figure 3 shows that each year from 1994 through 1996, average street dust concentrations have risen to about 1500 ppm by September. Street dust concentrations appear to start out at about 800 ppm in March, when there is still a lot of uncontaminated sand on the roads from winter maintenance.

Street dust samples could not be collected in March 1994, due to late snow cover.



Lead Concentrations by Media

Figure 4 shows that lead concentrations in outdoor dustfall are 10-20 times higher than concentrations in indoor dustfall and street dust. Soil and floor dust concentrations are not shown on this graph, but they are in the same order of magnitude as the street dust concentrations.

As postulated in our "Site Characterization Report", the fact that concentrations in outdoor dustfall are so much higher than in other media suggests that the major source of lead in dustfall must be current smelter emissions, rather than windblown soil or dust from the community.

Entry Mats

In June '94, we placed new entry mats in 33 of the Sentinel Homes and sampled them for surface dust immediately, then again in September. The mats had virtually no lead on their surfaces when placed in the homes and by September, the loadings were about 5 times the average for carpet surfaces in the interiors of the homes. (Similar to the factor of 7 times observed in the 1992 Exposure Pathways Study in Trail.)

We also noted that homes where entry mats were used at two entrances had significantly lower interior carpet lead loadings and indoor dustfall lead loadings than those homes where only one or no entrances had a mat. This effect was still significant even after statistical adjustment for neighbourhood (i.e. it isn't just that there are more homes with mats in some neighbourhoods.)

This indicates that entry mats trap and hold large quantities of lead dust at the door. The only down side is that people must ensure that children don't play on these mats and that they are cleaned frequently (e.g. monthly).

New Carpets

A number of the Sentinel Homes had new carpets installed during 1994. We noted that the lead loadings on the surfaces of these carpets were often the same as the loadings on other carpets in the house, only a few weeks or months after installation.

We also noted that the presence of new carpets in the home had no relationship to the amount of lead measured on carpet surfaces or in the indoor dustfall jars. The HEPA House Cleaning Project in 1993 also showed that carpet surface lead loading was not significantly related to age of carpets.

This indicates that the rate of contamination of interior floors in 1994 was high enough that carpet replacement might not provide much benefit. People considering getting rid of old carpets should consider replacing them with smooth flooring, which is easier to keep clean and does not act as a reservoir for lead particles, dust mites and other allergens.

In 1999, we will be collecting separate house dust samples from any new carpets installed in our Sentinel Homes. Also, in a separate project, we will be repeating our assessment of the rate of recontamination of carpets following thorough HEPA vacuuming, to see if the rate is lower now that smelter emissions are less.

Ground Cover

We observed that homes with less areas of bare soil in their yards had lower amounts of lead on interior carpet surfaces (also seen in 1992 Pathways Study and in studies done elsewhere). This effect was also still noticeable after statistical adjustment for neighbourhood. We also noticed a tendency for indoor dustfall lead levels to be lower in homes with less bare soil outdoors.

This finding confirmed the need for improving ground cover, which the Task Force supported through the Rotary Club Community Dust Abatement Project and through the Trail Lead Program's Case Management Program.

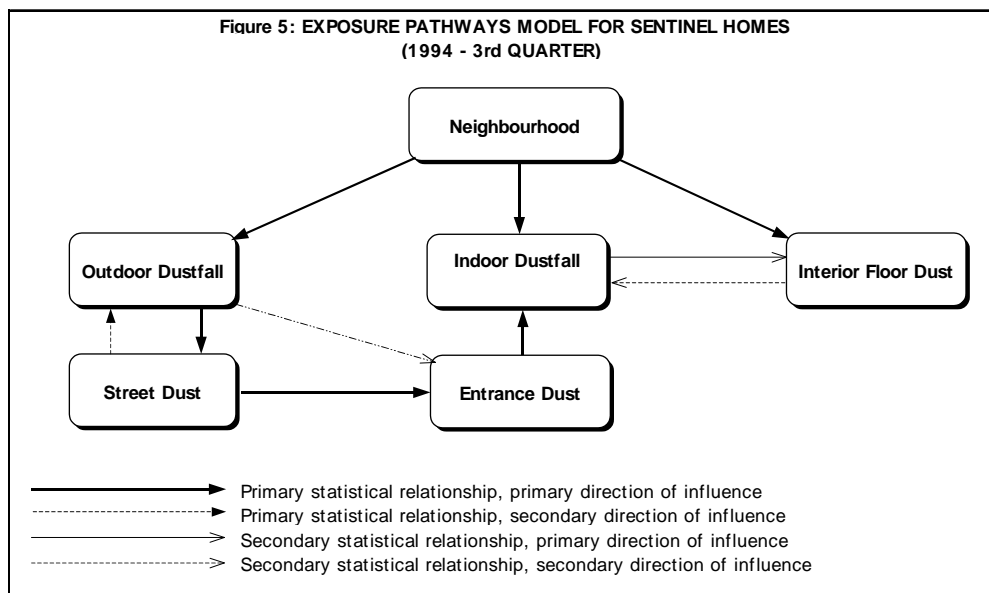
Renovations

Although only a small percentage of Sentinel Homes were under renovation in 1994 (typically about 5 of the 35 in each quarter), we saw that indoor dustfall lead was always significantly higher in homes being renovated. Carpet dust lead loading also tended to be higher in homes being renovated.

This confirms findings in previous studies and emphasizes the importance of following guidelines on renovating available from the Trail Lead Program

Pathways of Lead Movement into Homes

As in previous studies, neighbourhood was found to be the most important predictor of the level of lead in many of the media measured. This is because distance from the smelter and topography determine how much smelter emissions fallout occurs at each location.



The pathways diagram on the left shows that neighbourhood has a statistically significant effect on outdoor dustfall, indoor dustfall and interior floor dust. The diagram is based on structural equations modelling of relationships observed in the 3rd quarter results, as this was the quarter for which we had the greatest number of street dust and exterior entrance dust measurements.

The pathways diagram also shows that when neighbourhood is removed from consideration, the only measure directly associated with interior floor dust lead is

indoor dustfall lead. In turn, indoor dustfall lead appears to be influenced by exterior entrance dust lead. Entrance dust seems to be influenced by street dust and by outdoor dustfall. Finally, outdoor dustfall lead is a function of neighbourhood.

This pathways model is similar to that developed from the 1992 Trail data, with the addition of indoor dustfall as a new variable.

Results since New Lead Smelter Began Operation

The new lead smelter (NLS) commenced operation in April, 1997. Therefore, the floor and street dust samples collected in June 1997, and the indoor and outdoor dustfall samples from June-Sept 1997, are the first samples which represent the new conditions of dramatically reduced smelter emissions. However, the start-up of the new smelter was a complicated process, and it did not operate smoothly at full design capacity until December 1998.

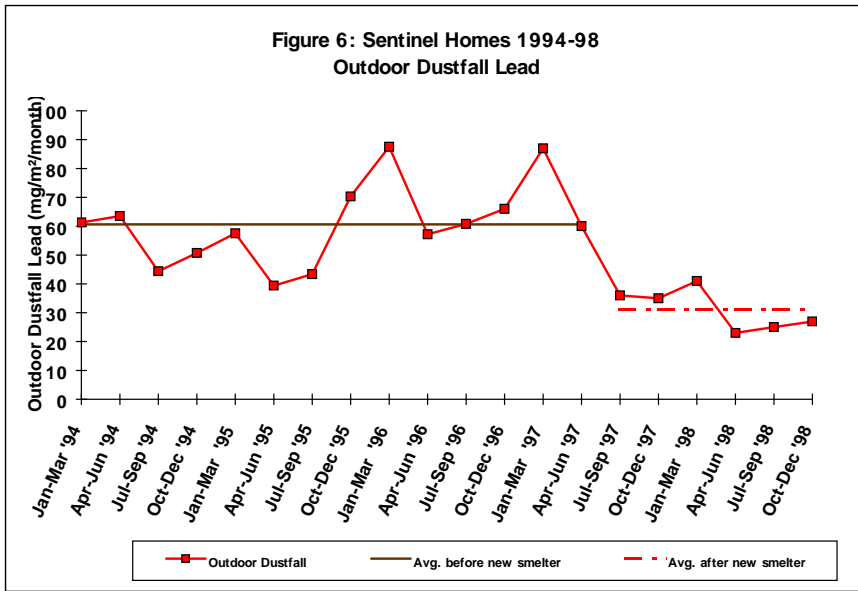
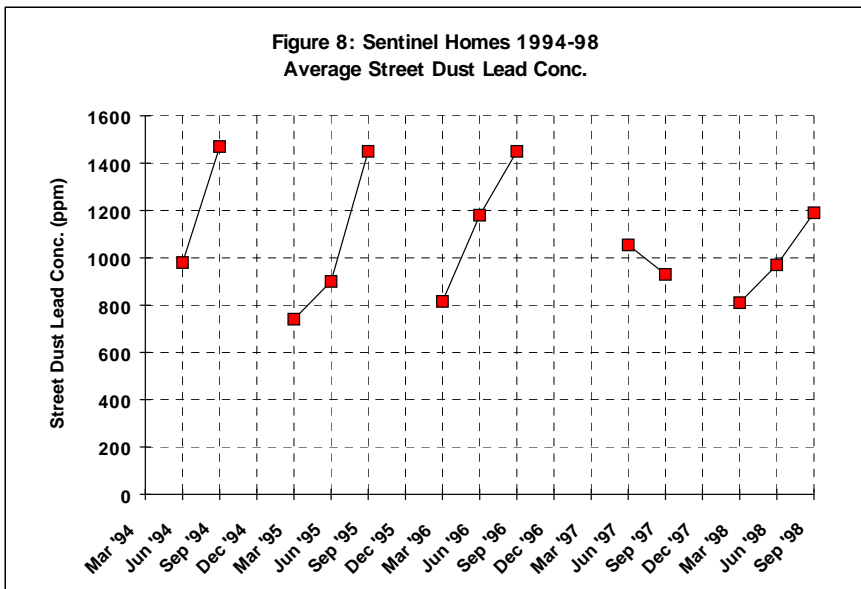
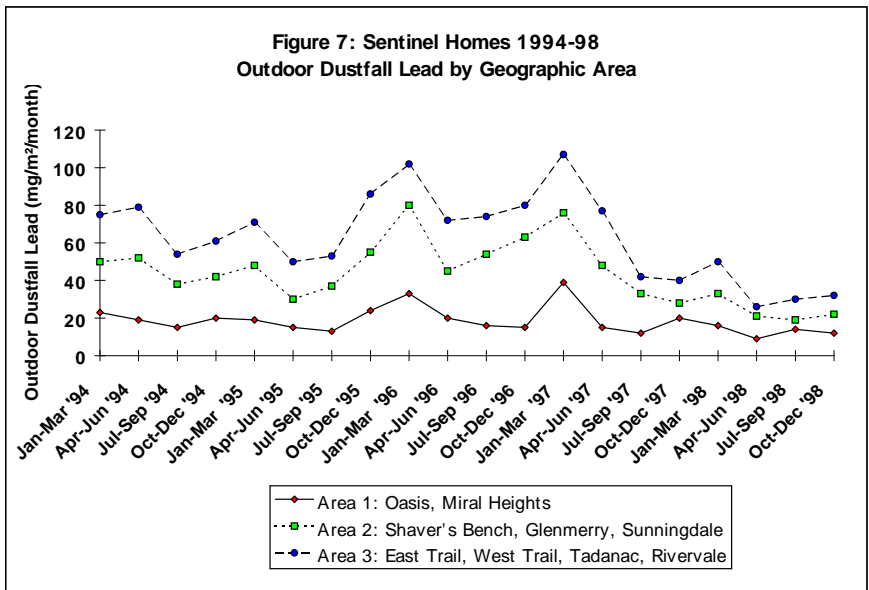


Figure 6 shows that the average outdoor dustfall loading fell about 50% from "before NLS" (1994-June 1997) to "after NLS" (July 1997- December 1998).

This decline is not surprising, given that smelter lead emissions have been reduced about 70% by the NLS. We had expected that reduced smelter emissions would have an immediate impact on the amount of lead in dustfall.

Figure 7 shows that the improvement in outdoor dustfall lead loadings has been most noticeable in the areas closer to the smelter (areas 3 & 2). This suggests that the NLS emission reductions have occurred mostly in the larger sized particles, which used to settle out relatively close to the smelter.

We have also noted that children's blood lead levels have shown the greatest improvement in areas close to the smelter, since the NLS started up.



The average street dust lead concentration in September has declined from about 1500 ppm before the NLS to about 1100 ppm after the NLS, as shown in Figure 8.

Average street dust concentrations in Mar and June do not appear to have changed.

The improvement in September street dust lead concentrations has occurred mostly in the area closest to the smelter (area 3).

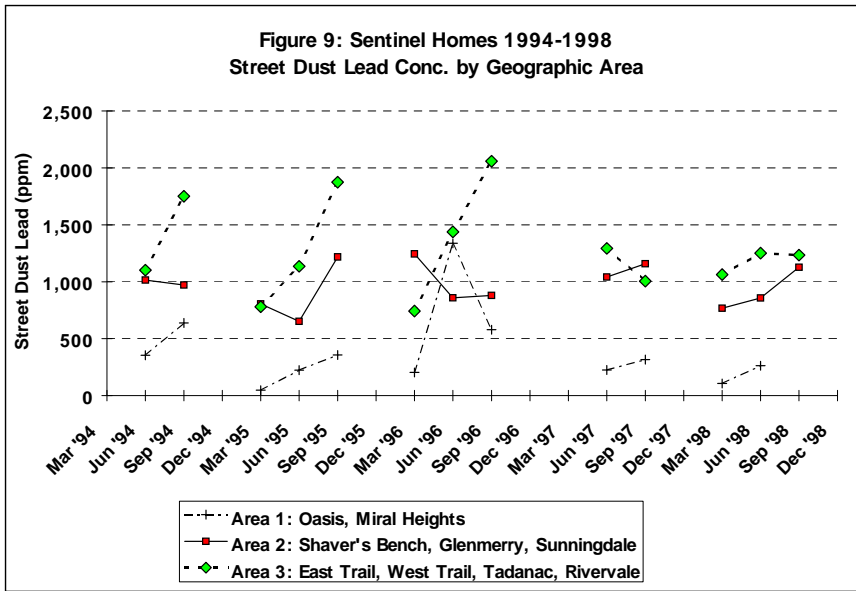


Figure 9 shows that most of the reduction in late summer street dust lead concentrations has occurred in the area closest to the smelter (Area 3).

Indoor dustfall lead loadings also appear to have improved since the new smelter began operation. Figure 10 shows that indoor dustfall lead loading has decreased by about 40%.

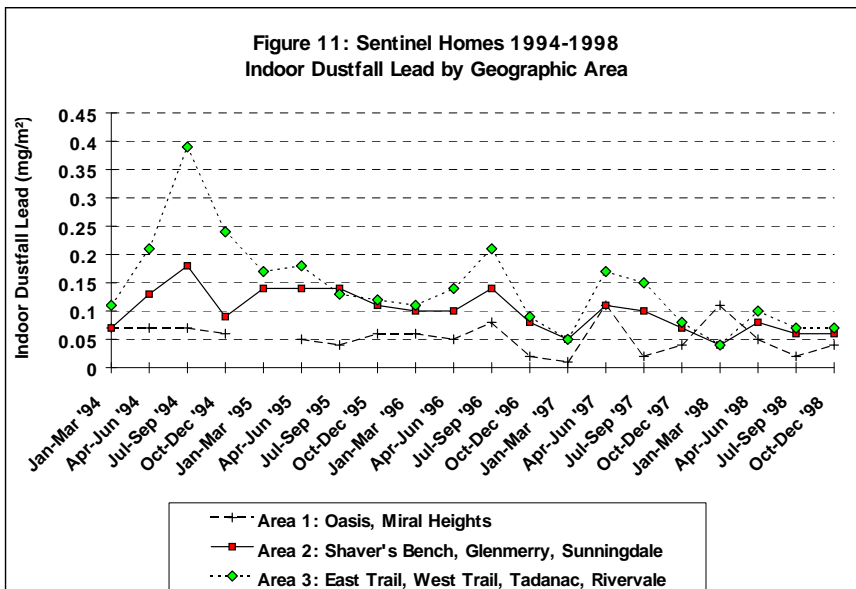
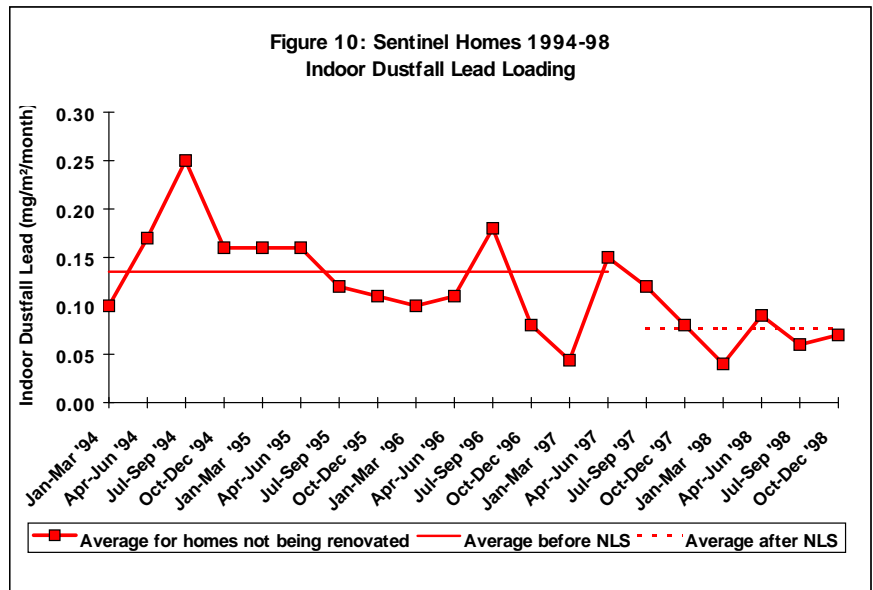
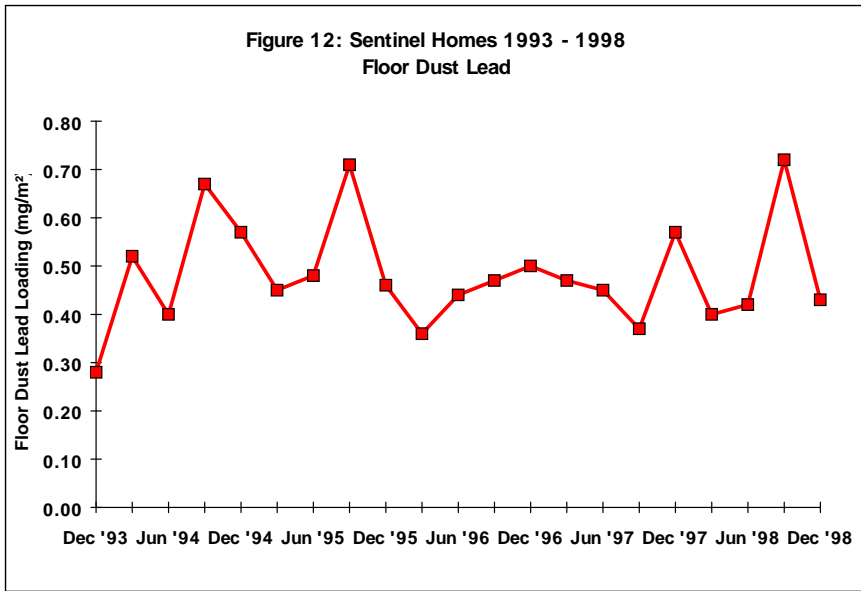


Figure 11 shows that, as with outdoor dustfall and street dust, most of the improvement in indoor dustfall lead loadings has occurred in Area 3 near the smelter.



Unfortunately, the average lead loading on carpets in our Sentinel Homes is not showing any improvement since start-up of the new lead smelter.

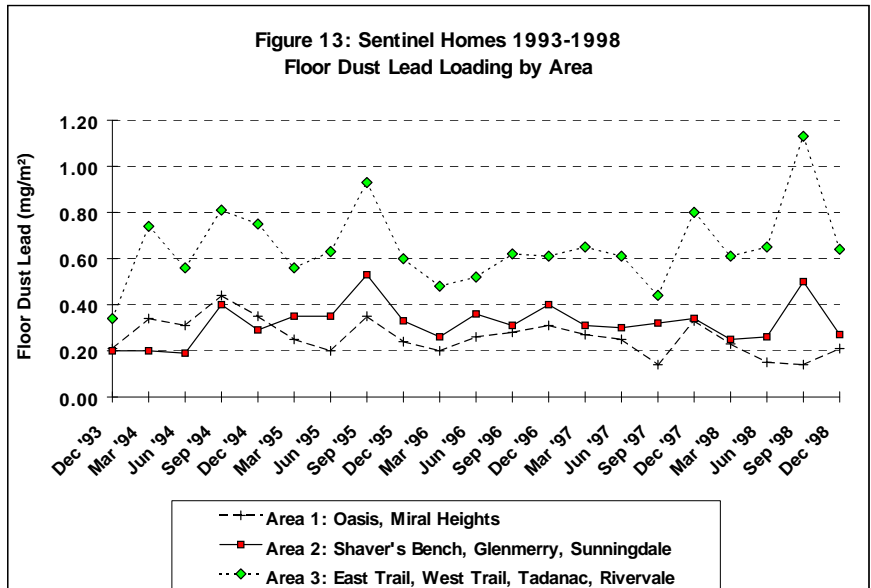
Overall, the trend from 1993 - 1998 appears to be toward increasing floor dust lead loadings.

Since floor dust lead loadings are likely quite dependent on the residents' housekeeping efforts, it is possible that a change in housekeeping effectiveness is responsible for the apparent increasing trend in dust lead levels. Many of our Sentinel Homes participants had young children at the start of the program, but as the years have gone by, most of these children have passed the age of greatest concern for lead exposure. Therefore, it is possible that their parents

might have become less concerned about maintaining very low dust levels in their homes during the later years of this program.

If the trend in floor dust lead levels in Sentinel Homes is actually representative of all homes in the community, then it is possible that intensified efforts to remove contaminated house dust from carpets might result in significant further reductions in children's lead exposure. Our reassessment of the rate of contamination of carpets this summer will be very important in answering this question.

Figure 13 shows that even when the floor dust results are examined by geographic area, no improvement is evident in any of the three areas.



Conclusions

1. Sentinel Homes monitoring is indicating that lead levels in outdoor dustfall, street dust and indoor dustfall have been significantly reduced since the new lead smelter was started up.
2. Most of the improvement in lead levels has occurred in neighbourhoods closest to the smelter. This supports our observation that children's blood lead levels have also shown the greatest improvement in areas close to the smelter.
3. Floor dust lead levels in the Sentinel Homes have not shown any improvement to this point. This summer, we will be repeating our 1994 assessment of the rate of contamination of carpets with lead dust, to see if the rate is lower now that smelter emissions have been reduced. If the rate of contamination is found to be lower, then intensified efforts to remove house dust from carpets might be expected to result in significant further reduction in children's lead exposure.
4. The first year of Sentinel Homes monitoring results (1994) confirmed some previous findings regarding lead exposure pathways:
 - Entrance mats can trap and hold large quantities of lead dust at the door;
 - New carpets quickly became contaminated with lead dust;
 - Homes with less bare soil in their yards had lower amounts of lead on interior carpet surfaces and in indoor dustfall; and
 - Indoor dustfall lead was also significantly higher in homes being renovated.