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Sampling Report:
Surface Soil Lead Levels in Winnipeg, Manitoba: 2007 & 2008

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EXECUTIVE SUMMARY

The Province of Manitoba conducted a series of studies in Winnipeg in the 1980s to investigate lead (Pb) concentrations in soils from boulevards, school yards, and playgrounds in the inner-city. Lead levels at some of the sites were above 2600 µg/g, which was the action criterion used at the time. As a result, remediation measures, such as removal and replacement of contaminated soil, were undertaken at several sites in Winnipeg.

Manitoba Conservation now uses the Canadian Council of Ministers of the Environment (CCME) soil quality guidelines when assessing a site for potential impact. The CCME human health protection guideline for lead in residential/parkland areas is 140 µg/g. This guideline was exceeded in the majority of the soil samples collected during the surveys of the 1980s. It must be emphasized that the current guideline for lead is to be used for screening purposes only and exceeding the guideline indicates that more site specific investigation may be appropriate to determine if there is unacceptable risk to human health.

Many of the sources of lead that resulted in the elevated concentrations, such as leaded gasoline, are no longer present. However, lead bonds with organic matter and other particles in the soil and can persist in the surface soil layer even though the source of the lead is no longer present. Thus, it was expected that much of the lead that was present in the soil during the 1980s would still be there.

In late August through September 2007, the Habitat Management and Ecosystem Monitoring Section of the Wildlife and Ecosystem Protection Branch re-sampled soil at sites that had been sampled during the 1980s. A total of 45 samples from 6 playgrounds, 97 samples from 7 school yards, and 77 samples from boulevards in four separate residential areas were collected. Most sample sites were in older, inner city neighbourhoods in central Winnipeg.

Concentrations of lead in most of the sod, soil, and aggregate samples collected in 2007 were lower than concentrations recorded at these sites during the 1980s. Dramatic decreases in concentrations at some sites were likely due to sod, soil, or aggregate replacement during the intervening years. More modest decreases in lead levels can be attributed to a decline in

deposition of lead at the surface, coupled with gradual movement of the metal down the soil profile. Most sand and aggregate samples collected from designated play areas in playgrounds (ex: sand boxes, under swing sets and play structures) and in school yards (ex: paved or concrete play surfaces) had very low concentrations of lead. Although lead concentrations were usually less than those recorded in the 1980s, levels in sod and soil at a number of sites (7) still exceeded the current CCME guideline. This included sod and soil samples collected from the Weston Elementary School sports field, from grass covered areas in a number of playgrounds, and from the boulevard along Sutherland Ave. in North Point Douglas.

In response to the 2007 soil survey, a second survey was conducted in 2008. The sampling in fall 2008 focused on collecting and analyzing surface soil, sand, pea gravel, and other surface aggregate material from City of Winnipeg playgrounds and sports fields in the vicinity of potential past and present point sources of lead. The lowest levels of lead in 2008 were usually found in sand and pea gravel samples collected from playgrounds and from sand/aggregate samples collected from the infield areas of baseball diamonds. Only one of the 90 samples collected from playgrounds and sports fields in 2008 had a lead concentration above the CCME guideline. This was from a grassed area in a playground bordered by Logan Ave.

The 2007 and 2008 results, coupled with the data collected in the 1980s, show that soil concentration arising from point sources of lead tends to be very localized, while impact along major roadways, due to the historic use of leaded gasoline

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INTRODUCTION

The Province of Manitoba conducted a series of studies in the late 1970s and the 1980s to investigate lead (Pb) concentrations in the City of Winnipeg, MB. One of the initial studies, undertaken in 1979, found elevated concentrations of lead in foliage and surface soils associated with industrial and non-industrial sources of lead in the west end of the city (Wotton 1980). Results from a subsequent sampling program in the Weston area of the city in the early 1980s showed that there were high levels of lead in soils in the vicinity of a secondary lead smelter. A 1983 survey found elevated lead levels in a high proportion of the dust samples collected from paved play areas at seven schools, and in soil samples from boulevards in three neighbourhoods in the inner city (Jones and Wotton 1983). The highest lead concentrations recorded during this survey were usually found in samples collected adjacent to major traffic routes; suggesting that the main source was combustion of leaded gasoline in vehicles. Samples of sod, soil and aggregate material collected from seven playgrounds in 1984 also showed elevated levels of lead at several of the sites (Jones 1986). Again, the highest concentrations tended to be in samples collected near streets with high traffic volumes. An unpublished preliminary investigation of heavy metals in soils in the Point Douglas area in 1988 found high concentrations of lead in samples collected near major thoroughfares and in the vicinity of two metal scrap yards on Sutherland Ave. (Manitoba Environment 1989 unpublished data).

At the time of these surveys the Province of Manitoba was using the Ontario Ministry of Environment guideline of 2600 μg/g as an intervention criterion for lead in soil (Jones and Wotton 1982). Soil lead levels at some of the sites sampled during the 1980s were above this criterion, and as a result, remediation measures, such as removal and replacement of contaminated soil and sod, were undertaken at several sites during that period (Jones and Wotton 1982 & 1984, Jones 1985). While lead concentrations in some samples collected during the 1980s were above 2600 μg/g, the majority of the sites sampled had concentrations well below this amount, which at the time was considered acceptable for soil in an urban environment.

Manitoba Conservation now uses the Canadian Council of Ministers of the Environment (CCME) Canadian Soil Quality Guidelines when conducting an initial screening of potentially contaminated sites. In 1999 the CCME finalized a scientifically based series of guidelines

designed to protect human health from exposure to lead in soil (CCME 1999, Environment Canada 1999). These guidelines were developed for four different land use classes including agriculture, residential/parkland, commercial, and industrial land use. Because the exposure risk is higher, guidelines for agricultural and residential/parkland soils are usually lower than the guidelines for commercial or industrial soils. The CCME human health protection guidelines for lead in soil for the four land-use classes are as follows:

- Agricultural land use 140 µg/g
- Residential/Parkland land use 140 µg/g
- Commercial land use 260 µg/g
- Industrial land use 740 µg/g

If CCME guidelines are exceeded, then further investigation and assessment of the site may be required.

The discovery of elevated concentrations of lead in soil at the Barber House property in North Point Douglas in 2006 by Pinchin Environmental (2006), lead Manitoba Conservation to conduct a review of the historic data on lead in soils in the inner city. The review indicated that the levels of lead at a large percentage of the sites sampled in the 1980s exceeded the present CCME residential/parkland guideline of 140 µg/g. It was suspected that most of this lead originated from the past use of leaded gasoline in vehicles, with more localized sources being emissions from secondary metal smelters, off-site migration from scrap metal industries, and the weathering of lead-based paints. The chemistry of lead allows it to readily bond with organic matter in the upper layer of the soil. Depending on the rate of deposition, the metal may accumulate in this surface layer and remain at elevated levels for a prolonged period of time even though the source of the deposition is no longer present. Thus, although the main sources of lead were phased out some time ago, it was expected that, assuming the soil has remained in place, much of the lead that was in the soil in the 1980s would still be there. Concentrations of lead above the guideline level in soil samples collected in 1997 from community garden plots in the inner city (Jones 1998), and in 2006 from the Barber House property (Pinchin Environmental 2006), support this theory.

In response to this issue the Habitat Management and Ecosystem Monitoring Section of the Wildlife and Ecosystem Protection Branch of Manitoba Conservation, in conjunction with the

Manitoba Conservation Operations Division (Environmental Services and Central Region) conducted soil sampling programs in 2007 and 2008 to investigate levels of lead in soil in the inner city of Winnipeg. The objectives of the 2007 program were to re-sample selected sites that were sampled during the 1980s to determine if concentrations had changed appreciably over time at these sites and to provide a very preliminary assessment of present conditions by comparing the new results to the CCME residential/parkland guideline for lead in soil (140 µg/g). The 2008 sampling program evolved out of the 2007 program with the objective of determining the present extent of lead impact to playgrounds and other recreational areas in the vicinity of potential past and present point sources of lead in the inner city.

A detailed human health risk assessment was beyond the scope of the 2007 and 2008 sampling programs.

SITE SELECTION AND SAMPLING METHODS

The 2007 Sampling Program

Several hundred separate sample sites were included in the soil surveys conducted in the 1980s. During the site selection process for the 2007 sampling program it was decided that, rather than attempt to re-sample all of the original sites, the objectives of the sampling program could be met by choosing a representative sub-sample of sites from each of the 1980s surveys. Table 1 provides a summary of the sites that were selected for re-sampling. .

Table 1. Summary of sites included in the 2007 sampling program.

Sampling Program	**Number of Sites Sampled in 1980s**	**Number of Sites Re-Sampled in 2007**
Playgrounds (Jones 1986)	Total of 62 sample sites in 7 playgrounds	Total of 45 sample sites in 6 playgrounds
Schools (Manitoba Consumer and Corporate Affairs and Environment 1981 unpublished data, Wotton and Doern 1983, Jones and Wotton 1983, Jones 1985)	Total of 156 sample sites in 9 school yards	Total of 95 sample sites in 7 school yards
Residential Boulevards (Jones and Wotton 1983, Manitoba Environment 1989 unpublished data)	Total of 123 sample sites in 4 residential areas	Total of 77 sample sites in 4 residential areas

An attempt was made to re-sample as close as possible the locations that were sampled during the 1980s studies. However, because the sites were not geo-referenced when they were first sampled in the 1980s, information about sample site locations had to be gleaned from existing published reports, line maps and diagrams, and photographs. Thus, the locations sampled in 2007 may not actually be the precise points that were sampled in the 1980s. Care was also taken to duplicate as close as possible the sampling protocols and soil preparation and analysis techniques that were used previously. It is important to note that sampling protocols varied somewhat in the 1980s surveys.

Playground Sites

Six of the seven playgrounds sampled in 1984 (Jones 1986) were re-sampled in 2007 (Figure 1). This included Archibald Tot Lot, Hespeler Park, Home Playground, Jacob Penner Park (formerly Notre Dame Park), Maryland Tot Lot, and Spence Tot Lot. Several sites were sampled within each playground. In both 1984 and 2007 there was considerable variation in ground cover at the playgrounds including a mix of grassed areas, sand and other aggregate material under swings and in sand boxes, and bare soil in shrub beds. Bare soil, sand, or other aggregate material samples were collected to a depth of 5 cm. Sampling of grassed areas involved collecting separate samples of the sod and top 5 cm of the underlying soil layer. A 5 cm diameter stainless steel soil sampler was used to collect the samples. Two to three cores of sod and two cores of soil, sand, or aggregate material, were collected for each sample in order to ensure that an adequate amount of material was available for analysis. The thickness of the sod sample was recorded to facilitate bulk density calculations. Sites re-sampled in 2007 were geo-referenced with a Global Positioning System receiver (GPS) and each playground was photographed.

The surface sod layer was usually readily distinguishable by the higher amount of roots and organic matter and generally lower bulk density relative to the underlying soil layer. However, at some sites, and in particular those where the sod and soil have been in place for many years, differentiation between the two layers was difficult and somewhat more subjective. This may have introduced some error into the sampling protocol and will have to be taken into account when comparing the 2007 results with the historic results.

Figure 1. Aerial photo of central Winnipeg showing locations of playgrounds re-sampled in 2007.

A composite sample of the top 2.5 cm of surface soil was also collected at five of the playgrounds re-sampled in 2007. Each composite sample consisted of a total of 20 soil cores (extracted using a 2 cm diameter Oakfield soil sampler) collected at approximately 3 – 5 m intervals along an "X" pattern criss-crossing each playground. Each sample was a mix of the various ground cover materials present at each site. Since this sampling protocol was not used in the 1984 survey, the results are not directly comparable to the historic data. However, this was done to determine the average concentration of lead currently in the surface contact layer for the entire playground.

School Yard Sites

Seven school yards that were sampled in the 1980s were sampled again in 2007 (Figure 2). These included Weston Elementary and Tyndall Park Elementary, both of which had been sampled previously during a relatively intensive survey of lead concentrations in soil in the Weston area of Winnipeg (Manitoba Consumer and Corporate Affairs and Environment 1981

unpublished data, Wotton and Doern 1983, Jones 1985). The remaining schools were originally sampled as part of a 1983 survey to determine if lead levels in school yard play areas were related to traffic flow volumes (Jones and Wotton 1983). Schools in the 1983 survey included Lord Nelson Elementary, Archwood Elementary, Dufferin Elementary, Fort Rouge Elementary, and Gordon Bell High School.

Figure 2. Aerial photo of central Winnipeg showing locations of school yards re-sampled in 2007.

Sampling at most of the school yard sites in the 1980s involved collecting loose soil, dust, and other particulate matter from paved or gravelled play areas using a small whisk brush. This sampling method was repeated in 2007 for sites located on paved, concrete, or gravelled areas. However, there were several sites at some schools that, although paved or gravelled when sampled in the 1980s, were now covered with soil and sod. The re-sampling protocol for these sites involved collecting 20 cores of the top 2.5 cm of surface material (sod, soil, or a combination of both) with a 2 cm diameter Oakfield soil sampler. All twenty cores were

extracted in close proximity to each other in order to minimize spatial variability at each sample site.

The sports field at Weston Elementary was sampled fairly extensively during surveys in 1981 (Manitoba Consumer and Corporate Affairs and Environment 1981 unpublished data). Sample sites were positioned at approximately 15 m (50 feet) intervals along six transects running across the field from Logan Ave. south to Alexander Ave. (Figure 3). Separate samples of sod and the top 5 cm of underlying soil were collected from each of the 30 sample sites during the 1981 survey. Twenty-one of these sites were re-sampled using the same method in 2007.

All school yards re-sampled in 2007 were photographed, each sample site was geo-referenced with a GPS, and the thickness of the sod samples collected was recorded to allow for volume and bulk density calculations.

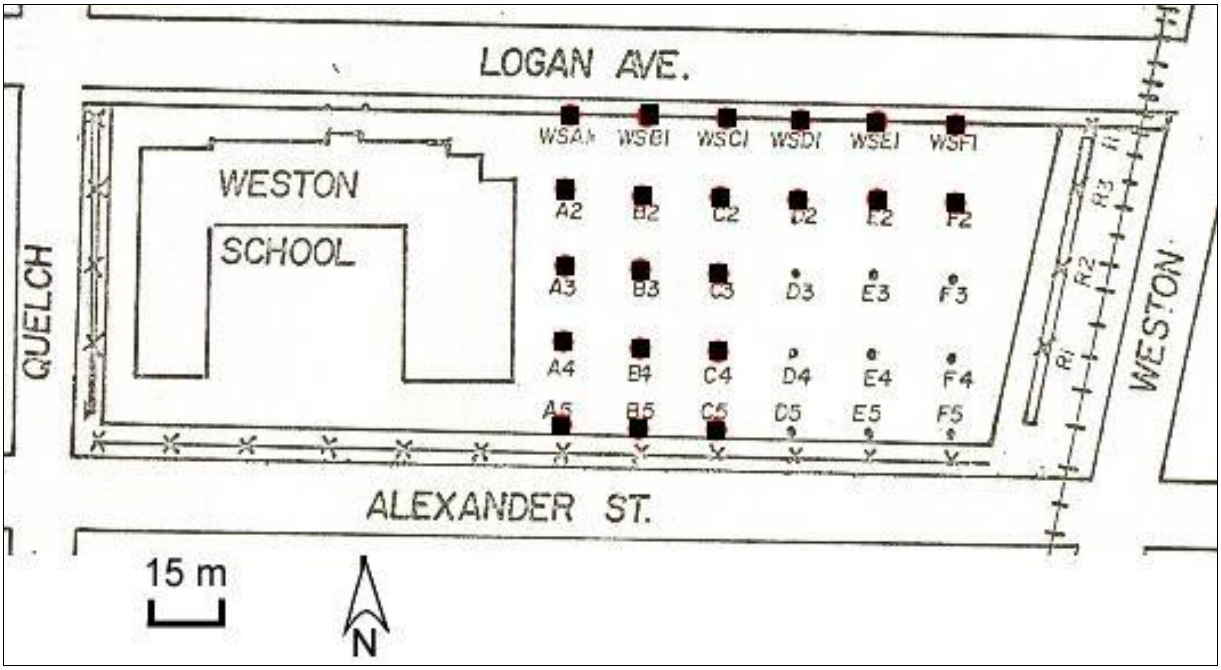

Figure 3. Locations of sample sites at the Weston Elementary sports field originally sampled in 1981. Large symbols indicate which sites were re-sampled in 2007.

Residential Neighbourhood Sites

A number of boulevard sites were sampled for lead concentration in several inner city neighbourhoods during the soil studies of the 1980s (Figure 4). Residential streets in present day neighbourhoods of Wolseley and Minto (referred to as Wolseley in the 1983 study), Riverview and Lord Roberts (Riverview), and Glenelm and Chalmers (Elmwood) were sampled in 1983, while streets in North Point Douglas were sampled in 1988. The objective of the sampling in 1983 was to determine if lead levels in boulevard soils were related to traffic flow volumes. Each of the neighbourhoods sampled in 1983 was associated with one of more major traffic routes. The 1983 results indicated that lead levels were highest where residential streets intersected with a major thoroughfare and decreased with distance away from the thoroughfare (Jones and Wotton 1983). The sampling program in North Point Douglas in 1988 concluded that elevated lead levels on boulevards were likely the result of a combination of vehicle emissions and possibly off-site impact (ex: airborne dust) from local scrap metal industries (Manitoba Environment 1989 unpublished data).

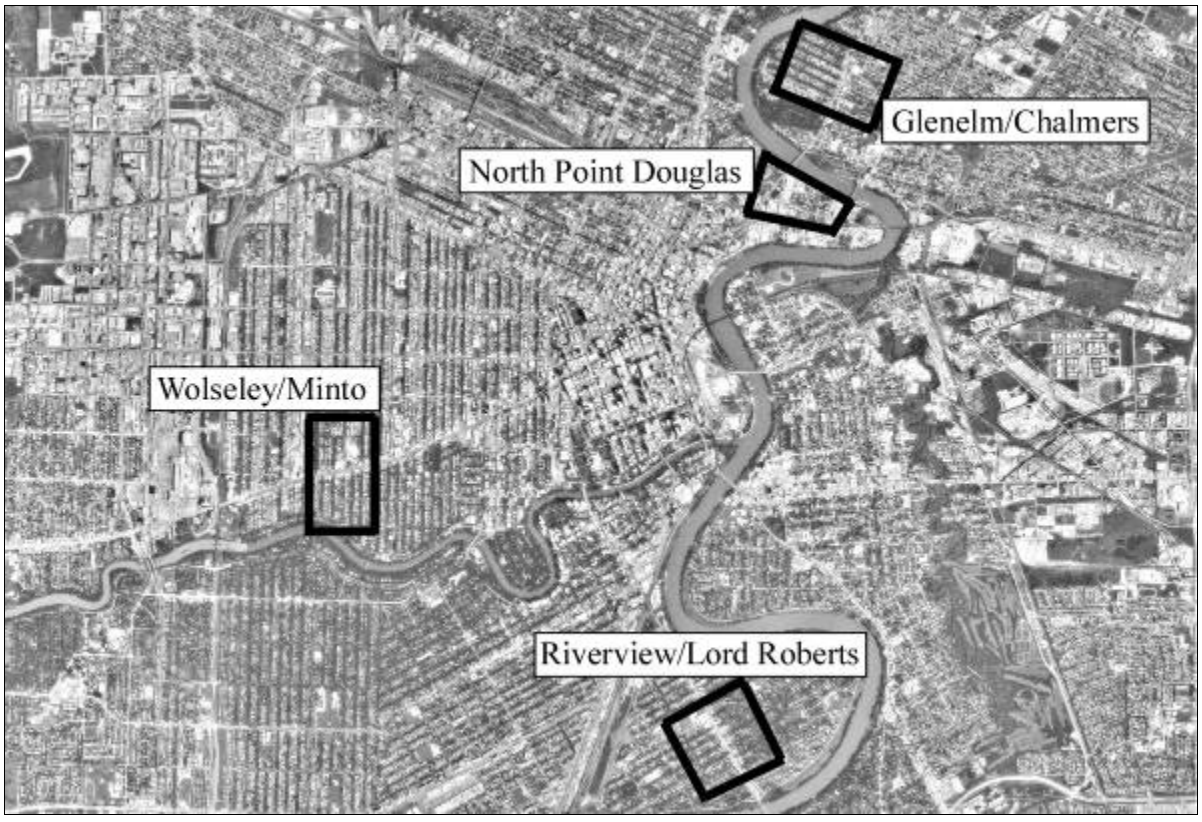

Figure 4. Aerial photo of central Winnipeg showing the location of residential neighbourhoods re-sampled in 2007.

Seventeen of the original 29 sites in Wolseley/Minto, 20 of 30 sites in Riverview/Lord Roberts, 17 of 26 sites in Glenelm/Chalmers, and 23 of 38 sites in North Point Douglas were re-sampled in 2007. Sampling in Wolseley/Minto, Riverview/Lord Roberts, and Glenelm/Chalmers involved collecting separate sod and soil samples from each site as outlined previously in the sampling of playgrounds and the Weston Elementary sports field. Sampling of sites in North Point Douglas involved collecting the top 5 cm of surface material, which usually amounted to a combination of 2 to 3 cm of sod and the upper 2 to 3 cm of underlying soil. Sod thickness (if present) was noted and all sample sites were geo-referenced with a GPS.

Samples of the top 2.5 cm of surface material (sod, soil, aggregate, or a combination of the three) were also collected at several selected sites in North Point Douglas to allow comparison between sampling protocols. Each sample consisted of 20 cores of surface material extracted in close proximity to each other using a 2 cm diameter Oakfield soil sampler.

The 2008 Sampling Program

Several known and suspected point sources of lead in Winnipeg were initially identified at the outset of the site selection process for the 2008 sampling program. These include three secondary lead smelters which operated for a number of years in the west end area of the city, several metal scrap recycling yards and metal manufacturing operations, and rail yards and other such heavily impacted industrial lands located mainly in the inner city. It is important to note that the secondary lead smelters are now closed. However, because of the tendency for lead to bind to soil particles, it is conceivable that, barring any soil replacement or improvements in the interim, elevated levels of the metal remain in soils impacted by these and other sources.

Site Selection

Data collected by the Province in 1981 (Manitoba Consumer and Corporate Affairs and Environment 1981 unpublished data) showed elevated concentrations of lead within a radius of at least 450 - 500 m of the Canadian Bronze Co. Ltd. smelter site. This smelter was located on Bury St., north of Logan Ave. in the Weston area of the city (Figure 5). The smelter operated for a number of years before closing in the 1990s. The smelter site property was remediated in 1999 – 2000 (Webber 2008, personal communication). The 1981 data were collected along eight transects extending outward from the smelter stack in the four cardinal and four intercardinal

directions. Concentrations fluctuated considerably along each transect, and although there was a general decrease in concentration with distance, sample points near the terminus of several transects still had concentrations of lead as high as 1000 µg/g. Krawchuk (1980) had collected soil samples in the vicinity of the Canadian Bronze Co. Ltd. smelter a few years prior to the provincial surveys. His results showed levels of lead as high as 450 µg/g and 780 µg/g at approximately 700 m southwest and west of the smelter respectively. However, since Krawchuk mainly collected boulevard soil samples, there was a possibility that the lead present was from vehicle exhaust (leaded gasoline use) or other sources in addition to emissions from the smelter.

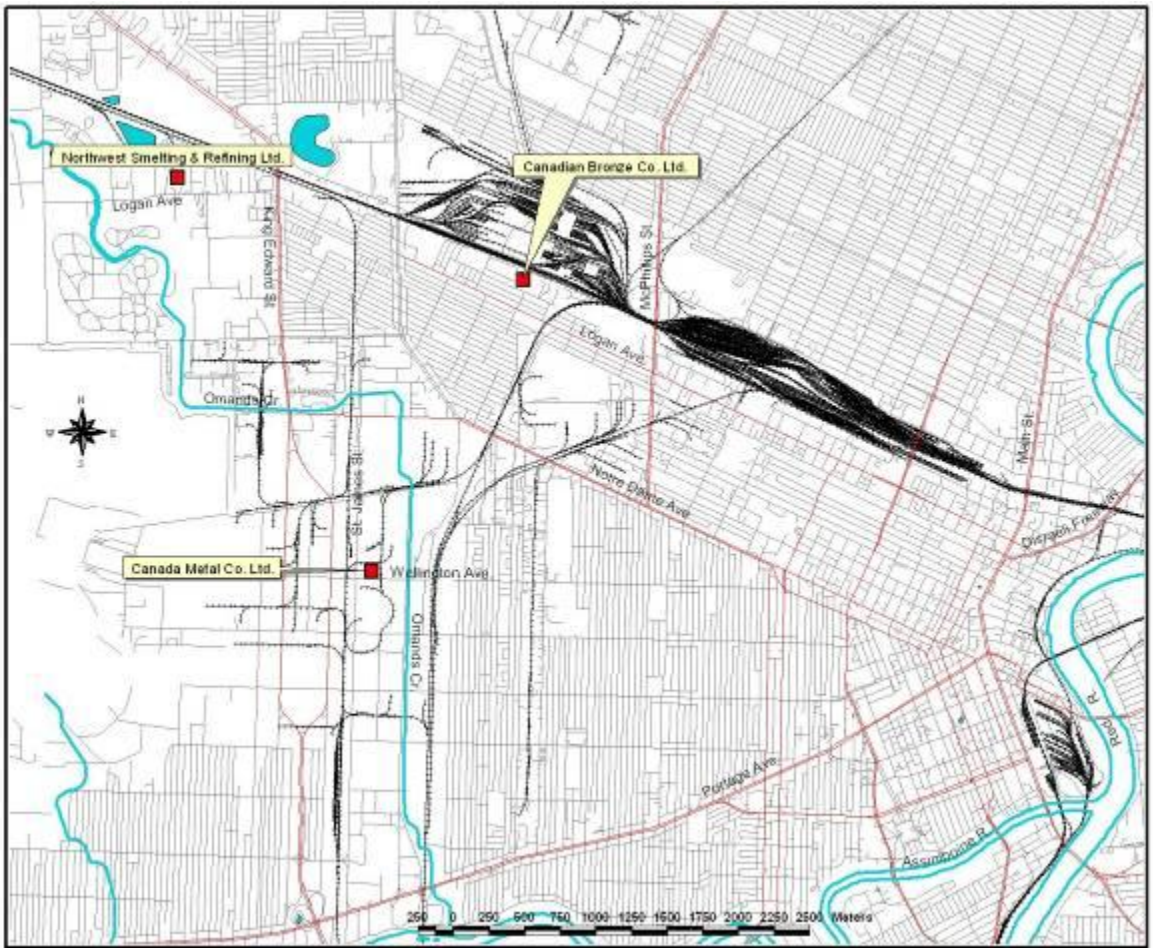

Figure 5. Location of the three secondary lead smelter sites in Winnipeg, MB.

The two other secondary lead smelters that operated in the city include the Canada Metal Co. smelter, which was located at St. James St. and Wellington Ave. in the St. James Industrial Park area of Winnipeg, and the Northwest Smelting Co. smelter, which was located in an industrial/commercial area at the west end of Logan Ave. (Figure 5). The Canada Metal Co. smelter operated from 1954 to 1976, with battery storage and smashing (to remove lead content)

occurring at the site from 1954 to 2002. All activities at the site ceased in 2002 and the area was remediated in 2004 (Webber 2008, personal communication). The Northwest Smelting Co. ceased smelting operations in the early 2000s (Webber 2008, personal communication). Soil samples collected by Krawchuk in 1978 and 1979 (Krawchuk 1980), and by the Province in 1979 (Wotton 1980) and 1982 (Manitoba Consumer and Corporate Affairs and Environment 1982 unpublished data) showed elevated concentrations of lead in the soil in the immediate vicinity of the Canada Metal site. However, concentrations in three samples collected from 300 - 600 m away from the smelter were relatively low (range 180 - 230 µg/g) (Krawchuk 1980). A similar trend was also observed in soils sampled by Krawchuk and the Province near the Northwest Smelting site.

It must be noted that the intensity and extent of sampling around the latter two smelters was quite limited compared to the sampling associated with the Canadian Bronze operation. This is likely because the Canadian Bronze smelter was located adjacent to a residential area, while the other two smelters were not. Nonetheless, the historic sampling results suggest that, depending on the facility, soil impact may extend at least as far as 700 m.

Boulevards and residential property samples collected by the Province in 1988 near scrap metal yards on Sutherland Ave (North Point Douglas) showed elevated levels of lead in soils within a zone of approximately 60 m of the scrap yards (Manitoba Environment 1989 unpublished data). Results from re-sampling some of the boulevard sites during the 2007 program indicated that soils within this zone still had elevated levels of lead. Soil sampling conducted by Manitoba Conservation in a residential area near a battery recycling scrap yard in Brandon in 2005 revealed elevated lead levels in soil within a zone of about 75 m from the property (Dillon Consulting Limited 2007). Concentrations of lead at the Brandon sites were all below 500 µg/g; however, concentrations near the Sutherland Avenue scrap yards were often considerably higher.

Based on the historic concentrations and the data collected in 2007, and erring on the side of caution, sample sites for the 2008 sampling program were limited to the area within a 1500 m radius of each smelter and 200 m radius of each metal scrap/recycling yard (or other such potential industrial point source of lead). Sample sites included publicly accessible City of Winnipeg recreational areas such as playgrounds and sports fields where there was a potential for

children to be exposed to lead in the soil through normal play activity. The list of sites included 18 playgrounds with play structures and/or designated play areas, 13 baseball diamonds, 12 soccer pitches, and 2 football fields (Figure 6). Several of the sites actually fell within the influence of two or more potential sources of lead. GIS software (Arcview 3.1, ESRI), aerial photography (Manitoba Land Initiative), satellite imagery (Google Earth), and field level ground-truthing were also employed in the site selection process.

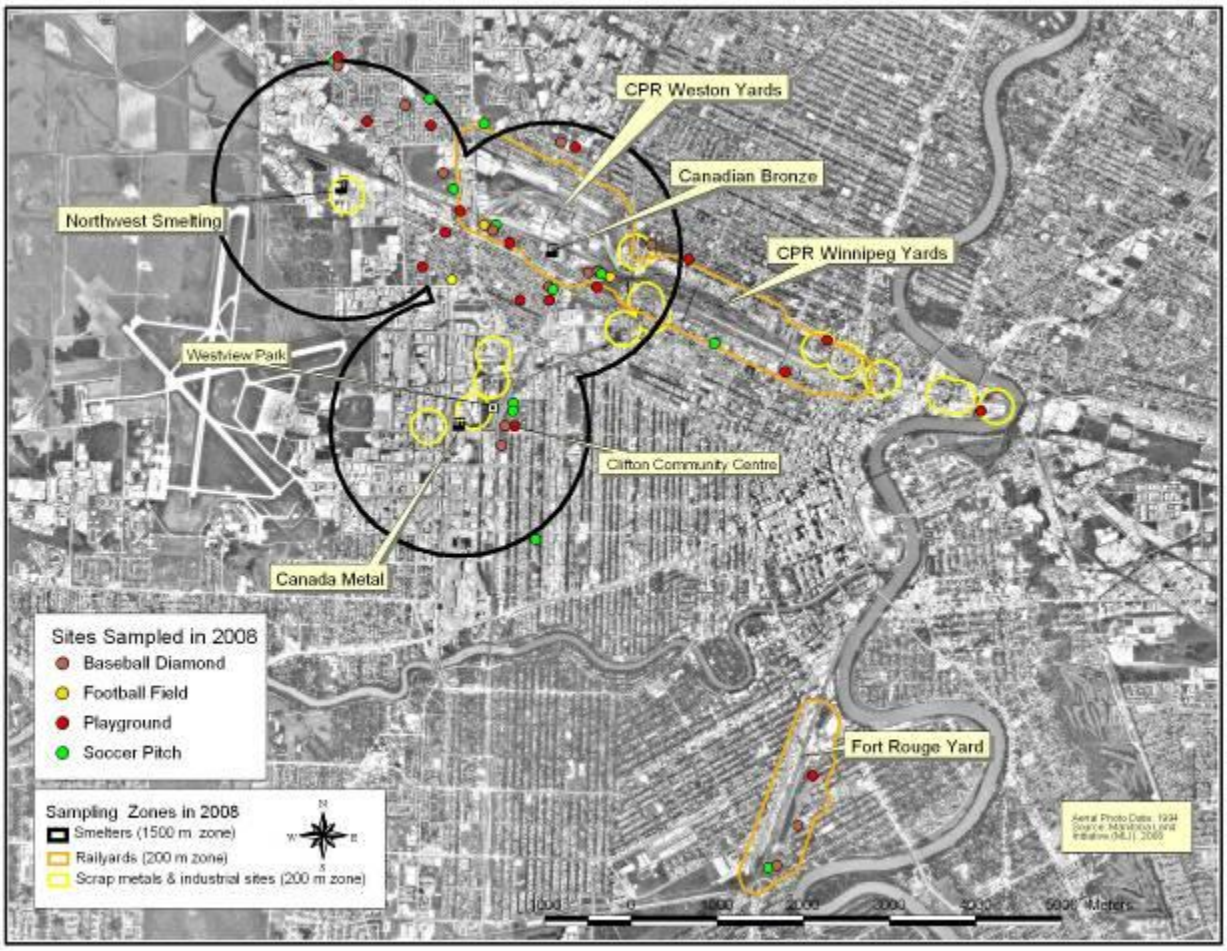

Figure 6. Map of Winnipeg showing playgrounds and sports fields selected for sampling in 2008.

In addition to sampling playgrounds and sports fields, three surface soil samples were also collected from Westview Park, which is located between the old Canada Metal smelter site and the Clifton Community Centre complex. Westview Park does not have any play structures or designated play areas that may be frequented by young children and therefore did not actually fit the selection criteria for sampling in 2008. However, because elevated levels of lead were recorded at the park in the 1980s and the park is adjacent to the Clifton Community Centre

complex the decision was made to collect samples to provide information on present day levels in the park. Surface soil samples were taken from grassed areas near the Wellington Ave. entrance area and from the south and north ends of the park.

Sampling Methods

Sampling playgrounds in 2008 involved collecting separate surface soil, sand, and pea gravel samples. Soil samples from grassed areas in playgrounds were taken from the top 2.5 cm of the soil profile (generally the "sod" layer) using a 2 cm diameter Oakfield soil sampler (Figure 7). Each sample consisted of a composite of 20 cores to ensure that an adequate amount of material was available for laboratory analysis. The soil cores were extracted at intervals along two transect lines forming an "X" pattern at each playground site. Effort was made to collect the samples in such a way as to be representative of the site size and dimension. Thus, the length and shape of each transect and the sampling interval along each transect varied between sample sites. Sand from sand boxes and sand and pea gravel from under and around play structures was collected to a depth of 5 cm using a 5 cm diameter stainless steel soil sampler. Three cores were collected per sample to ensure adequate sample size.

The outfield and the infield areas of baseball diamonds were sampled separately. The surface area of infields usually consisted partially or wholly of aggregate materials such as sand or finely crushed rock. These areas were sampled to a depth of 2.5 cm using an Oakfield soil sampler. Cores were extracted from the infield at intervals along two transect lines forming an "+" pattern; one transect extended roughly from first base across to third base, and the other extended from home plate out to second base. Ball diamond outfields were grass covered and soil samples were extracted to a depth of 2.5 cm along two parallel lines across the width of each field. Soil samples from soccer pitches and football fields were also extracted to a depth of 2.5 cm with an Oakfield soil sampler. However, unlike the ball diamonds, samples from pitches and football fields were collected along two transects forming an "X" pattern across each field. Twenty soil cores were collected per sample from each ball diamond and sports field to ensure an adequate amount of material for analysis.

(a)  **(b)** 

(c) 

Figure 7. Collecting soil and sand samples. (a) sampling soil using a 2 cm diameter Oakfield soil sampler; (b) sampling sand from a sand box using a 5 cm diameter sampler; (c) a typical playground with grassed area, sand box, swings, and play structure.

Samples were collected in replicate at each site. Sampling tools were rinsed with distilled water and wiped dry with facial tissue between sampling sites. Sampled material was placed directly into pre-labelled plastic bags and kept cool while awaiting laboratory preparation and analysis. All sample locations and sites were geo-referenced with a GPS and photographed.

Sample Preparation and Analysis

All sod, soil, and aggregate samples collected in 2007 and 2008 were processed using methods similar to those used in the 1980s. Fresh samples were weighed and then lightly disaggregated by hand and placed in a drying oven at 60^{o}C until dry (at least 48 hours). Dried samples were weighed again and then further disaggregated by light grinding with a mortar and pestle. Pebbles, roots, pieces of vegetation, and any large foreign material were removed by sieving with a #10 Canadian Standard sieve (2 mm). Each sample was then ground somewhat more vigorously with a mortar and pestle and screened through a #80 Canadian Standard sieve (0.177 mm). Care was taken to not pulverize any small pebbles or sand particles while grinding. The mortar, pestle, and sieves were cleaned thoroughly between samples using a combination of high pressure vacuum and wet wiping and drying with paper towel.

A 15 g portion of the screened material was submitted to CANTEST Laboratories Ltd (Burnaby, BC) for analysis. Laboratory analysis involved digesting a sub-sample (1 g) of soil in a mix of nitric and hydrochloric acids, and then analyzing the extract for lead content using inductively coupled argon plasma spectroscopy (ICAP). The laboratory detection limit for lead was 0.2 μg/g. Soil moisture and bulk density were calculated using fresh and dry weights and known sample volumes. Material that did not pass through the sieves, as well as any remaining sieved material, was archived for possible further analysis in the future. Only one of the two replicate samples collected in 2008 was submitted for analysis. The remaining sample served as back-up material in case the first replicate was lost and, if necessary, to help verify results of the first replicate.

RESULTS AND DISCUSSIONS

The 2007 Sampling Program

Playground Sites

As in 1984, concentrations of lead in sod, soil, and other aggregate materials varied between and within playgrounds in 2007. Overall, the concentration of lead at most playground sites was lower in 2007 than in 1984. However, there were several exceptions to this as shown

in Table 2. It is probable that the large decrease in lead at some sites was the result of sod, soil, or aggregate enhancement or replacement since 1984, while sites where lead concentrations remained elevated likely had not received this type of attention.

Concentrations of lead in sod and soil at most of the playground sites sampled in 1984 were above the present CCME residential/parkland guideline for human health protection of 140 μg/g. While the data show that concentrations were substantially lower in 2007 (particularly in sod and sand samples), there were still a number of sites with lead levels above the guideline. It is notable from a health risk perspective that concentrations of lead in the composite samples and in samples collected from areas most frequented by toddlers and children (ex: sand boxes and under swings and play structures) were all well below the CCME guideline (Table 2).

School Yard Sites

According to the 2007 results, the levels of lead to which school students might be exposed have decreased quite dramatically at the sites that were sampled as part of the 1983 school yards survey (Table 3). The sites sampled in 1983 were located on paved, concrete, or graveled play areas within each school yard. Samples collected in 1983 consisted of dust, soil, sand, and other aggregate materials present on the play area at the time of sampling. Each of these school yards is bordered by a major traffic thoroughfare, and the high concentrations of lead that were recorded at these sites in 1983 were attributed to exhaust from vehicles using leaded gasoline. Some of the play areas where these sites were originally located have since been resurfaced with concrete or pavement, or are now covered with soil and sod. This, in addition to the fact that widespread use of leaded gasoline was phased out by the late 1980s, appears to have resulted in relatively low lead concentrations being measured in 2007.

Almost all school yard play surface samples collected in 1983 had levels of lead above the current CCME guideline for residential/parkland soil. However, by 2007 the concentrations at these sites were considerably lower, and only a few of the sites had levels of lead above the guideline.

Table 2. Concentrations of lead in samples collected from sites in Winnipeg playgrounds in 1984 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g. Note that summary statistics do not include composite samples.

Playground	2007 TQ Site	1984 Site Number	Pb in Surface Sod Layer (µg/g)		Pb in top 5 cm of Soil under Sod Layer (µg/g)		Pb in Sand/Aggregate (µg/g)		Comments
			1984	2007	1984	2007	1984	2007	
Archibald Tot Lot	TQ0795	1	**190**	124	**160**	**241**	-	-	sod layer over soil
	TQ0796	2	**270**	129	**165**	**179**	-	-	sod layer over soil
	TQ0797	3	**395**	**143**	**295**	**258**	-	-	sod layer over soil
	TQ0798	4	-	-	-	-	30	6	sand
	TQ0799	5	**195**	58	110	57	-	-	sod layer over soil
	TQ0800	6	110	75	**150**	83	-	-	sod layer over soil
	TQ0801	composite	-	115	-	-	-	-	mainly sod with some sand
Hespeler Park	TQ0803	1	**330**	94	**235**	74	-	-	sod layer over soil
	TQ0804	2	no sod	no sod	**240**	54	-	-	soil only, no sod layer
	TQ0805	3	140	32	120	61	-	-	sod layer over soil
	TQ0806	4	-	-	-	-	35	5	sand
	TQ0807	5	-	-	-	-	15	3	sand
	TQ0808	6	**200**	41	100	51	-	-	sod layer over soil
	TQ0809	7	-	-	-	-	50	13	sand in 1984, pea gravel in 2007
	TQ0810	composite	-	61	-	-	-	-	mainly sod with some sand
Home Playground	TQ0870	5	**200**	105	**170**	**189**	-	-	sod layer over soil
	TQ0871	6	110	36	130	58	-	-	sod layer over soil
	TQ0872	7	80	21	80	30	-	-	sod layer over soil
	TQ0873	8	**170**	**199**	**160**	**212**	-	-	sod layer over soil
	TQ0874	composite	-	63	-	-	-	-	mainly sod with some sand
Jacob Penner	TQ0875	1	no sod	no sod	**190**	140	-	-	soil only, no sod layer
(Notre Dame Park)	TQ0876	2	no sod	no sod	30	113	-	-	soil only, no sod layer
	TQ0877	3	100	58	125	93	-	-	sod layer over soil
	TQ0878	4	-	-	-	-	30	81	gravel in 1984, bare soil in 2007
	TQ0879	6	60	50	70	69	-	-	sod layer over soil
	TQ0880	7	60	58	70	90	-	-	sod layer over soil
	TQ0881	8	-	-	-	-	30	3	sand
	TQ0882	9	105	101	**165**	**339**	-	-	sod layer over soil
Maryland Tot Lot	TQ0822	1	**345**	**207**	**155**	**237**	-	-	sod layer over soil
	TQ0823	2	**310**	115	125	**156**	-	-	sod layer over soil
	TQ0824	3	-	-	-	-	**180**	115	sand/gravel
	TQ0825	4	-	-	-	-	95	33	sand
	TQ0826	5	-	-	-	-	120	34	sand/gravel
	TQ0827	6	-	-	-	-	50	19	sand
	TQ0828	7	-	-	-	-	30	2	sand
	TQ0829	8	-	-	-	-	**170**	21	sand
	TQ0830	9	**285**	**341**	120	**436**	-	-	sod layer over soil
	TQ0831	10	**155**	**142**	**145**	**268**	-	-	sod layer over soil
	TQ0832	composite	-	100	-	-	-	-	mainly sod with some sand
Spence Tot Lot	TQ0811	1	**380**	113	**320**	**214**	-	-	sod layer over soil
	TQ0812	2	**245**	no sod	**300**	48	-	-	sod layer over soil in 1984, no sod in 2007
	TQ0813	3	**500**	18	**450**	24	-	-	sod layer over soil
	TQ0814	4	-	-	-	-	50	39	sand in 1984 and 2007
	TQ0815	5	-	-	-	-	40	40	sand in 1984 and 2007
	TQ0816	6	**360**	33	**335**	30	-	-	sod layer over soil
	TQ0817	7	-	-	-	-	**260**	35	sandy soil in 1984, sand in 2007
	TQ0818	8	-	-	-	-	**230**	39	sand/gravel in 1984, sand in 2007
	TQ0819	9	**680**	**712**	**740**	**429**	-	-	sod layer over soil
	TQ0820	10	**600**	**201**	**640**	**320**	-	-	sod layer over soil
	TQ0821	composite	-	88	-	-	-	-	mainly sod with some sand
Average concentration of Pb (µg/g)			**253**	**122**	**210**	**157**	**88**	**31**	
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**69**	**28**	**62**	**45**	**25**	**0**	

Table 3. Concentrations of lead in samples collected from sites in Winnipeg school yards in 1983 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME Residential/parkland guideline for human health protection of 140 µg/g. (n/s – no sample collected).

School Yard	2007 TQ Site	Historic Site Number	Pb Concentration (µg/g)		Type of Material Sampled in 2007
			1983	2007	
Archwood	TQ0718	A1	110	5	aggregate particles on paved surface
Elementary	TQ0719	A2	**360**	28	aggregate particles on paved surface
	TQ0720	A3	**530**	27	aggregate particles on paved surface
	TQ0721	A4	**570**	31	soil & dust particles on paved surface
	TQ0722	A7	**520**	26	soil & dust particles on paved surface
	TQ0723	A8	**610**	32	aggregate particles on paved surface
	TQ0724	A9	**530**	27	aggregate particles on paved surface
	TQ0725	A10	**430**	27	aggregate particles on paved surface
	TQ0726	A13	**230**	24	aggregate particles on paved surface
	TQ0727	A14	130	19	aggregate particles on paved surface
	TQ0728	-	-	6	composite pea gravel sample
Lord Nelson	TQ0700	LN1	**1500**	73	mix of sod and soil
Elementary	TQ0701	LN2	**2300**	126	soil
	TQ0702	LN3	**1600**	15	sod
	TQ0703	LN4	**2000**	**176**	soil
	TQ0704	LN5	**1250**	62	soil & dust particles on paved surface
	TQ0705	LN6	**1100**	64	soil & dust particles on paved surface
	TQ0706	LN7	**1750**	66	soil
	TQ0707	LN8	**430**	131	soil
	TQ0708	LN9	**790**	51	aggregate particles on paved surface
	TQ0709	LN10	**330**	78	aggregate particles on paved surface
	TQ0710	LN11	**400**	85	aggregate particles on paved surface
	TQ0711	LN12	**400**	15	sod
	TQ0712	LN13	**205**	51	aggregate particles on paved surface
	TQ0713	LN14	**560**	99	aggregate particles on paved surface
	TQ0714	LN16	**2400**	105	soil
Gordon Bell	TQ0782	GB1	**950**	129	mix of sod and soil
High	TQ0783	GB2	**310**	74	aggregate particles on paved surface
	TQ0784	GB3	**435**	114	mix of sod and soil
	TQ0785	GB4	**440**	72	mix of sod and soil
	TQ0786	GB5	**440**	85	mix of sod and soil
	TQ0787	GB6	**330**	86	aggregate particles on concrete surface
	TQ0788	GB7	**510**	101	aggregate particles on concrete surface
	TQ0789	GB8	**1100**	96	aggregate particles on concrete surface
	TQ0790	GB9	**440**	**151**	aggregate particles on concrete surface
	TQ0791	GB11	**1900**	**290**	aggregate particles on concrete surface
	TQ0792	GB12	**1300**	104	mix of sod and soil
	TQ0793	GB13	**1050**	**144**	sod
	TQ0794	GB14	**1550**	140	sod

School Yard	2007 TQ Site	Historic Site Number	Pb Concentration (µg/g)		Type of Material Sampled in 2007
			1983	2007	
Dufferin	TQ0758	D1	**1100**	**185**	mix of sod and soil
Elementary	TQ0759	D2	**1100**	**228**	sod
	TQ0760	D3	**1400**	48	sod
	TQ0761	D4	**980**	107	sod
	TQ0762	D5	**1050**	19	mix of sod and soil
	TQ0763	D6	**970**	21	mix of sod and soil
	TQ0764	D7	**850**	25	mix of sod and soil
	TQ0765	D8	**610**	**153**	mix of sod and soil
	TQ0766	D10	**1200**	**238**	soil & dust particles on paved surface
	TQ0767	D11	**930**	**307**	soil & dust particles on paved surface
	TQ0768	D13	n/a	89	soil & dust particles on paved surface
	TQ0769	D14	**555**	62	soil & dust particles on paved surface
	TQ0770	D15	**950**	18	soil & dust particles on paved surface
	TQ0771	D16	**800**	39	soil & dust particles on paved surface
Fort Rouge	TQ0772	FR5	**1850**	69	aggregate particles on paved surface
Elementary	TQ0773	FR6	**900**	**204**	aggregate particles on paved surface
	TQ0774	FR7	**1200**	43	mix of sod and soil
	TQ0775	FR8	**1300**	36	mix of sod and soil
	TQ0776	FR9	**630**	43	mix of sod and soil
	TQ0777	FR10	**780**	17	sod
	TQ0778	FR11	**870**	20	sod
	TQ0779	FR12	**840**	19	sod
	TQ0780	FR13	**1010**	19	sod
	TQ0781	FR14	**830**	134	aggregate particles on pavement surface
Weston	TQ0750	1	**2200**	92	aggregate particles on concrete surface
Elementary	TQ0751	3	**3200**	99	mix of sod and soil
	TQ0752	5	**3800**	82	sod
	TQ0753	6	**2300**	116	sod
	TQ0754	8	**2500**	86	aggregate particles on concrete surface
	TQ0755	10	**4800**	102	mix of sod and soil
	TQ0756	12	**2800**	50	sod
	TQ0757	14	**2500**	46	sod
Tyndal School	TQ0715	-	n/s	125	aggregate particles on paved surface
	TQ0716	-	n/s	3	sand from sand box
	TQ0717	1	60	12	sod
Average concentration of Pb (ug/g)			**1125**	**82**	
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**96**	**14**	

Results from the 2007 re-sampling program indicate that levels of lead in the sod and the underlying soil of the Weston Elementary sports field continues to be elevated (Table 4). The data indicate that, on the whole, lead concentrations in the sod layer have declined somewhat since 1981. Weston School is located on a relatively busy traffic thoroughfare (Logan Ave.) and is also approximately 280 m south of the old Canadian Bronze smelter site.

Table 4. Concentrations of lead in sod and soil samples collected from the Weston Elementary sports field in 1981 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g. (n/s = no sample)

2007 TQ Site	Historic Site Number	Distance from Logan Ave. fence (m)	Pb in Surface Sod Layer (µg/g)		Pb in top 5 cm of Soil under Sod Layer (µg/g)	
			1981	2007	1981	2007
TQ0729	A1	0	**1700**	n/s	**450**	113
TQ0730	A2	15	**690**	**389**	**190**	**685**
TQ0731	A3	30	**560**	**195**	**370**	**380**
TQ0732	A4	46	**940**	**146**	**190**	**228**
TQ0733	A5	61	**710**	89	60	**168**
TQ0734	B1	0	**1300**	89	70	126
TQ0735	B2	15	**820**	**907**	**200**	**583**
TQ0736	B3	30	**650**	**458**	100	**420**
TQ0737	B4	46	**580**	**328**	130	**235**
TQ0738	B5	61	**670**	**187**	120	**355**
TQ0739	C1	0	**1500**	**183**	100	**1130**
TQ0740	C2	15	**770**	113	**190**	**514**
TQ0741	C3	30	**500**	**497**	**160**	**720**
TQ0742	C4	46	**560**	**499**	130	**397**
TQ0743	C5	61	**510**	**169**	70	**315**
TQ0744	D1	0	**1500**	113	**280**	**839**
TQ0745	D2	15	**1200**	**815**	130	**453**
TQ0746	E1	0	**1700**	**260**	**260**	**610**
TQ0747	E2	15	**1100**	**503**	**330**	**629**
TQ0748	F1	0	**1400**	**212**	**200**	**461**
TQ0749	F2	15	**1200**	**430**	**310**	**363**
Average concentration of Pb (µg/g)			**979**	**329**	**192**	**463**
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**100**	**80**	**60**	**90**

Concentrations of lead in all 30 sod samples collected at the Weston Elementary sports field in 1981 exceeded the present CCME Residential/parkland soil guideline (Manitoba Consumer and Corporate Affairs and Environment 1981 unpublished data). While only 21 of the original 30 sites were re-sampled in 2007, the results suggest that much of the sod layer of this

sports field continues to contain concentrations above the guideline. Lead concentrations in the majority of the underlying soil samples collected in 1981 also exceeded the present guideline. However, in 1981 there were several sites (particularly those furthest away from Logan Ave.) where levels in the underlying soil layer did not exceed the guideline. The results from the 2007 re-sampling indicate that levels of lead in the soil layer may now exceed the guideline over a larger area of the field than before (due to a lowering of the guideline value).

Residential Neighbourhood Sites

Concentrations of lead in sod and soil samples collected from boulevards in Wolseley/Minto, Riverview/Lord Roberts, and Glenelm/Chalmers in 2007 were usually lower than concentrations recorded at the same sites in 1983 (Tables 5, 6, 7, respectively). In most cases the decrease in concentration was quite dramatic (ex: often an order of magnitude). The majority of sod and soil samples collected in 1983 had levels of lead well above the CCME guideline, and the highest concentrations were usually found at sites associated with streets that had heavy traffic volumes (ex: Portage Avenue, Osborne Street, Henderson Highway). The number of sites that had concentrations above the guideline in 2007 was minimal, and the relationship between traffic flow and lead levels in sod and soil was not as evident.

Table 5. Concentrations of lead in sod and soil samples collected from boulevards in the Wolseley/Minto neighbourhoods in 1983 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME Residential/parkland guideline for human health protection of 140 µg/g.

2007 TQSite	1983 Site Number	Site Description	Pb in Surface Sod Layer (µg/g)		Pb in top 5 cm of Soil under Sod Layer (µg/g)	
			1983	2007	1983	2007
TQ0853	4	Sprague St. at Wolseley Ave.	**220**	17	**160**	35
TQ0854	5	Sprague St. btn Wolseley & Portage	**200**	82	**220**	**182**
TQ0855	6	Sprague St. at Portage Ave.	**800**	13	**1000**	86
TQ0856	7	Greenwood Pl. at Portage Ave.	**600**	65	**300**	98
TQ0857	8	Greenwood Pl. btn Wolseley & Portage	**180**	28	**160**	34
TQ0858	9	Greenwood Pl. at Wolseley Ave.	**210**	102	**170**	**149**
TQ0859	10	Garfield St. at Westminster Ave.	**360**	42	**200**	25
TQ0860	11	Garfield St. btn Westminster & Portage	**240**	**200**	**220**	108
TQ0861	12	Garfield St. at Portage Ave.	**620**	54	**800**	22
TQ0862	13	Sherburn St. at Portage Ave.	**680**	92	**700**	21
TQ0863	14	Sherburn St. btn Westminster & Portage	**380**	19	**270**	20
TQ0864	15	Sherburn St. at Westminster Ave.	**450**	27	**320**	9
TQ0865	16	Sherburn St. btn Wolever & Portage	**310**	126	**260**	67
TQ0866	17	Sherburn St. at Wolever Ave.	**380**	26	**320**	32
TQ0867	20	Minto St. at Portage Ave.	**150**	22	30	60
TQ0868	21	Minto St. btn Wolever & Portage	**190**	22	**200**	20
TQ0869	22	Minto St. at Wolever Ave.	**240**	31	130	24
Average concentration of Pb (µg/g)			**365**	**57**	**321**	**58**
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**100**	**6**	**88**	**12**

Table 6. Concentrations of lead in sod and soil samples collected from boulevards in the Riverview/Lord Roberts neighbourhoods in 1983 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g.

2007 TQSite	1983 Site Number	Site Description	Pb in Surface Sod Layer (µg/g)		Pb in top 5 cm of Soil under Sod Layer (µg/g)	
			1983	2007	1983	2007
TQ0833	1	Osborne St. at Maplewood Ave.	**1044**	109	**348**	131
TQ0834	2	Maplewood Ave. btn Osborne & Hay	**144**	39	84	39
TQ0835	3	Maplewood Ave. at Hay St.	**168**	15	108	23
TQ0836	7	Osborne St. at Baltimore Ave.	**348**	77	72	**228**
TQ0837	8	Baltimore Rd. btn Osborne & Hay	60	27	36	45
TQ0838	9	Baltimore Rd. at Hay St.	108	23	48	28
TQ0839	13	Osborne St. at Balfour Ave.	**720**	95	**348**	**310**
TQ0840	14	Balfour Ave. btn Osborne & Hay	84	73	**144**	23
TQ0841	15	Balfour Ave. at Hay St.	108	9	84	9
TQ0842	16	Hay St. at Clare Ave.	84	33	96	119
TQ0843	17	Clare Ave. btn Osborne & Hay	**192**	29	**456**	35
TQ0844	18	Osborne St. at Clare Ave.	**816**	36	**528**	45
TQ0845	19	Jubilee Ave. btn Osborne & Nassau	**600**	40	**640**	41
TQ0846	20	Jubilee Ave. at Nassau St.	**276**	43	**144**	47
TQ0847	21	Rosedale Ave. at Nassau St.	**384**	21	**240**	13
TQ0848	22	Rosedale Ave. btn Osborne & Nassau	**348**	17	**288**	34
TQ0849	25	Rathgar Ave. at Nassau St.	**240**	29	**240**	76
TQ0850	26	Rathgar Ave. btn Osborne & Nassau	**372**	67	**252**	56
TQ0851	29	Kylemore Ave. at Nassau St.	132	78	**372**	**280**
TQ0852	30	Kylemore Ave. btn Osborne & Nassau	**312**	34	**216**	45
Average concentration of Pb (µg/g)			**327**	**45**	**237**	**81**
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**70**	**0**	**65**	**15**

Table 7. Concentrations of lead in sod and soil samples collected from boulevards in the Glenelm/Chalmers neighbourhoods in 1983 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g.

2007 TQSite	1983 Site Number	Site Description	Pb in Surface Sod Layer (µg/g)		Pb in top 5 cm of Soil under Sod Layer (µg/g)	
			1983	2007	1983	2007
TQ0883	1	Martin Ave. W. at Beatrice St.	**310**	20	**310**	19
TQ0884	2	Martin Ave. W. W of Henderson Hwy.	**300**	37	**370**	29
TQ0885	3	Martin Ave. W. at Henderson Hwy.	**660**	28	**530**	20
TQ0886	7	Cobourg Ave. at Beatrice St.	**280**	56	**290**	107
TQ0887	8	Cobourg Ave. btn Henderson & Beatrice	**180**	42	140	23
TQ0888	9	Cobourg Ave. at Henderson Hwy.	**700**	75	**480**	**343**
TQ0889	13	Hart Ave. at Beatrice St.	10	45	90	63
TQ0890	14	Hart Ave. btn Henderson & Beatrice	10	49	40	81
TQ0891	15	Hart Ave. at Hendeson Hwy.	70	**191**	40	**369**
TQ0892	16	Hespeler Ave. at Henderson Hwy.	**1600**	34	**580**	**347**
TQ0893	17	Hespeler Ave. btn Henderson & Beatrice	**900**	30	**450**	84
TQ0894	18	Hespeler Ave. at Beatrice St.	**980**	22	**410**	22
TQ0895	19	Martin Ave. W. at Henderson Hwy.	**710**	26	**700**	24
TQ0896	20	Martin Ave. W. E of Henderson Hwy.	**420**	62	**440**	**160**
TQ0897	21	Martin Ave. W. at Brazier St.	30	95	80	114
TQ0898	28	McIntosh Ave. btn Henderson & Brazier	**260**	32	20	34
TQ0899	29	McIntosh Ave. at Brazier St.	**340**	29	**450**	21
Average concentration of Pb (µg/g)			**456**	**51**	**319**	**109**
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**76**	**6**	**65**	**24**

Most of the sites re-sampled in North Point Douglas in 2007 had lower concentrations of lead in sod/soil than when they were originally sampled in 1988 (Table 8). The degree to which lead levels decreased was quite variable between these sites. Only three of the 23 sites re-sampled in 2007 showed an increase in lead over the 1988 level. In 1988 all but one of the sites had levels of lead above the CCME Residential/parkland guideline, and although there was an overall decrease in concentration of lead at the sites, a clear majority still had levels above the new guideline in 2007.

Table 8. Concentrations of lead in samples collected from boulevards in the North Point Douglas neighbourhood in 1988 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g.

2007 TQSite	1988 Site Number	Site Description	Pb in Sod/Soil (µg/g)	
			1988	2007
TQ0900	1	SE corner Madeline St. at Sutherland Ave.	**550**	**444**
TQ0901	2	S. side Sutherland Ave. btn Madeline & Syndicate	**2270**	**800**
TQ0902	4	SE corner Syndicate St. at Sutherland Ave.	**1500**	**1120**
TQ0903	5	SW corner Stephens St. at Sutherland Ave.	**220**	**649**
TQ0904	6	Middle Syndicate St. btn Sutherland & Rover	**290**	81
TQ0905	7	South Syndicate St. btn Sutherland & Rover	**440**	**212**
TQ0906	8	NE corner Syndicate St. at Sutherland Ave.	**520**	**492**
TQ0907	12	Middle Stephens St. btn Sutherland & Rover	**360**	105
TQ0908	13	South Stephens St. btn Sutherland & Rover	**240**	**156**
TQ0909	14	NW corner Stephens St. at Sutherland Ave.	82	**235**
TQ0910	15	Middle Stephens St. btn Sutherland & rail line	**770**	**593**
TQ0911	16	South end Stephens St. near rail line	**960**	**367**
TQ0912	17	SE corner Stephens St. at Sutherland Ave.	**1150**	**666**
TQ0913	18	West Sutherland btn. Stephens & Angus	**3040**	**605**
TQ0914	19	East Sutherland btn. Stephens & Angus	**4650**	104
TQ0915	24	Middle Angus St. btn Sutherland & rail line	**1200**	**2240**
TQ0916	25	South end Angus St. near rail line	**2300**	**1170**
TQ0917	34	Sutherland Ave. east of Angus	**480**	**181**
TQ0918	35	Sutherland Ave. east of Angus	**260**	**165**
TQ0919	30	NE corner Sutherland Ave. at Disraeli St.	**1110**	119
TQ0920	31	South end Disraeli St. between Sutherland & Rover	**353**	31
TQ0921	32	Middle Disraeli St. between Sutherland & Rover	**310**	32
TQ0922	33	SE corner of ball park on Disrtaeli btn Sutherland & Rover	**510**	**202**
Average concentration of Pb (µg/g)			**1025**	**468**
Percentage of Samples Above CCME Guideline for Protection of Human Health (140 µg/g)			**96**	**74**

Samples of the top 2.5 cm of surface soil were collected from 10 of the sites re-sampled in North Point Douglas in 2007. Since it was assumed that most of the elevated levels of lead in the soil originated from atmospheric deposition, it was expected that lead concentrations in the 2.5 cm samples might be notably higher than in the sample collected to a depth of 5 cm. This was not the case as the results from the two sampling depths were very similar (Table 9).

Table 9. Comparison between concentrations of lead in samples collected from various soil depths in the North Point Douglas neighbourhood in 1988 and in 2007. Shading and bold font indicates that the lead concentration was above the CCME residential/parkland guideline for human health protection of 140 µg/g.

2007 TQ Site	1988 Site Number	Site Description	Lead in Sod/Soil (µg/g)		
			1988 5cm	2007 5 cm	2007 2.5 cm
TQ0900	1	SE corner Madeline St. at Sutherland Ave.	**550**	**444**	**380**
TQ0902	4	SE corner Syndicate St. at Sutherland Ave.	**1500**	**1120**	**893**
TQ0904	6	Middle Syndicate St. btn Sutherland & Rover	**290**	81	**166**
TQ0906	8	NE corner Syndicate St. at Sutherland Ave.	**520**	**492**	**503**
TQ0908	13	South Stephens St. btn Sutherland & Rover	**240**	**156**	**230**
TQ0911	16	South end Stephens St. near rail line	**960**	**367**	**397**
TQ0914	19	East Sutherland btn. Stephens & Angus	**4650**	104	**202**
TQ0915	24	Middle Angus St. btn Sutherland & rail line	**1200**	**2240**	**1790**
TQ0917	34	Sutherland Ave. east of Angus	**480**	**181**	121
TQ0922	33	SE corner of ball park on Disrtaeli btn Sutherland & Rover	**510**	**202**	**167**

The 2008 Sampling Program

A total of 93 samples were collected from the 46 sites identified for sampling in 2008. This included:

- four pea gravel samples, 31 sand samples, and 19 surface soil (sod) samples from the 18 playground sites
- 13 samples of sand or other aggregate material from 13 baseball diamond infields
- 23 surface soil samples from grass covered baseball diamond outfields, soccer pitches, and football fields
- three surface soil samples from grassed areas of Westview Park

The lead concentration results from the 2008 sampling program are summarized in Table 10 and in the map of Figure 8. Note that the summary table does not include the results from the three Westview Park sites. A complete list of the lead concentrations at the sites sampled in 2008 can be founding the Appendix section.

Concentrations of lead in the sieved dust material from playground pea gravel samples were very low; ranging from 10.8 µg/g to 27. 9 µg/g (Table 10). Levels of lead in sand samples from playgrounds were also very low, with most samples having a concentration of less than 30 µg/g. The two highest lead concentrations in sand, 39.3 µg/g and 56.7 µg/g, were found in samples collected from under play structures at the Bannatyne Playground on Bannatyne Ave. in the Brooklands neighbourhood and the Habitat Playground on Dufferin Ave. in the Lord Selkirk Park neighbourhood, respectively.

Table 10. Summary of lead concentrations in soil, sand/aggregate, and pea gravel samples collected in Winnipeg in 2008. Note the results from Westview Park are not included in this summary table.

Site Category	Sub categories	Sample Type	Number of Samples	Min	Max	Median	Mean	SD
Playgrounds - 18 locations	Play areas with pea gravel	Pea gravel	4	10.8	27.9	13.7	16.5	7.7
	Play areas with sand	Sand	31	2.2	56.7	6.8	11.3	12.1
	Play areas with sod	Surface Soil (Sod)	19	21.4	161.0	57.2	65.2	36.9
Sports Fields - 27 locations (13 ball diamonds , 12 soccer pitches, and 2 football fields)	Ball diamond infields	Sand/aggregate	13	2.4	31.8	3.8	7.4	8.2
	Ball diamond outfields, soccer pitches, and football fields	Surface Soil (Sod)	23	7.3	115.0	26.2	43.4	31.2
		Overall Totals	90	2.2	161.0	16.9	30.5	33.0

Levels of lead in surface soil samples collected from grassed areas in playgrounds ranged from 21.4 µg/g to 161.0 µg/g, with an average concentration of 65.2 µg/g. The soil sample with the highest concentration of lead (161.0 µg/g) was collected from the western portion of Stanley Knowles Park (Figure 8). This sample was the only sample collected in 2008 that exceeded the CCME soil quality guideline for the protection of human health. Note that this area of Stanley Knowles Park is located approximately 550 m east of the old Canadian Bronze smelter site and is bordered on the south by Logan Ave., a busy traffic thoroughfare. Concentrations of lead in the remaining samples collected from Stanley Knowles Park, including a surface soil sample from the eastern half of the playground and sand samples from under the swing set and from the sandbox, were all well below the guideline level (87.8 µg/g, 5.9 µg/g, and 2.9 µg/g, respectively). Two other playgrounds had concentrations of lead in soil that approached the guideline level. These were Grace Playground, located on Grace St. in South Point Douglas, with a concentration of 128 µg/g, and Weston Park, about 550 m west of the Canadian Bronze site on Logan Ave., with a concentration of 115 µg/g. The second replicate sample collected from the west half of Stanley Knowles Park and from the grassed area of Grace Playground were also submitted for analysis. The concentration of lead in the second replicate from the Stanley Knowles Park site was 173 µg/g, while that of the Grace Playground site was 120 µg/g; thus confirming the results from analysis of the first replicate sample.

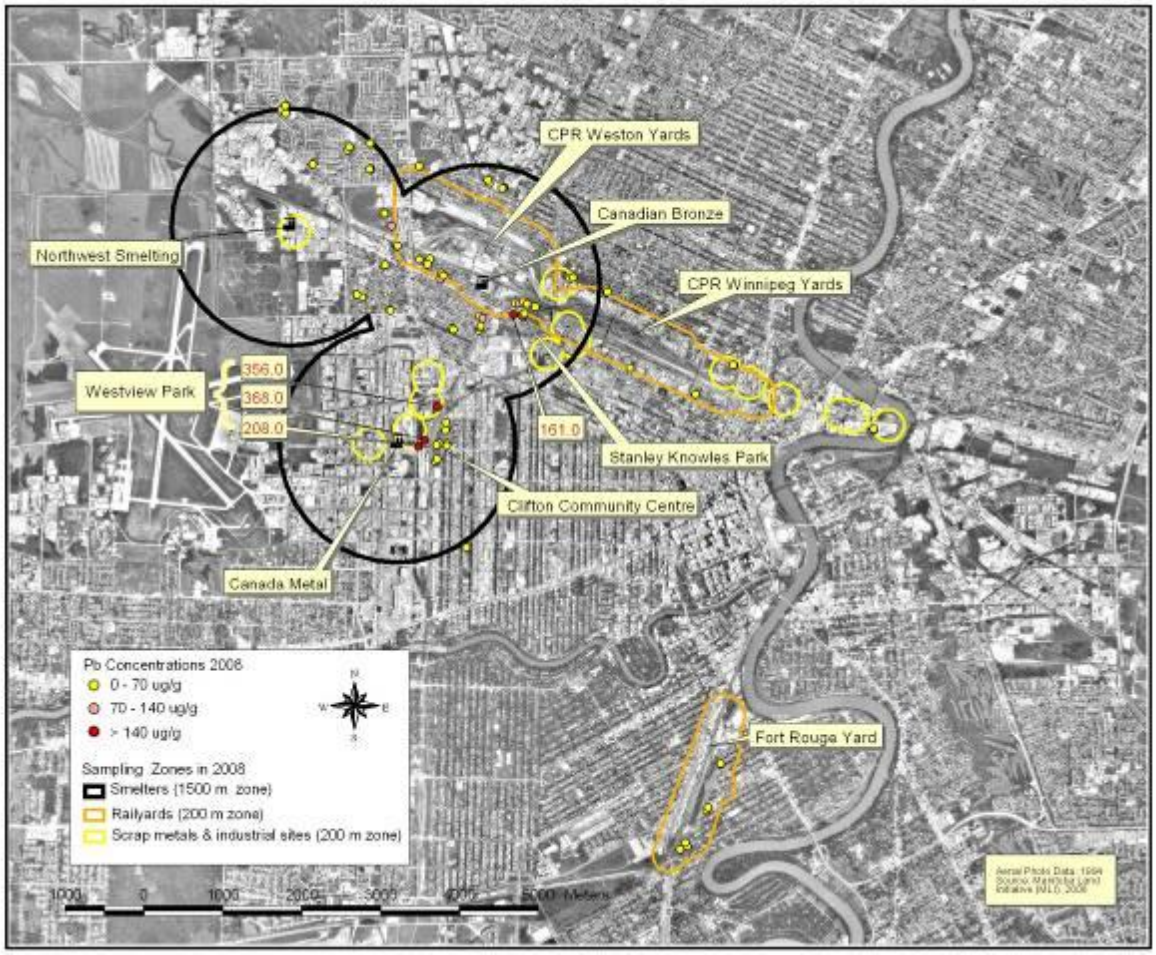

Figure 8. Map of Winnipeg showing lead concentrations in samples collected from playgrounds and sports fields in 2008.

Concentrations of lead in the sand and aggregate material of ball diamond infields ranged from 2.4 µg/g to 31.8 ug/ (Table 10). Concentrations of lead in the surface soil samples collected from ball diamond outfields, soccer pitches, and football fields ranged from 7.3 µg/g to 115.0 µg/g with a mean of 43.4 µg/g. None of the samples collected from sports fields exceeded the CCME health protection guideline.

Concentrations of lead in the Westview Park samples were 208 µg/g, 356 µg/g, and 368 µg/g, at the Wellington Ave. entrance, north end, and south end, respectively (Figure 8). All three samples exceeded the CCME guideline of 140 µg/g. The 2008 results for Westview Park were considerably lower than the concentrations of 560 µg/g, 850 µg/g and 1265 µg/g reported for three samples collected near the south end of park in 1979 (Wotton 1980). Although the levels of lead in the park have been high in the past and were still elevated in 2008, levels in the

soil, sand, and pea gravel samples collected from the nearby Clifton Community Centre sports fields and playground areas were all low in comparison, with no concentrations exceeding the guideline.

SUMMARY AND CONCLUSIONS

Concentrations of lead in most of the sod, soil, and aggregate samples collected in 2007 were lower than concentrations recorded at these sites during the 1980s. A dramatic decrease in concentrations at some sites was likely due to sod, soil, or aggregate replacement during the intervening years. More modest decreases in lead levels can be attributed to a decline in deposition of lead at the surface (ex: discontinued use of lead in gasoline), coupled with gradual movement of the metal down the soil profile. It should also be emphasized that the location of sample sites in 2007 were estimated using diagrams and maps in existing reports. Therefore, differences in lead concentrations between the historic data and the 2007 data could be due in part to the fact that the samples collected in 2007 may have not been collected at precisely the same location as during the 1980s. As well, the difficulty in distinguishing between sod and soil layers at some sites may also have contributed to the variability in results between the 1980s and 2007.

Lead concentrations in samples collected during the surveys of the 1980s often exceeded the present CCME human health guideline for lead in Residential/parkland soil. The 2007 results indicate that the number of sites exceeding the guideline has decreased substantially at school yard play areas and along boulevards in the Wolseley/Minto, Riverview/Lord Roberts, and Glenelm/Chalmers neighbourhoods. However, the guideline was still exceeded at several grass covered locations within City playgrounds, as well as at most of the sites re-sampled at the Weston Elementary School sports field and at boulevard sites along Sutherland Ave. in North Point Douglas (Table 11).

Table 11. Summary of lead concentrations and guideline exceedences (>140 µg/g) in samples collected from sites in 2007.

Site Type	Sample Type	Pb in the 2007 Samples (µg/g)			Number of Sites Sampled	Number of Sites Above CCME Guideline (% in parenthesis)
		Min	Max	Mean		
Playgrounds	Sod	17.5	712	122	25	7 (28%)
	Soil	24.1	436	157	29	13 (45%)
	Aggregate material	1.8	115	31	16	0
School yards	Sod/soil	12	228	84	37	5 (14%)
	Aggregate material	3	307	81	37	5 (14%)
Weston Elementary sports field	Sod	89	907	429	20	16 (80%)
	Soil	113	1130	463	21	19 (90%)
Residential neighbourhoods (Riverview/Lord Roberts, Wolseley/Minto, Glenelm/Chalmers)	Sod	9.2	200	51	54	2 (4%)
	Soil	9.1	369	83	54	9 (17%)
North Point Douglas	Sod/Soil	31.1	2240	468	23	17 (74%)

Sampling in 2008 focused on testing surface soil, sand, pea gravel, and other surface aggregate material from City of Winnipeg playgrounds and sports fields in the vicinity of potential past and present point sources of lead. Sampling was conducted over a four week period from mid-September until early-October 2008. The lowest levels of lead in 2008 were usually found in sand and pea gravel samples collected from playgrounds and from sand/aggregate samples collected from the infield areas of baseball diamonds. Lead levels in surface soil samples collected from grassed areas in playgrounds and from sports fields in 2008 tended to be higher than lead levels in the sand, pea gravel, and aggregate samples. This is not surprising since soil, being higher in organic matter content and less rapidly drained than sand, pea gravel, or other aggregate materials, tends to more readily trap and accumulate lead particles deposited to the surface. As well, it is likely that the sand and aggregate material in playground play areas and ball diamond infield areas has been periodically renewed with fresh material, while the same may not be the case with grassed play areas and sports fields (recent renewal of play sand and ball diamond infield material was evident at several of the sites sampled).

Only one of the 90 samples collected in 2008 had a lead concentration above the CCME Residential/parkland soil quality guideline for the protection of human health (140 µg/g). This sample (lead = 161 µg/g) was collected from the open grassed area in the western portion of Stanley Knowles Park.

The 2008 results indicate that lead levels at playgrounds and sports fields in the vicinity of potential point sources in the inner-city are less than the CCME Residential/parkland soil quality guideline for the protection of human health (140 µg/g).

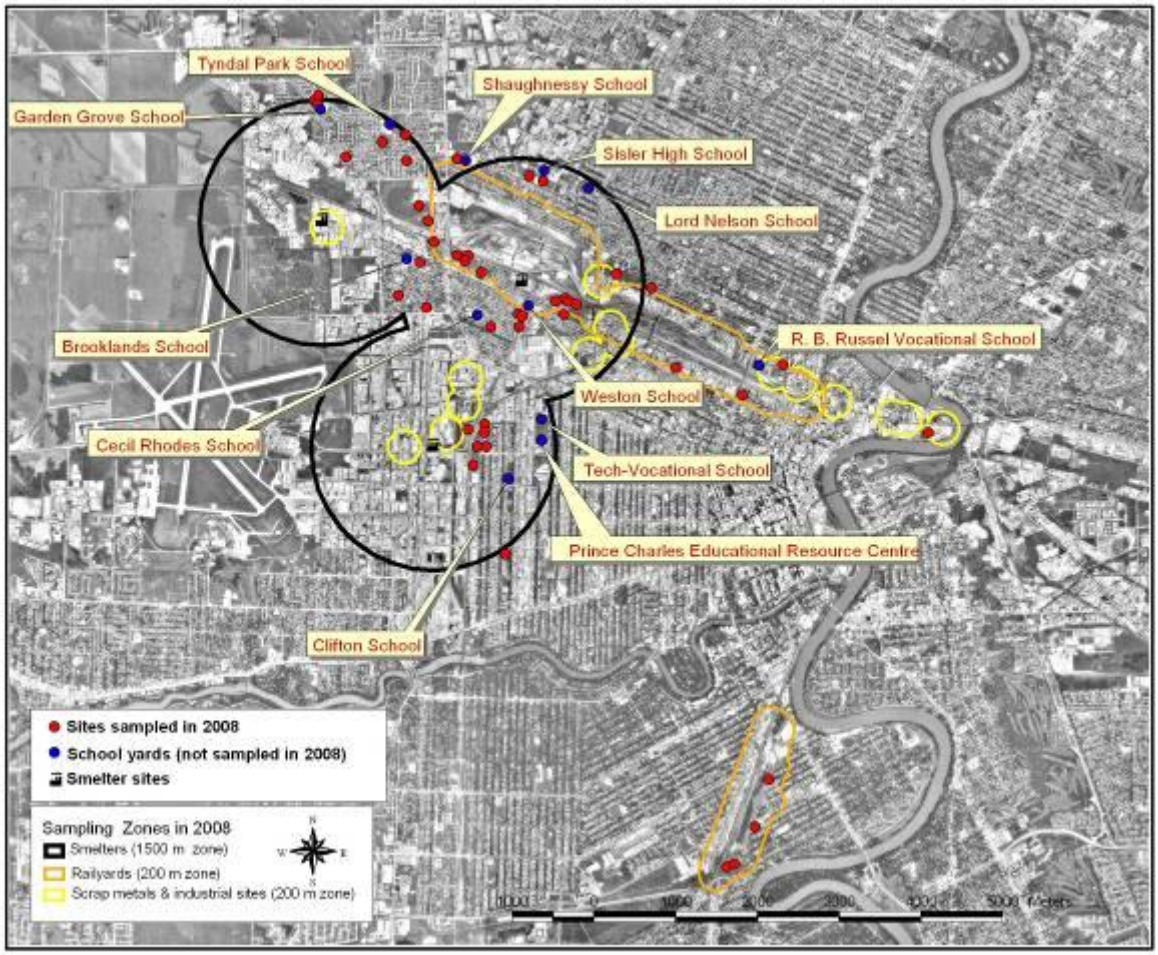

Figure 9. Map of Winnipeg showing proximity of sample sites to school yards that were not sampled in 2008.

Lead levels in the majority of playgrounds, school yards, sports fields, and boulevards sampled in 2007 and 2008 were below the CCME guideline of 140 µg/g and therefore could be considered acceptable from a human health risk perspective.

Although lead levels were usually lower in 2007 and 2008 than during the 1980s, there were several areas where concentrations of lead were still above the current guideline of 140 µg/g. These included the boulevard along Sutherland Ave in North Point Douglas, the Weston School sports field, and grassed areas within several city playgrounds.

REFERENCES

CCME. 1999 (updated to 2007). Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Summary table available at http://www.ccme.ca/assets/pdf/sqg_summary_table.pdf

Dillon Consulting Limited. 2007. *Human Health Risk Assessment for Residential Properties; Brandon, Manitoba. Final Report.* A risk assessment conducted by Dillon Consulting Ltd. for Manitoba Conservation. Winnipeg, MB.

Environment Canada. 1999. *Canadian Soil Quality Guidelines for Lead. Scientific Supporting Document*. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada. Ottawa, ON.

Jones, D. C. 1985. *A Synopsis of the Lead Program at Weston Elementary School in the City of Winnipeg*. Manitoba Environment and Workplace Safety and Health, Environmental Management Division, Terrestrial Standards and Studies Section. Winnipeg, MB. Report No. 85-3. 21 pp.

Jones, D. C. 1986. *A Survey of Lead-in-Soil Concentrations at Seven Tot Lots in The City of Winnipeg.* Manitoba Environment and Workplace Safety and Health, Terrestrial Standards and Studies Section. Winnipeg, MB. Report No. 86-3. 17 pp. http://www.gov.mb.ca/conservation/wildlife/managing/pdf/pb_wpgtotlots_1986.pdf

Jones, D. C. and D. L. Wotton. 1982. *Lead Program Report Soil/Sod Removal and Replacement in the Weston Area of Winnipeg, 1982*. Manitoba Consumer and Corporate Affairs and Environment. Winnipeg, MB.

Jones, D. C. and D. L. Wotton. 1983. *A Survey of Lead in Soil from Seven Schools and Three Residential Areas of Winnipeg, 1983*. Manitoba Environment and Workplace Safety and Health, Environmental Management Services Branch, Terrestrial Standards and Studies. Winnipeg, MB. Report No. 83-15. 21 pp. http://www.gov.mb.ca/conservation/wildlife/managing/pdf/pb_wpg_schools_res_1983.pdf

Jones, D. C. and D. L. Wotton. 1984. *Lead Program Report Boulevard Sod/Soil Removal and Replacement in the Weston Area of Winnipeg, 1983*. Manitoba Environment and Workplace Safety and Health, Environmental Management Division, Terrestrial Standards and Studies Section. Winnipeg, MB. Report No. 83-16. 15 pp.

Jones, G. 1998. Lead concentrations in Winnipeg garden plots. Poster presented at the 41st Annual Manitoba Society of Soil Science Meeting, Winnipeg, MB. Terrestrial Quality Management, Manitoba Environment. Winnipeg, MB.

Jones, G. and F. Phillips. 2003. *Metal Concentrations in Surface Soils of Thompson, Manitoba, September 2001*. Habitat Management and Ecosystem Monitoring Section, Wildlife and Ecosystem Protection Branch, Manitoba Conservation. Winnipeg, MB. Manitoba

Conservation Report No. 03-01. 21 pp.
http://www.gov.mb.ca/conservation/wildlife/managing/pdf/thompson_metalcon.pdf

Krawchuk, B. P. 1980. *A Survey of Soil Lead Levels in the City of Winnipeg*. MSc. Thesis. Department of Chemistry, University of Manitoba. Winnipeg, MB. 148 pp.

Manitoba Conservation. 2007. *Concentrations of Metals and Other Elements in Surface Soils of Flin Flon, Manitoba and Creighton, Saskatchewan, 2006.* Manitoba Conservation. Report No. 2007-01, Winnipeg, MB. 64 pp.
http://www.gov.mb.ca/conservation/wildlife/managing/pdf/flinflon_metalcon2.pdf

Manitoba Consumer and Corporate Affairs and Environment. 1981. unpublished data. Environmental Management Division, Manitoba Consumer and Corporate Affairs and Environment. Winnipeg, MB.

Manitoba Consumer and Corporate Affairs and Environment. 1982. unpublished data. Environmental Management Division, Manitoba Consumer and Corporate Affairs and Environment. Winnipeg, MB.

Manitoba Environment. 1989. unpublished data. Terrestrial Standards and Studies, Environmental Management Division, Manitoba Environment. Winnipeg, MB.

Pinchin Environmental. 2006. *Phase II Environmental Site Assessment: 99 & 105 Euclid Avenue, Winnipeg, Manitoba.* Prepared for Sistars Community Economic Development Co-op Inc. by Pinchin Environmental Ltd. Winnipeg, Manitoba. 9 pp. plus appendices.

Wotton, D. L. 1980. *A Survey of Lead Accumulation in Tree Foliage and Surface Soil of the Winnipeg Area*. Manitoba Consumer and Corporate Affairs and Environment, Environmental Management Division. Winnipeg, MB. Report No. MS 80-1. 31 pp.

Wotton, D. L. and F. E. Doern. 1983. *Lead Particulate Analysis in Air and Soil of the City of Winnipeg, 1982*. Manitoba Environment and Workplace Safety and Health, Environmental Management Division, Terrestrial Standards and Studies Section. Report 83-3. 64 pp.

Personal Communication

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APPENDIX

Laboratory results for samples collected during the 2008 sampling Program in Winnipeg.

TQ Sample/ Site #	Sample Site Description	Rep #	Sample Date	Sample Type	Depth (cm)	Wet Wt (g)	Dry Wt (g)	Moisture %	Density (g/cm^3)	Lead Pb ug/g
TQ0923	Grace Playground sod area, Grace St., South Point Douglas	1	11-Sep-08	Sod	2.5	238.9	164.5	31.1	1.0	128.0
TQ0924	Grace Playground sandbox, Grace St., South Point Douglas	1	11-Sep-08	Sand	5	308.4	297.9	3.4	1.5	3.9
TQ0925	Grace Playground swing area, Grace St., South Point Douglas	1	11-Sep-08	Pea gravel	5	856.6	833.1	2.7	1.7	27.9
TQ0926	Playground sod area, Logan Ave. & Salter St.	1	11-Sep-08	Sod	2.5	208.0	140.5	32.4	0.9	40.0
TQ0927	Playground swing area, Logan Ave. & Salter St.	1	11-Sep-08	Sand	5	557.8	540.0	3.2	1.8	8.7
TQ0928	Habitat Playgrd sod area, b/w Jarvis Ave. & Dufferin Ave. (N. of Tessler Iron & Metal)	1	11-Sep-08	Sod	2.5	181.2	123.7	31.7	0.8	58.7
TQ0929	Habitat Playgrd play structure, b/w Jarvis Ave. & Dufferin Ave. (N. of Tessler Iron & Metal)	1	11-Sep-08	Sand/aggragate	5	347.3	334.0	3.8	1.7	56.7
TQ0930	Pioneer Arena soccer pitch, Logan Ave.	1	11-Sep-08	Sod	2.5	165.4	125.5	24.1	0.8	60.3
TQ0931	Old Exhibition Grounds Sinclair Playground sod area, Sinclair Ave.	1	11-Sep-08	Sod	2.5	217.8	153.6	29.5	1.0	36.0
TQ0932	Old Exhibition Grounds Sinclair Playground swing area, Sinclair Ave.	1	11-Sep-08	Sand	5	351.9	338.4	3.8	1.7	4.2
TQ0933	Old Exhibition Grounds Sinclair Playground swing area, Sinclair Ave.	1	11-Sep-08	Sand	5	428.8	418.2	2.5	2.1	9.9
TQ0934	Old Exhibition Grounds Sinclair Playground sandbox, Sinclair Ave.	1	11-Sep-08	Sand	5	380.9	357.3	6.2	1.8	15.1
TQ0935	Old Exhibition Grounds SW ball diamond outfield	1	11-Sep-08	Sod	2.5	191.4	132.0	31.0	0.8	21.0
TQ0936	Old Exhibition Grounds SW ball diamond infield	1	11-Sep-08	Sand/aggragate	2.5	250.5	235.8	5.9	1.5	7.7
TQ0937	Stanley Knowles Park west sod area, Logan Ave.	1	18-Sep-08	Sod	2.5	147.0	108.2	26.4	0.7	161.0
TQ0938	Stanley Knowles Park east sod area, Logan Ave.	1	18-Sep-08	Sod	2.5	171.7	122.7	28.5	0.8	87.8
TQ0939	Stanley Knowles Park swing area, Logan Ave.	1	18-Sep-08	Sand	5	504.3	494.9	1.9	1.7	5.9
TQ0940	Stanley Knowles Park sandbox, Logan Ave.	1	18-Sep-08	Sand	5	529.2	519.2	1.9	1.8	2.9
TQ0941	McPhillips Athletic Grounds west ball diamond infield	1	18-Sep-08	Sand/Sod	2.5	169.7	156.1	8.0	1.0	15.2
TQ0942	McPhillips Athletic Grounds west/east ball diamond outfield	1	18-Sep-08	Sod	2.5	129.9	101.0	22.2	0.6	89.7
TQ0943	McPhillips Athletic Grounds east ball diamond infield	1	18-Sep-08	Sand/Sod	2.5	189.4	175.9	7.1	1.1	9.9
TQ0944	McPhillips Athletic Grounds soccer pitch	1	18-Sep-08	Sod	2.5	132.3	108.7	17.9	0.7	23.7
TQ0945	McPhillips Athletic Grounds football field	1	18-Sep-08	Sod	2.5	136.1	112.5	17.3	0.7	22.7
TQ0946	Pascoe Park ball diamond infield, Pacific Ave. & Pascoe St.	1	18-Sep-08	Sod/Sand	2.5	188.3	172.7	8.3	1.1	31.8
TQ0947	Pascoe Park soccer pitch, Pacific Ave. & Pascoe St.	1	18-Sep-08	Sod	2.5	128.8	101.3	21.4	0.6	97.7
TQ0948	Pascoe Park Playground sod area, Jordain St.	1	18-Sep-08	Sod	2.5	173.4	143.4	17.3	0.9	62.6
TQ0949	Pascoe Park Playground play structure, Jordain St.	1	18-Sep-08	Sand	5	663.4	652.7	1.6	2.2	11.5
TQ0950	Pascoe Park Playground S swing area, Jordain St.	1	18-Sep-08	Sand	5	602.1	593.6	1.4	2.0	9.1
TQ0951	Pascoe Park Playground teeter totter area, Jordain St.	1	18-Sep-08	Sand	5	604.4	597.0	1.2	2.0	16.8
TQ0952	Pascoe Park Playground N swing area, Jordain St.	1	18-Sep-08	Sand	5	527.0	519.2	1.5	1.8	10.2
TQ0953	Campion Tot Lot sod area, William Ave. W	1	18-Sep-08	Sod	2.5	217.4	166.5	23.4	1.1	56.2
TQ0954	Campion Tot Lot W swing area, William Ave. W	1	18-Sep-08	Sand	5	498.0	491.9	1.2	1.7	17.0
TQ0955	Campion Tot Lot W play structure, William Ave. W	1	18-Sep-08	Sand	5	514.6	493.1	4.2	1.7	15.6
TQ0956	Weston Memorial Community Centre soccer pitch, Logan Ave.	1	18-Sep-08	Sod	2.5	163.2	136.3	16.5	0.9	12.6
TQ0957	Weston Memorial Community Centre football field, Logan Ave.	1	18-Sep-08	Sod	2.5	174.5	144.3	17.3	0.9	62.7
TQ0958	Weston Memorial Community Centre ball diamond infield, Logan Ave.	1	18-Sep-08	Sand/aggragate	2.5	237.7	233.7	1.7	1.5	3.3
TQ0959	Weston Park sod area near Logan Ave.	1	18-Sep-08	Sod	2.5	155.3	118.6	23.7	0.8	117.0
TQ0960	Weston Park E swing area, Logan Ave.	1	18-Sep-08	Sand	5	457.9	451.6	1.4	1.5	24.6

TQ Sample/ Site #	Sample Site Description	Rep #	Sample Date	Sample Type	Depth (cm)	Wet Wt (g)	Dry Wt (g)	Moisture %	Density (g/cm^3)	Lead Pb ug/g
TQ0961	Weston Park sandbox, Logan Ave.	1	18-Sep-08	Sand	5	511.3	505.1	1.2	1.7	2.2
TQ0962	Weston Park W swing area, Logan Ave.	1	18-Sep-08	Sand	5	557.6	547.1	1.9	1.9	25.7
TQ0963	Weston Park sod/sand play area, Logan Ave.	1	18-Sep-08	Sod/Sand	2.5	222.1	204.7	7.8	1.3	40.1
TQ0964	Bluebird Park sod area, Oddy St.	1	23-Sep-08	Sod	2.5	198.8	153.7	22.7	1.0	48.2
TQ0965	Bluebird Park play structure, Oddy St.	1	23-Sep-08	Pea gravel	5	514.8	483.9	6.0	1.6	14.0
TQ0967	Bannatyne Playground sod area, Bannatyne Ave.	1	23-Sep-08	Sod	2.5	228.9	179.4	21.6	1.1	59.8
TQ0968	Bannatyne Playground sandbox, Bannatyne Ave.	1	23-Sep-08	Sand	5	338.7	318.8	5.9	1.1	2.8
TQ0969	Bannatyne Playground play structure/slide, Bannatyne Ave.	1	23-Sep-08	Sand	5	417.7	376.9	9.8	1.3	39.3
TQ0970	Galmar Playground sod area, Midmar Ave.	1	23-Sep-08	Sod/Sand	2.5	240.0	200.8	16.3	1.3	65.2
TQ0971	Galmar Playground sandbox, Midmar Ave.	1	25-Sep-08	Sand	5	383.5	359.9	6.2	1.2	19.7
TQ0972	Eldon Ross Wading Pool sod area, Alexander Ave.	1	25-Sep-08	Sod/Sand	2.5	204.7	169.3	17.3	1.1	33.8
TQ0973	Eldon Ross Wading Pool sandbox, Alexander Ave.	1	25-Sep-08	Sand	5	531.8	506.7	4.7	1.7	4.0
TQ0974	Woodsworth Park northwest ball diamond infield, Heckla Ave.	1	25-Sep-08	Sand/aggragate	2.5	258.1	239.1	7.4	1.5	3.4
TQ0975	Woodsworth Park northwest ball diamond outfield, Heckla Ave.	1	25-Sep-08	Sod	2.5	167.8	116.1	30.8	0.7	61.5
TQ0976	Woodsworth Park soccer pitch, Park Lane Ave.	1	25-Sep-08	Sod	2.5	192.0	142.3	25.9	0.9	115.0
TQ0977	Tyndall Park Community Centre sod area, Manitoba Ave.	1	25-Sep-08	Sod	2.5	214.2	165.2	22.8	1.1	57.2
TQ0978	Tyndall Park Community Centre sandbox, Manitoba Ave.	1	25-Sep-08	Sand	5	495.3	481.1	2.9	1.6	3.2
TQ0979	Tyndall Park Community Centre play structure, Manitoba Ave.	1	25-Sep-08	Pea gravel	5	852.4	832.6	2.3	2.1	10.8
TQ0980	Gainsborough Cove Park sod area, Gainsborough Cove	1	25-Sep-08	Sod	2.5	192.1	139.4	27.4	0.9	37.5
TQ0981	Gainsborough Cove Park sandbox, Gainsborough Cove	1	26-Sep-08	Sand	5	474.8	459.8	3.2	1.6	3.0
TQ0982	Gainsborough Cove Park slide, Gainsborough Cove	1	26-Sep-08	Sand	5	609.6	593.2	2.7	2.0	4.6
TQ0983	Berwick soccer pitch, Argue St.	1	26-Sep-08	Sod	2.5	203.2	143.4	29.4	0.9	7.3
TQ0984	Berwick ball diamond infield, Argue St.	1	26-Sep-08	Sand/Sod	2.5	239.4	199.2	16.8	1.3	4.8
TQ0985	Berwick ball diamond outfield, Argue St.	1	26-Sep-08	Sod	2.5	164.6	76.4	53.6	0.5	55.6
TQ0986	Hetherington Park sod area, Hetherington Ave. & Daly St. S	1	29-Sep-08	Sod	2.5	173.5	119.9	30.9	0.8	21.4
TQ0987	Hetherington Park play structure, Hetherington Ave. & Daly St. S	1	29-Sep-08	Sand	5	481.8	460.6	4.4	1.6	3.7
TQ0988	Lord Roberts Community Centre ball diamond infield, Kylemore Ave.	1	29-Sep-08	Sand	2.5	224.5	203.9	9.2	1.3	4.4
TQ0989	Lord Roberts Community Centre ball diamond outfield, Kylemore Ave.	1	29-Sep-08	Sod	2.5	212.6	158.1	25.7	1.0	9.7
TQ0990	Isaac Brock Community Centre N soccer pitch, Tefler St. N	1	29-Sep-08	Sod	2.5	215.7	171.8	20.4	1.1	23.1
TQ0994	Shaughnessy Community Centre SW soccer pitch, Tefler St. N	1	2-Oct-08	Sod	2.5	215.9	179.4	16.9	1.1	26.2
TQ0995	Northwood Community Centre ball diamond infield, Burrows Ave.	1	2-Oct-08	Sand/aggragate	2.5	251.0	241.2	3.9	1.5	3.2
TQ0996	Northwood Community Centre ball diamond outfield, Burrows Ave.	1	2-Oct-08	Sod	2.5	182.2	142.0	22.1	0.9	66.8
TQ0997	Northwood Community Centre Playground play structure, Burrows Ave.	1	2-Oct-08	Sand	5	534.0	516.7	3.2	1.8	3.8
TQ0998	Northwood Community Centre Playground sandbox, Burrows Ave.	1	2-Oct-08	Sand	5	538.8	529.3	1.8	1.8	2.4
TQ0999	Northwood Community Centre Playground sod area, Burrows Ave.	1	2-Oct-08	Sod	2.5	191.7	148.7	22.4	0.9	34.3
TQ1000	Tyndall Park Community Centre SE soccer pitch, backlane N side Tyndall Ave.	1	2-Oct-08	Sod	2.5	171.7	135.7	21.0	0.9	54.9
TQ1001	Tyndall Park Community Centre SW ball diamond infield, King Edward St.	1	2-Oct-08	Sand	2.5	252.9	246.7	2.5	1.6	2.5
TQ1002	Tyndall Park Community Centre SW ball diamond outfield, King Edward St.	1	2-Oct-08	Sod	2.5	182.2	132.3	27.4	0.8	21.8
TQ1003	Tyndall Park Community Centre (Garden Grove) soccer pitch, Burrows Ave.	1	2-Oct-08	Sod	2.5	160.7	126.8	21.1	0.8	7.4
TQ1004	Tyndall Park Community Centre (Garden Grove) ball diamond infield, Burrows Ave.	1	2-Oct-08	Sand/aggragate	2.5	241.1	234.9	2.6	1.5	2.4
TQ1005	Tyndall Park Community Centre (Garden Grove) Playground play structure, Burrows Ave.	1	2-Oct-08	Sand	5	516.5	496.7	3.8	1.7	6.8
TQ1006	Tyndall Park Community Centre (Garden Grove) Playground sandbox, Burrows Ave.	1	2-Oct-08	Sand	5	601.2	591.9	1.6	2.0	2.9
TQ1007	Clifton Community Centre N soccer pitch, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sod	2.5	170.6	138.1	19.0	0.9	54.0
TQ1008	Clifton Community Centre S soccer pitch, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sod	2.5	144.4	105.9	26.7	0.7	70.3
TQ1009	Clifton Community Centre Playground/Pool sod area, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sod	2.5	169.9	130.9	23.0	0.8	94.9
TQ1010	Clifton Community Centre Playground/Pool play structure, Wellington Ave. & Strathcona St.	1	2-Oct-08	Pea gravel	5	838.9	827.0	1.4	2.1	13.3
TQ1011	Clifton Community Centre Playground Sandbox, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sand	5	589.9	550.5	6.7	1.9	2.2
TQ1012	Clifton Community Centre Playground/Pool S swing area, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sand	5	550.8	540.1	1.9	1.8	12.0
TQ1013	Clifton Community Centre N ball diamond infield, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sand/aggragate	2.5	237.4	232.7	2.0	1.5	3.8
TQ1014	Clifton Community Centre N ball diamond outfield, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sod	2.5	201.4	157.1	22.0	1.0	16.4
TQ1015	Clifton Community Centre S ball diamond infield, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sand/aggragate	2.5	245.9	238.3	3.1	1.5	3.6
TQ1016	Clifton Community Centre S ball diamond outfield, Wellington Ave. & Strathcona St.	1	2-Oct-08	Sod	2.5	185.8	133.5	28.1	0.9	16.9
TQ0991	Westview Park south entrance sod area, Empress St. & Wellington Ave.	1	29-Sep-08	Sod	2.5	209.6	158.3	24.5	1.0	208.0
TQ0992	Westview Park top of slope, south end sod area	1	29-Sep-08	Sod	2.5	147.0	108.8	26.0	0.7	368.0
TQ0993	Westview Park top of slope, north end sod area	1	29-Sep-08	Sod	2.5	165.7	126.5	23.6	0.8	356.0