#29

SOIL ANALYSIS

FORMER REGINA IMPERIAL OIL REFINERY

Introduction:

The Regina Imperial Oil refinery started operations in 1916 and ceased operations in 1975, after a 60-year period of refining activity where there was little or no environmental oversight or consciousness with regard to the handling of process hazardous waste. The City of Regina purchased the entire refinery site in 1979 then rezoned, sold and serviced commercial redevelopment on the site that still contains most of the original underground infrastructure, namely pipes and foundations. To date there has been no remediation and or any environmental profiling or characterization of the property. Currently Saskatchewan Environment, many years after the refinery ceased operations, has completed a Phase I Environmental Site Assessment (ESA) and has ordered the City of Regina and Imperial Oil to prepare a Phase II ESA. However, grid soil sampling of the area has not yet taken place.

It is under these conditions and circumstances that the surface soil sampling relative to this report has become an important forerunner in respect to determining existing conditions.

With regard to the age and type of site operations the former refinery property has been subjected to, testing for the presence of polychlorinated biphenyls is an initial prerequisite.

Polychlorinated Biphenyls (PCB):

PCBs are synthetic compounds that contain chlorine and can occur in 209 congeners or configurations. PCBs are extremely volatile, repel water and have a very high affinity for fat molecules and coupled with their slow metabolic rate in animals make PCBs a health hazard to humans and other animal species. The major pathways of PCB entry into the human body are through direct contact with PCB contaminated soil, ingestion of contaminated food and water and inhalation of PCB vapour.

PCBs gained wide spread industrial use beginning in 1929 when it was employed in electrical insulators, lubricants, hydraulic fluids, flame retardants, ink solvents, and waterproofing materials just to list a few.

Polychlorinated Biphenyls (PCB) Guidelines:

The Canadian Soil Quality Guidelines, the permissible limit of PCBs in commercial and industrial lands is 33 ppm.

The Canadian Council of Ministers of the Environment (CCME) put the acceptable level of PCBs in agricultural and residential lands at 1200 ppm (dermal contact + ingestion) and 30 ppm (vapour inhalation), and for commercial and industrial lands the levels are 1900 ppm (dermal contact + ingestion) and 320 ppm (vapour inhalation).

These limits were developed as regard to the susceptibility of a toddler (i.e. a child between the ages of 7 months and 4 years), since this age group would receive the greatest dose per unit body weight and therefore represents a critical receptor for human health risk assessment.

The Government of Saskatchewan on the other hand has more stringent regulations regarding PCB storage and disposal. The current permissible level of PCBs in the environment is 5 ppm and this is contained in the PCB Waste Storage Regulations.

Heavy Metal Contamination:

Heavy metal contamination of soil results from human activities such as mining[1], smelting procedures[2] and agriculture[3] as well as natural activities. Chemical and metallurgical industries are the most typical sources of heavy metals in the environment.

By definition metals are categorized as "heavy metals" if in their standard state they have a specific gravity of more than 5 g/cm^3.

With the exception of lead, cadmium and mercury, which are toxic, even in very low concentrations, all other heavy metals in trace amounts in plants or animals are not toxic.

The main aim of this analysis is to provide an assessment regarding the presence of PCBs and heavy metals in the soil, in and around the site of the old Regina Imperial Oil refinery.

PCB Site Sampling:

For determination of PCBs, eight spots were sampled. The sample locations are marked as solid black dots in **Appendix 1**.

Sample 1 was taken from around the vicinity of the old ethyl plant.

Sample 2 was collected at the site where the incinerator once stood.

Samples 3, 4, 5 and 6 were taken along the base of the embankment that was created from the back-fill.

Sample 7 was taken from a spot directly in front of the current daycare facility situated on Winnipeg Street.

Sample 8 was collected on the property of 682 Adams Street.

Heavy Metals Site Sampling:

For the analysis of heavy metals thirteen locations on the site of the old refinery were chosen for sampling. These locations are marked as solid black dots in **Appendix 2**. Samples 1 and 2 were collected in the vicinity of the refined product storage.

Samples 3, 4, 5 and 10 were collected from the area close to the mechanical shops/warehouses.

Sample 6 was taken from the area around the boiler and electrical buildings.

Samples 7, 8, and 9 were obtained from the cooling/ process water reservoir area.

Samples 11, 12 and 13 from the area sandwiched between the lab/chemical storage and boiler/electrical buildings.

The steps applied for sampling were as follows:

- Step 1: Holes with an area of approximately 5x5 cm^2 were dug for purpose of collecting samples for routine heavy metal analysis and for PCB analysis holes with areas of approximately 23 x 23 cm^2 were dug.
- Step 2: Soil samples were taken from depths of approximately 7 cm for heavy metal analysis and 20 cm for PCB analysis.

- Soil samples were put in glass containers previously treated with a molar solution of hydrochloric acid and rinsed with distilled water and air-dried.
- Step 3: The samples were sifted through a 50-micron sieve and homogenized after air-drying.

For PCB analysis, 10 g of each sample were extracted with 6 ml of Butyl Diglyme/water. The soil extract was then forced through a 15 cm column of florisil to dry it. Into a tube was delivered 5 ml of the dried diglyme soil extract. Two ampules were used, one containing sodium dispersed in oil and the other containing naphthalene were placed in the tube and then sealed. The naphthalene was added first to the extract by breaking the ampule that contained it. The mixture was shaken vigorously for about 10 seconds after which the second ampule containing sodium was broken to get the sodium into the reaction mixture. The reaction mixture was shaken vigorously for one minute. At this point 3 ml of buffer solution was added to the reaction mixture in a tube. The tube was sealed and the mixture was shaken for one minute…resulting a clear solution. Into a new tube was delivered 5 ml of the clear reaction mixture together with two ampules, one containing mercuric nitrate and the other containing ethanol were placed in the tube. The tube was sealed and the ampule containing mercuric nitrated was broken. The mixture was shaken for about ten seconds followed by the breaking of the ampule containing the ethanol. The resulting reaction mixture was shaken for another ten seconds. The resultant color was observed and then compared to a chart for PCB determination.

For heavy metal analysis, 5 g of each sample were put in separate Erlenmeyer flasks and 15 ml of distilled water added. Each mixture was brought to a boil on a hot plate for 10 minutes and then allowed to cool to room temperature overnight.

The cooled mixtures were filtered through a filter paper. The filtrates were concentrated to half their original volume and used for the analysis as such.

Prior to the analysis, the pH of each sample filtrate was measured using a Fisher Scientific AB15 pH meter.

Scheduled Results:

Eight samples were collected (see **Appendix 1**) and analyzed for PCBs using the test kit *Chlor-N- Soil*® and protocol both developed by Dexil® Corporation.

We detected PCBs in all eight samples at levels 50 ppm and above.

Eight Samples Tested for PCBs

Sample 1	Procedure	Observations	Inference/Conclusio
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into	Bright purple colored solution produced	PCB present

	closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.		

Sample 2	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.	Bright purple colored solution produced	PCB present

Sample 3	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.	Bright purple colored solution produced	PCB present

Sample 4	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate	Bright purple colored solution produced	PCB present

	and ethanol added sequentially and mixture shaken for 10 seconds.		

Sample 5	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.	Bright purple colored solution produced	PCB present

Sample 6	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously	Bright purple colored solution produced	PCB present

	for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.		

Sample 7	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.	Bright purple colored solution produced	PCB present in the area of the daycare centre

Sample 8	Procedure	Observations	Inference/Conclusion
	To a 5 ml dried butyl diglyme extract of sample in a closed test tube was added	Bright purple colored solution produced	PCB present

	naphthalene and then sodium. After 10 seconds, 3 ml buffer solution was added. Mixture shaken vigorously for 1 min to give clear solution. 5 ml of clear solution delivered into closed test tube. Mercuric nitrate and ethanol added sequentially and mixture shaken for 10 seconds.		

Twelve soil samples and one cork sample (see **Appendix 2**) were collected and analyzed using reagents and analytical protocol obtained from Hazcat Systems Inc™. The results are presented below.

Twelve Samples Tested for Heavy Metals

Sample 1	Procedure	Observations	Inference/Conclusion
pH = 8.41	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent

	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added the arsenic test reagents 1, 2, 3, 4, 5 and 6	Test paper did not change color on contact with vapors	As absent
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 2	Procedure	Observations	Inference/Conclusion
pH = 8.20	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results Pink precipitates form after standing for a few minutes	Cd present
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	Mixture turned purple for a brief moment	Pb present

	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added the arsenic test reagents 1, 2, 3, 4, 5 and 6	Test paper did not change color on contact with vapors	As absent
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 3	Procedure	Observations	Inference/Conclusion
pH = 8.32	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results no precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present

	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 4	Procedure	Observations	Inference/Conclusion
pH = 8.83	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent

	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 5	Procedure	Observations	Inference/Conclusion
pH = 8.28	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results Pink precipitates form after standing for a few minutes	Cd present
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent

	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 6	Procedure	Observations	Inference/Conclusion
pH = 8.02	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results no precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent

	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 7	Procedure	Observations	Inference/Conclusion
pH = 8.14	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Mixture turned pink Precipitates formed on standing for a few minutes	Cd present
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	Mixture turned purple for a brief moment	Pb present
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each	No color change was observed, no effervescence	Cr absent

	of diphenylcarbazide and 3N HCl	observed	
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Clear solution results	Cl^- absent
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 8	Procedure	Observations	Inference/Conclusion
pH = 7.84	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results no precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent

	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 9	Procedure	Observations	Inference/Conclusion
pH = 8.03	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results no precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present

	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 10	Procedure	Observations	Inference/Conclusion
pH = 8.44	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results no precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	No color change observed	Sr absent

	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 11	Procedure	Observations	Inference/Conclusion
pH = 8.23	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results No precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent
	To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
	3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent

	To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
	To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
	Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
	3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
	A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Sample 13	Procedure	Observations	Inference/Conclusion
pH = 7.80	To 0.5 ml of sample in test tube was added 3 drops of a,a'-dipyridyl	Pink solution results No precipitates formed	Cd absent
	To 0.5 ml of sample in test tube was added 3 drops of chloranilic acid	No color change observed	Pb absent
	3 drops of NH_4OH was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Cu absent

To 0.5 ml of sample in test tube was added 3 drops each of diphenylcarbazide and 3N HCl	No color change was observed, no effervescence observed	Cr absent
3 drops of $K_4[Fe(CN)_6]$ was added to 0.5 ml of sample in test tube	No color change was observed, no effervescence observed	Fe absent
To 0.5 ml of sample in test tube was added 3 drops each of NH_4OH/oxalic acid and H_2O_2	No color change was observed, no effervescence observed	Mn absent
To 0.5 ml of sample in test tube was added 1 drop NH_4OH and 3 drops rhodozonic sodium	Color of mixture turned brown and faded to yellow	Sr present
Hair pin was dipped into sample solution and then heated over a flame	Flame color did not change	Zn absent
3 drops of AgCl were added to 0.5 ml of sample in test tube	Mixture turned cloudy	Cl^- present
A preheated copper wire that was treated with methanol was dipped in sample and then heated strongly in a flame	Flame assumed an intense blue color that faded to green	Halogenated compound(s) detected

Conclusion:

The presence of PCBs in the soil on the grounds of the old refinery is cause for concern. It was obvious during the sampling process that there had been an attempt to (layer over) backfill the land and in most places this backfill rose as high as 1-2 meters. An attempt was made to reach the original soil as much as possible during sampling but the backfill made our task a daunting one. Thus, if we have been able to detect PCBs in all samples as collected around the perimeter, it is safe to suggest that the more central original soils are much more polluted and that if those zones are analyzed with more sensitive instruments and methods, the results obtained will prove that an even more serious overall condition exists.

Even though there is no universally acceptable limit for PCBs in the environment agreeable between all authorities and jurisdictions. The levels of contamination as determined in our analyses (50 ppm and above) is high enough to warrant serious and urgent action on the part of the authorities by way of a Phase II ESA and any site remediation as maybe necessary.

Sample 12 (cork) (appendix 2) was not amenable to the analytical method and protoc employed in these analyses; the extract form the corks was too colored to make a meaningful qualitative analysis possible.

The presence of lead, cadmium, strontium, chlorides and halogenated compounds were detected in most of the soils analyzed. While this is instructive, assessing the concentrations of each species present will be necessary in order to determine if the levels are above the permissible limits.

References:

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3. Vaalgama, S.; Conley, D.J. *Estuarine, Coastal and Shelf Science* **2008**, *76*(1), 45-56.

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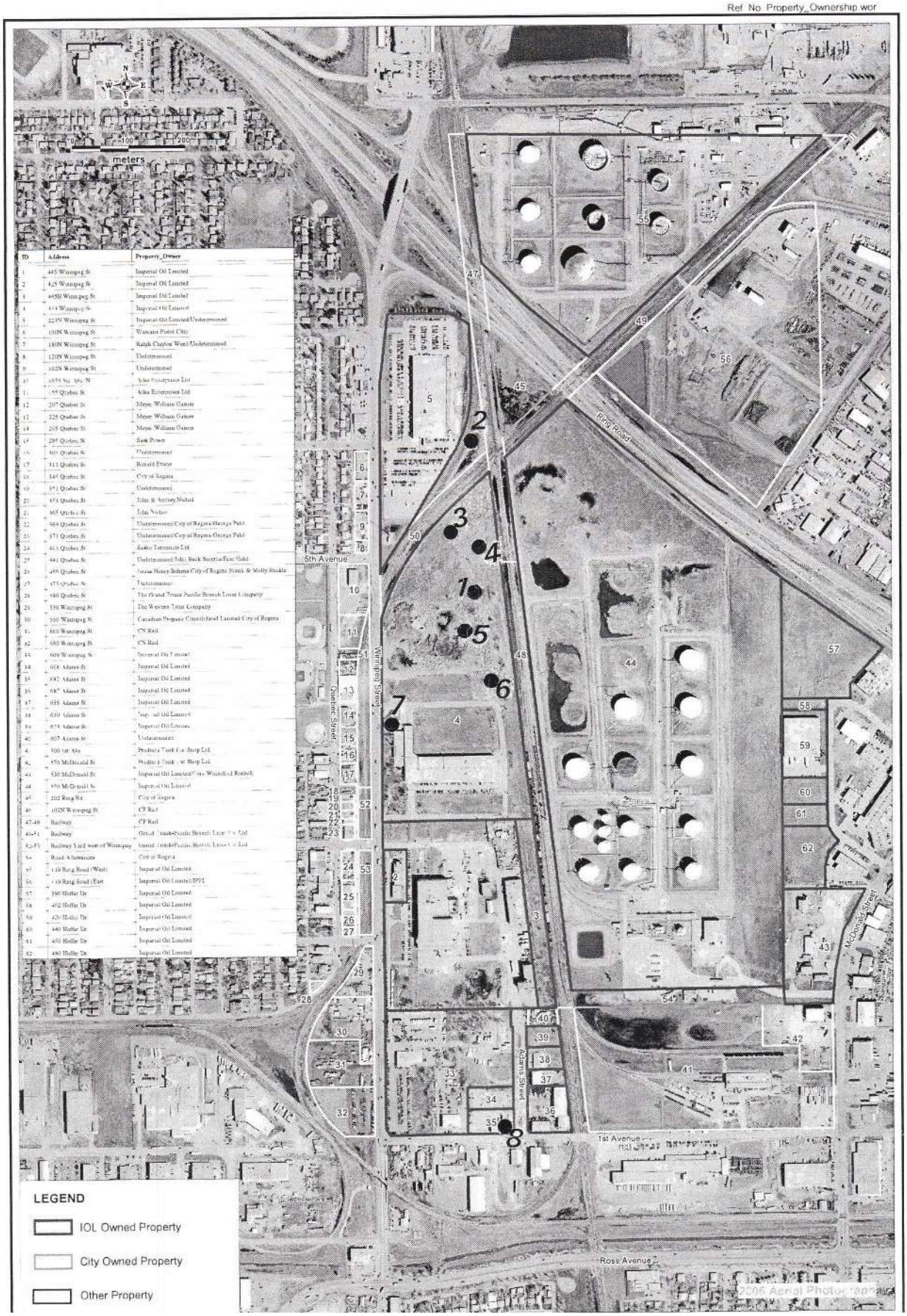
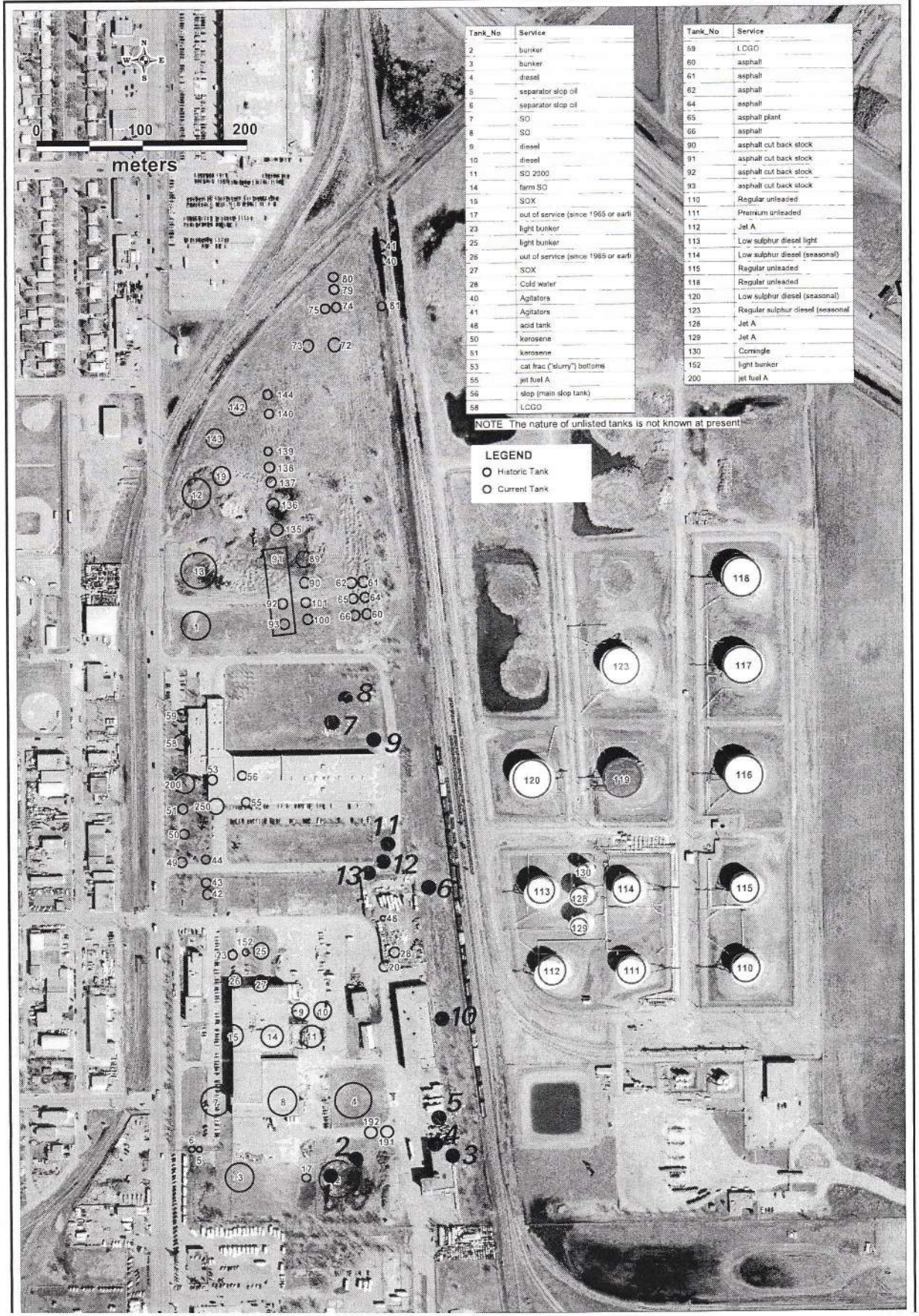
Appendix 1


Ref_No Property_Ownership wor
N
W
E
S
0
100
200
meters
ID | Address | Property_Owner
1 | 445 Winnipeg St | Imperial Oil Limited
2 | 425 Winnipeg St | Imperial Oil Limited
3 | 445B Winnipeg St | Imperial Oil Limited
4 | 411 Winnipeg St | Imperial Oil Limited
5 | 221N Winnipeg St | Imperial Oil Limited/Undetermined
6 | 190N Winnipeg St | Wascana Pointe Ctre
7 | 180N Winnipeg St | Ralph Clayton Wood/Undetermined
8 | 120N Winnipeg St | Undetermined
9 | 102N Winnipeg St | Undetermined
10 | 1035 Sq. Wy. N | Atlas Enterprises Ltd
11 | 155 Quebec St | Atlas Enterprises Ltd
12 | 207 Quebec St | Meyer, William Gaines
13 | 225 Quebec St | Meyer, William Gaines
14 | 265 Quebec St | Meyer, William Gaines
15 | 285 Quebec St | Sask Power
16 | 305 Quebec St | Undetermined
17 | 311 Quebec St | Ronald Evans
18 | 345 Quebec St | City of Regina
19 | 351 Quebec St | Undetermined
20 | 451 Quebec St | John & Audrey Nichol
21 | 505 Quebec St | John Nichol
22 | 569 Quebec St | Undetermined/City of Regina/George Pahl
23 | 571 Quebec St | Undetermined/City of Regina/George Pahl
24 | 415 Quebec St | Sasko Terminals Ltd
25 | 441 Quebec St | Undetermined/John Buck Scottie/Eric Hohl
26 | 455 Quebec St | Teresa Henry Schmit/City of Regina Frank & Molly Stickle
27 | 475 Quebec St | Undetermined
28 | 480 Quebec St | The Grand Trunk Pacific Branch Lines Company
29 | 530 Winnipeg St | The Western Trust Company
30 | 560 Winnipeg St | Canadian Propane Consolidated Limited/City of Regina
31 | 600 Winnipeg St | CN Rail
32 | 680 Winnipeg St | CN Rail
33 | 609 Winnipeg St | Imperial Oil Limited
34 | 658 Adams St | Imperial Oil Limited
35 | 642 Adams St | Imperial Oil Limited
36 | 687 Adams St | Imperial Oil Limited
37 | 685 Adams St | Imperial Oil Limited
38 | 639 Adams St | Imperial Oil Limited
39 | 675 Adams St | Imperial Oil Limited
40 | 607 Adams St | Undetermined
41 | 700 1st Ave | Prudence Tank Car Stop Ltd.
42 | 570 McDonald St | Prudence Tank Car Stop Ltd.
43 | 530 McDonald St | Imperial Oil Limited c/o Winnifred Rodwell
44 | 550 McDonald St | Imperial Oil Limited
45 | 202 Ring Rd | City of Regina
46 | 102N Winnipeg St | CP Rail
47-48 | Railway | CP Rail
49-51 | Railway | Grand Trunk Pacific Branch Lines Co Ltd
52-53 | Railway Yard west of Winnipeg | Grand Trunk Pacific Branch Lines Co Ltd
54 | Road Allowances | City of Regina
55 | 119 Ring Road (West) | Imperial Oil Limited
56 | 119 Ring Road (East | Imperial Oil Limited/IPPL
57 | 390 Hoffer Dr | Imperial Oil Limited
58 | 402 Hoffer Dr | Imperial Oil Limited
59 | 420 Hoffer Dr | Imperial Oil Limited
60 | 440 Hoffer Dr | Imperial Oil Limited
61 | 450 Hoffer Dr | Imperial Oil Limited
62 | 480 Hoffer Dr | Imperial Oil Limited
Ring Road
5th Avenue
Winnipeg Street
Dewdney Street
Adams Street
McDonald Street
1st Avenue
Ross Avenue
LEGEND
IOL Owned Property
City Owned Property
Other Property
2006 Aerial Photography

Appendix 2

Ref. No. Facility_Tank_Summary wor



Tank_No	Service
2	bunker
3	bunker
4	diesel
5	separator slop oil
6	separator slop oil
7	SO
8	SO
9	diesel
10	diesel
11	SO 2000
14	farm SO
15	SOX
17	out of service (since 1965 or earli
23	light bunker
25	light bunker
26	out of service (since 1965 or earli
27	SOX
28	Cold water
40	Agitators
41	Agitators
48	acid tank
50	kerosene
51	kerosene
53	cat frac ("slurry") bottoms
55	jet fuel A
56	slop (main slop tank)
58	LCGO

Tank_No	Service
59	LCGO
60	asphalt
61	asphalt
62	asphalt
64	asphalt
65	asphalt plant
66	asphalt
90	asphalt cut back stock
91	asphalt cut back stock
92	asphalt cut back stock
93	asphalt cut back stock
110	Regular unleaded
111	Premium unleaded
112	Jet A
113	Low sulphur diesel light
114	Low sulphur diesel (seasonal)
115	Regular unleaded
116	Regular unleaded
120	Low sulphur diesel (seasonal)
123	Regular sulphur diesel (seasonal
126	Jet A
129	Jet A
130	Comingle
152	light bunker
200	jet fuel A

TABLE 1 SUMMARY OF CHEMICAL ANALYSES

TEST HOLE	SAMPLE NUMBER	DEPTH (m)	CHEMICAL ANALYSIS		
TH 108	#30	1.5	Hydrocarbon	88 ppm	
	#33	6.1	Hydrocarbon	470 ppm	
TH 111	#36	1.5	Hydrocarbon	840 ppm	
TH 112	#23	1.5	Hydrocarbon	730 ppm	
	#25	4.6	Hydrocarbon	540 ppm	
	#26	6.1	Hydrocarbon	13,500 ppm	(i.e. 1.35%)
	#28	9.1	Hydrocarbon	<20 ppm	
TH 113	#17	1.5	Hydrocarbon	4,200 ppm	

TRACE CONSTITUENTS

TH 112	#23	1.5	B	11 ppm
			Hg	<0.05 ppm
			P	580 ppm
			Phenol	0.5 ppm

TRACE METALS

Ag	<0.001	ppm
Al	52,000	ppm
As	11	ppm
Ba	370	ppm
Be	7	ppm
Ca	24,000	ppm
Cd	<1	ppm
Co	15	ppm
Cr	29	ppm
Cu	31	ppm
Fe	38,000	ppm
K	11,000	ppm
Mg	15,000	ppm
Mn	520	ppm
Mo	48	ppm
Na	1,100	ppm
Ni	42	ppm
Pb	73	ppm
Ti	1,100	ppm
V	110	ppm
W	<1	ppm
Zn	100	ppm

PHYSICAL PROPERTIES

Ph on solids (50% slurry)	8.07