APPENDIX R

METALS IN SNOW COLUMNS

Metals in Snow Columns, Flin Flon

FINAL

Prepared for:
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Flin Flon, Manitoba

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Executive Summary

Background

Jacques Whitford AXYS Ltd. (JWA) was retained by Hudson Bay Mining and Smelting Co., Limited (HBM&S) in February, 2008, to conduct a snow column sampling program for metals in the City of Flin Flon, Manitoba and surrounding communities, hereafter referred to as the Site.

This report summarizes the 2008 snow sampling activities.

Scope of Work

The scope of work included the collection of snow column samples in the City of Flin Flon and the surrounding areas, their subsequent analytical analysis and the generation of the report presented herein.

Snow Column Sampling

Snow samples were to be collected from sites within the City of Flin Flon and surrounding area to give a representative overview of metal concentrations and metal deposition in snow within and surrounding the Site. The snow column sampling program was intended to present a preliminary view of metal deposition around the City of Flin Flon, and was not intended to present an exhaustive statistical analysis of metal deposition.

Conclusions

The snow column data analysis is presented as additional information for the Community Based Risk Assessment. All analytical data is presented in Section 6 and the Appendices.

The snow column sampling conducted by JWA on March 8 and 9, 2008 in and around Flin Flon, Manitoba has generated the following conclusions.

- Snow column metal concentrations and deposition in the Flin Flon area samples generally tended to be lower with increasing distance from the smelter smoke stack.
- Snow column metal depositions in the Flin Flon area samples generally tended to be higher at sample sites that were located in areas southeast of the stack (downwind of the prevailing winds). This is in keeping with results reported in previous studies for the Flin Flon area.

The statements made in this Executive Summary text is subject to the same limitations described in the Closure Section 7.0 of this report, and should be read in conjunction with the remainder of this report.

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Abbreviations

JWA ..... Jacques Whitford AXYS Limited
HBM&S ..... Hudson Bay Mining and Smelting Co., Ltd.
CSRA ..... Contaminated Sites Remediation Act
CCME ..... Canadian Council of Ministers of the Environment
CCWQG ..... Canadian Community Water Quality Guidelines
CAEAL ..... Canadian Association of Environmental Analytical Laboratories

1 Introduction

Jacques Whitford AXYS Ltd. (JWA) was retained by Hudson Bay Mining and Smelting Co., Limited (HBM&S) in February, 2008, to conduct a snow column sampling program for metals in the City of Flin Flon, Manitoba and surrounding area, hereafter referred to as the Site.

This report summarizes the 2008 snow sampling activities.

1.1 Background

In the 1930's a smelter was built in the City of Flin Flon to process metal ore from the on-site mine. The smelter released all emissions via two smoke stacks at the Site. One stack was 150 feet in height (close to the current stack), and the other was 250 feet high (located due west from the current stack and at a slightly lower elevation).

HBM&S has implemented numerous pollution control measures since operations commenced in the 1930's. Highlights of these measures include the following.

1950's

Reduction in particulate emissions with the commissioning of the Copper Smelter baghouse.

1973

The installation of a new smoke stack, 825 feet in height (located near the former 150 foot tall stack) to replace the two shorter stacks, resulting in a reduction of local deposition.

1974 and 1982

New electrostatic precipitators were commissioned, firstly on the copper roaster (1974) and later the zinc roaster (1982) which resulted in a reduction in particulate emissions.

1993

To address the wider issue of "Acid Rain", the Zinc Pressure Leach facility was commissioned in 1993. This resulted in a step reduction in particulate emissions as it led to the shutdown of the zinc roasters and zinc fuming plant.

2000

Fugitive emissions that may have impacted local ambient air quality were reduced by completion of the smelter gas handling project.

2007

The current expansion to the tailings facility will minimize airborne dusting potential for the community.

1.2 Physical Setting

The Site is located on the Precambrian shield in the Boreal forest portion of northwest Manitoba and northeast Saskatchewan.

2 Literature Review

Annual snow sampling programs have been conducted in the Flin Flon area since 1979 to monitor pH and deposition patterns of heavy metals and sulphur emissions from the Hudson Bay Mining and Smelting Company (Phillips et al., 1986). Two of these studies conducted by Phillips et al. (1986) and Shewchuk (1985) found that deposition of heavy metals in the Flin Flon area was inversely related to distance from the smelter stack. Phillips et al. (1986) also reported that wind direction in Flin Flon during the winter months (November to March) is predominately from the northwest with metal deposition highest in a southeast direction from the smelter. Phillips et al (1986) collected samples from a maximum distance of 38.1 km from the smelter and found heavy metals present. The study conducted by Shewchuk estimated metal deposition to be in a 100 km radius from the stack.

A study conducted by Barrie and Whelpdale (1977) found that the analyses of undisturbed snowpack is an effective method for monitoring the distribution of air pollutants. Air pollutants are reported to be deposited in snow profiles through three processes including: 1. fallout of particles due to gravity, 2. pollutants from the air being collected on falling rain droplets or snowflakes, and 3. adsorption/absorption of gaseous pollutants to the surface of the snowpack (Barrie and Whelpdale, 1977).

3 Regulatory Guidelines

In Manitoba, the investigation of contaminated sites is authorized and guided under the *Contaminated Sites Remediation Act C.C.S.M. c. C205 (CSRA)*. Currently there are no CCME guidelines for metals in snow columns. The analytical results for the snow columns are presented in this report, however no comparisons to criteria can be made.

3.1 Contaminated Sites Remediation Act

This Act establishes a process whereby the party responsible for a contaminated site can work with the regulatory authority to ensure the protection of human health, safety and the environment, in an economically feasible and sustainable manner. It provides a baseline for developing applicable risk-based remedial action and management plans for contaminated sites and its associated Guideline 98-01, Environmental Investigations in Manitoba (June 1998, revised May 2002) outlines a three tier assessment program for a contaminated site.

Tier I – is a criteria based approach using generic guidelines to determine impact at a Site and the final remediation requirements are based on these criteria.

Tier II – is based on a Site-specific approach that determines site sensitivities and sets criteria based on site-determined parameters.

Tier III – is based on a risk management basis where methods employed at the Site contain, control, monitor, and otherwise minimize the potential negative effects of contaminated media at the Site.

For this Site, a Tier III approach will be conducted by Intrinsik Environmental using the data presented in this report.

4 Scope of Work for Snow Column Sampling

4.1 Objectives

The scope of work included the collection of snow column samples in the City of Flin Flon and the surrounding area, to give a representative overview of metal concentrations in snow within and surrounding the Site. The snow column sampling program was intended to present a preliminary view of metal concentrations around the City of Flin Flon, and was not intended to present an exhaustive statistical analysis of metal deposition.

5 Snow Column Sampling Methodology

JWA conducted a snow column sampling of select areas in the Creighton and Flin Flon areas on March 8 and 9, 2008. Snow samples were collected in March in order to collect total winter accumulation. Twelve (12) sites in total were sampled.

5.1 Sample Site Locations

Previous soil, dust and water assessments were concentrated around the human population surrounding the HBM&S smelter, i.e. the town of Flin Flon and the immediate surrounding areas (Metals in Soil, Flin Flon, April 21, 2008 Jacques Whitford AXYS Limited Report for HBM&S). In keeping with this community assessment, snow sample site locations were selected within this localized area based on their non-disturbed snow profiles, relative accessibility and location downwind of the prevailing winds for the area[1]. Sites close to the smelter stack were not sampled due to the lack of availability of non-disturbed snow profiles.

[1] Prevailing winds in the Flin Flon area are from the northwest.

5.2 Snow Column Sample Collection

Snow samples were collected in order to assess the current status of metals in the snow at each location. These samples were collected as a part of the Community Based Risk Assessment and do not necessarily indicate a risk to human health or the environment without further assessment. Sample analysis present a preliminary view of metal concentrations around the City of Flin Flon, and are not intended to present an exhaustive statistical analysis of metal deposition.

The snow sampling methodology utilized by JWA closely adhered to the protocol developed by Manitoba Conservation for a snow sampling program conducted in Flin Flon in late February 2006. A pre-cleaned (60 cm length, 5.8 cm inside diameter) plastic tube was pushed through the snow to near the bottom of the snow profile (within 2 cm of the ground, to avoid debris). A rigid plastic sheet was placed below the bottom of the tube and the plastic tube was removed. Snow was allowed to flow from the tube into a pre-weighed wide mouth 500 mL container, the snow was packed into the container and the container was capped. The snow was allowed to melt at room temperature and the amount of residue in the melt water was assessed. Each sample was photographed, and the water samples preserved with nitric acid (5 mL). The sample was then swirled for a minimum of one minute to ensure any residue on the container side was brought into solution.

Sampling locations are described in Table 5-1 and illustrated in Appendix A. Quality control/assurance is described in Appendix B. Select photos of the sampling areas and sampling procedures are included in Appendix C.

Table 5-1 Snow Column Sampling Locations

Site ID	Approximate Distance from Stack (m)	Direction from Stack	Description
Site 1	1,570	SW	End of Creighton Avenue.
Site 2	3,030	SW	100 metres north along the snowmobile track, leaving the corner of the back alley at Bereskin Avenue and Queen Street.
Site 3	3,800	SW	South end of Creighton, SK, on west side of Creighton Avenue at Bomber Lake Road, up the snowmobile path on a small pond.
Site 4	10,440	SW	***Local Control Site** - 8 km southwest on Highway 167 in a small pond, ice bottom, used as a local control site.
Site 5	1,210	SE	End of Hapnot Street in a level portion of the ravine.
Site 6	2,030	SE	South from Northern Bus Lines across the paved road, in a poplar vegetated area.
Site 7	1,240	E	West side of Ross Lake, in a nearly level area setback approximately 20 metres from shoreline in an open area surrounded by small poplar, birch and shrub vegetation.
Site 8	1,650	SE	West side of Centoba Park, 6 metres west of ditch, in a poplar vegetated area.
Site 9	1,790	NE	Northeast corner of Ross Lake, poplar vegetated area 35 metres in from shoreline.
Site 10	2,050	E	Southwest from corner of Bracken Street and Phelan Avenue in wetland area.
Site 11	9,650	NW	***Local Control Site** - 10 km from bus depot in Creighton, SK, northwest on Highway 106, 55 metres north of the highway. Used as a local control site.
Site 12	2,830	E	Flin Flon Campground across from Wal-Mart® department store.

*Initially sampled as local control sites. Refer to Section 6.1 for further explanation.

5.3 Snow Column Laboratory Analysis

All samples were submitted for the analysis of 34 metals. Laboratory analyses included the following:

- Metals ICP-MS (**Total**) in water, US EPA and APHA, Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8.
- Mercury (**Total**) in Water, US EPA. Determination of Hg in Sediment by Cold Vapour Atomic Absorption Spectroscopy 245.5.

The snow column metal concentration analytical results are tabulated in Appendix D, and the original laboratory analysis certificates are included in Appendix E. There are no CCME criteria for metals in snow, therefore all metals have been tabulated for the snow sampling program.

5.3.1 Metal Deposition

The values reported directly from the laboratory analysis are presented as total metal concentrations in water (mgL^{-1}) and not as dissolved metals. Results are presented in Table D-1, Appendix D.

In order to demonstrate the amount of metals deposition by area, Manitoba Conservation has developed a calculation for aerial deposition which they have used for their 2006 snow sampling program. In order to allow for the comparison of datasets, the Manitoba Conservation calculation was applied to the JWA snow column sample analytical results (Manitoba Conservation, Internal Document No. GJ 12012008, Snow Sampling Methods & Analysis, provided to JWA through correspondence in March 2008).

The concentrations reported by the laboratory can be converted into units of deposition using the following equation:

$$D = C \times \frac{V}{A} \times 10$$

Where:

D = Deposition (mg/m^2)

C = Concentration of the substance in water (mg/L)

V = Volume of water in the sample obtained from massing the snow sample and based on the relationship 1 g snow = 1 mL of water

A = Area of the sample (cm^2)

10 = Constant (to account for unit changes of mL to L and cm^2 to m^2)

The sample volume was determined by weighing the sample containers before and after the snow was sampled. The difference between the final weight (container + snow) and initial weight (empty container) is the mass of snow collected. The mass of snow was converted to volume of water using the relationship 1 g of snow = 1 mL of water. The plastic tube cores used in sampling had a radius of 2.9 cm. The area of all samples was calculated as:

$$A = \pi \times r^2 = \pi \times (2.9)^2 = 26.42\ cm^2$$

The following is an example calculation used to determine Deposition. The example uses the metal aluminum at Site 1:

- C = 0.972 mg/L of aluminum
- V = 183.24 mL (183.24 g of melt water)
- A = 26.42 cm^2

Therefore:

$$D = \frac{0.972mg}{L} \times \frac{183.24\ mL}{26.42\ cm^2} \times 10 = 67.41\ mg/m^2$$

The snow column metal deposition results are presented in Table D-2, Appendix D.

6 Intrusive Investigation Results

The results of the snow column sampling program are confidential and are presented here with Site location but without property identification.

6.1 Metal Concentrations in Snow Columns

The snow column data analysis is presented as additional information for the Community Based Risk Assessment and does not necessarily indicate a risk to human health or the environment without further assessment

Local control sites were chosen in order to provide local control samples, up-gradient from the prevailing northwest wind, thought to be the main vector of metal deposition. However, two control snow columns were sampled 10 km outside of Flin Flon (Site 4, southwest; Site 11, northwest). Studies conducted by Phillips et al. (1986) and Shewchuk (1985) indicate that the maximum radius of metal deposition in snowpack around the Flin Flon area may be from 38 to 100 km from the stack respectively. Based on these reports, the metal levels found at the control sites 10 km outside of Flin Flon are of limited value as local control sites. Thus, these sites may be considered as additional data points in this report.

This preliminary analysis of snow in the Flin Flon area can only be used to draw general conclusions in terms of metal concentrations. No statistical assessment was conducted.

To highlight the differences in select metals, the discussion of metals is limited to those with associated CCME criteria (16 metals). Metal concentration ranges for the Flin Flon area are listed in Table 6-1 below:

Table 6-1 Range of Metal Concentrations in Snow Columns

Metal	Range of Metal Concentrations in Snow Columns (mgL^{-1})
Mercury	0.0001 - 0.0018
Aluminum	0.122 - 1.1
Antimony	0.0016 - 0.0061
Arsenic	0.0297 - 0.147
Barium	0.003 - 0.034
Boron	All samples were below the laboratory detection limit (<0.002)
Cadmium	0.0287 – 0.183
Chromium	0.0008 – 0.004
Copper	0.253 – 4.94
Lead	0.151 – 0.732
Selenium	0.0003 – 0.0028
Uranium	All samples were below the laboratory detection limit (<0.0005)
Zinc	0.285 – 3.77
Iron	0.4 – 7.0
Manganese	<0.005 – 0.044
Sodium	<0.4 – 1.9

Table 6-2 depicts metal concentrations in snow columns as a function of distance and direction from the smelter smoke stack. Generally, concentrations of heavy metals in the snow columns decrease with increasing distance from the stack in Flin Flon.

Table 6-2. Metals (CCME associated) in Flin Flon Area Snow Columns Arranged By Distance and Direction

	Laboratory Lot Ref. #	1	2	3	4	5	8	6	7	10	12	9	11
	Laboratory Sample #	2608584	2608585	2608586	2608587	2608588	2608591	2608589	2608590	2608593	2608595	2608592	2608594
	Sample ID	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 8**	**Site 6**	**Site 7**	**Site 10**	**Site 12**	**Site 9**	**Site 11**
	Distance from Stack (m)	1,570	3,030	3,800	10,440	1,210	1,650	2,030	1,240	2,050	2,830	1,790	9,650
	Direction from Stack	*SW*	*SW*	*SW*	*SW*	*SE*	*SE*	*SE*	*E*	*E*	*E*	*NE*	*NW*
Analytical Results (mgL^{-1})	**Mercury**	0.0005	0.0004	0.0004	0.0003	0.0018	0.0006	0.0005	0.0004	0.0003	0.0002	0.0007	0.0001
	Aluminum	0.972	0.211	0.243	0.122	1.1	0.395	0.772	0.371	0.232	0.152	0.274	0.164
	Antimony	0.0026	0.0019	0.0034	0.0016	0.005	0.0056	0.0061	0.0026	0.0029	0.0031	0.006	0.0016
	Arsenic	0.0653	0.0388	0.055	0.0305	0.118	0.108	0.147	0.0502	0.065	0.0749	0.124	0.0297
	Barium	0.015	0.008	0.009	0.003	0.034	0.018	0.018	0.015	0.012	0.009	0.018	0.004
	Cadmium	0.0646	0.0463	0.0706	0.0287	0.0956	0.132	0.183	0.0426	0.0773	0.0953	0.165	0.0403
	Chromium	0.0018	0.0009	0.0012	0.0009	0.004	0.0033	0.0024	0.0016	0.0012	0.0008	0.0012	0.0008
	Copper	2.56	1.39	1.35	0.253	3.62	3.08	2.78	4.94	2.63	1.82	2.83	0.352
	Lead	0.221	0.2	0.397	0.151	0.538	0.626	0.732	0.186	0.282	0.358	0.641	0.153
	Selenium	0.0019	0.0007	0.0012	0.0003	0.0028	0.0025	0.0028	0.0026	0.0022	0.0016	0.0025	0.0003
	Zinc	1.34	0.955	1.39	1.01	3.77	2.49	2.91	1.72	1.05	1.18	2.23	0.285
	Iron	7	1.4	1.5	0.4	5.2	3.3	5	3.7	1.9	1.2	2.2	0.6
	Manganese	0.044	0.008	0.009	<0.005	0.039	0.021	0.033	0.018	0.008	0.008	0.012	<0.005
	Sodium	<0.4	<0.4	0.7	1.7	1.3	<0.4	1.9	<0.4	<0.4	<0.4	<0.4	0.4

Notes

1. There are no CCME criteria available for snow.
2. These samples were collected as a part of the Community Based Risk Assessment and do not necessarily indicate a risk to human health or the environment without further assessment.

6.2 Metal Deposition in Snow Columns

Table 6-3 depicts metal deposition in snow columns as a function of distance and direction from the smelter smoke stack. When the snow column metal concentrations are expressed as depositional units, metals generally tend to be more abundant in the snow samples collected from sites closer to the stack. The general trend was also for metal deposition to be greater at sample sites that were located in areas southeast of the stack (downwind of the prevailing winds). This is in keeping with results reported in previous studies for the Flin Flon area (Phillips et al., 1986 and Shewchuk, 1985).

Table 6-3. Metal Deposition in Flin Flon Area Snow Columns Sorted by Distance and Direction

	Laboratory Lot Ref. #	1	2	3	4	5	8	6	7	10	12	9	11
	Laboratory Sample #	2608584	2608585	2608586	2608587	2608588	2608591	2608589	2608590	2608593	2608595	2608592	2608594
	Sample ID	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 8**	**Site 6**	**Site 7**	**Site 10**	**Site 12**	**Site 9**	**Site 11**
	Distance (m)	1,570	3,030	3,800	10,440	1,210	1,650	2,030	1,240	2,050	2,830	1,790	9,650
	Direction from Stack	*SW*	*SW*	*SW*	*SW*	*SE*	*SE*	*SE*	*E*	*E*	*E*	*NE*	*NW*
	Container Weight (g)	64.86	65.08	66.54	64.62	66.24	64.07	64.52	65.05	64.59	64.23	64.37	63.77
	Container + Water (g)	248.1	254.36	236.38	274.42	293.38	267.34	263.01	281.73	275.22	270.04	237.7	280.63
	Volume of water* (cm3)	183.24	189.28	169.84	209.8	227.14	203.27	198.49	216.68	210.63	205.81	173.33	216.86
Deposition (mg/m^2)	**Mercury**	0.035	0.029	0.026	0.024	0.155	0.046	0.038	0.033	0.024	0.016	0.046	0.008
	Aluminum	67.413	15.116	15.621	9.688	94.567	30.390	57.998	30.426	18.495	11.840	17.975	13.461
	Antimony	0.180	0.136	0.219	0.127	0.430	0.431	0.458	0.213	0.231	0.241	0.394	0.131
	Arsenic	4.529	2.780	3.536	2.422	10.144	8.309	11.044	4.117	5.182	5.834	8.135	2.438
	Barium	1.040	0.573	0.579	0.238	2.923	1.385	1.352	1.230	0.957	0.701	1.181	0.328
	Cadmium	4.480	3.317	4.538	2.279	8.219	10.156	13.748	3.494	6.162	7.424	10.825	3.308
	Chromium	0.125	0.064	0.077	0.071	0.344	0.254	0.180	0.131	0.096	0.062	0.079	0.066
	Copper	177.547	99.580	86.782	20.090	311.212	236.962	208.851	405.135	209.667	141.772	185.658	28.892
	Lead	15.327	14.328	25.520	11.990	46.252	48.162	54.993	15.254	22.481	27.887	42.052	12.558
	Selenium	0.132	0.050	0.077	0.024	0.241	0.192	0.210	0.213	0.175	0.125	0.164	0.025
	Zinc	92.935	68.417	89.353	80.201	324.108	191.570	218.618	141.059	83.707	91.918	146.296	23.393
	Iron	485.481	100.297	96.424	31.763	447.045	253.888	375.632	303.441	151.470	93.476	144.328	49.248
	Manganese	3.052	0.573	0.579	<0.410	3.353	1.616	2.479	1.476	0.638	0.623	0.787	<0.410
	Sodium	<32.804	<32.804	44.998	134.992	111.761	<32.804	142.740	<32.804	<32.804	<32.804	<32.804	32.832

Notes

1. There are no CCME criteria available for snow.
2. These samples were collected as a part of the Community Based Risk Assessment and do not necessarily indicate a risk to human health or the environment without further assessment.
3. The metal concentrations reported by the laboratory have been converted into units of deposition based on a calculation developed by Manitoba Conservation.

7 Conclusions

The snow column data analysis is presented as additional information for the Community Based Risk Assessment. All analytical data is presented in the Appendices.

The snow column sampling conducted by JWA on March 8 and 9, 2008 in and around Flin Flon, Manitoba has generated the following conclusions.

- Snow column metal concentrations and deposition in the Flin Flon area samples generally tended to be lower with increasing distance from the smelter smoke stack.
- Snow column metal depositions in the Flin Flon area samples generally tended to be higher at sample sites that were located in areas southeast of the stack (downwind of the prevailing winds). This is in keeping with results reported in previous studies for the Flin Flon area.

8 Closure

This report is prepared for the sole benefit of Hudson Bay Mining and Smelting Co., Limited. The report may not be relied upon by any other person or entity without the express written consent of Jacques Whitford AXYS Limited and Hudson Bay Mining and Smelting Co., Limited.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific and agricultural practices current at the time the work was performed. The conclusions presented herein represent the best judgement of Jacques Whitford AXYS Ltd. based on the data obtained from the work and on the site conditions encountered at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations.

In addition, analysis has been carried out for a limited number of chemical parameters, and it should not be inferred that other chemical species are not present. Due to the nature of the investigation and the limited data available, Jacques Whitford AXYS Ltd. cannot warrant against undiscovered environmental liabilities.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, we request that this information be brought to our attention so that we may reassess the conclusions provided herein. The field work was conducted by Jim Hicks, B.Sc., P.Ag. This report was prepared by Kimberly Marko, B.Env.Sc. and Danette Sahulka, M.Sc., and senior reviewed by Peter Reid, M.Eng, P.Eng.

Respectfully Submitted,

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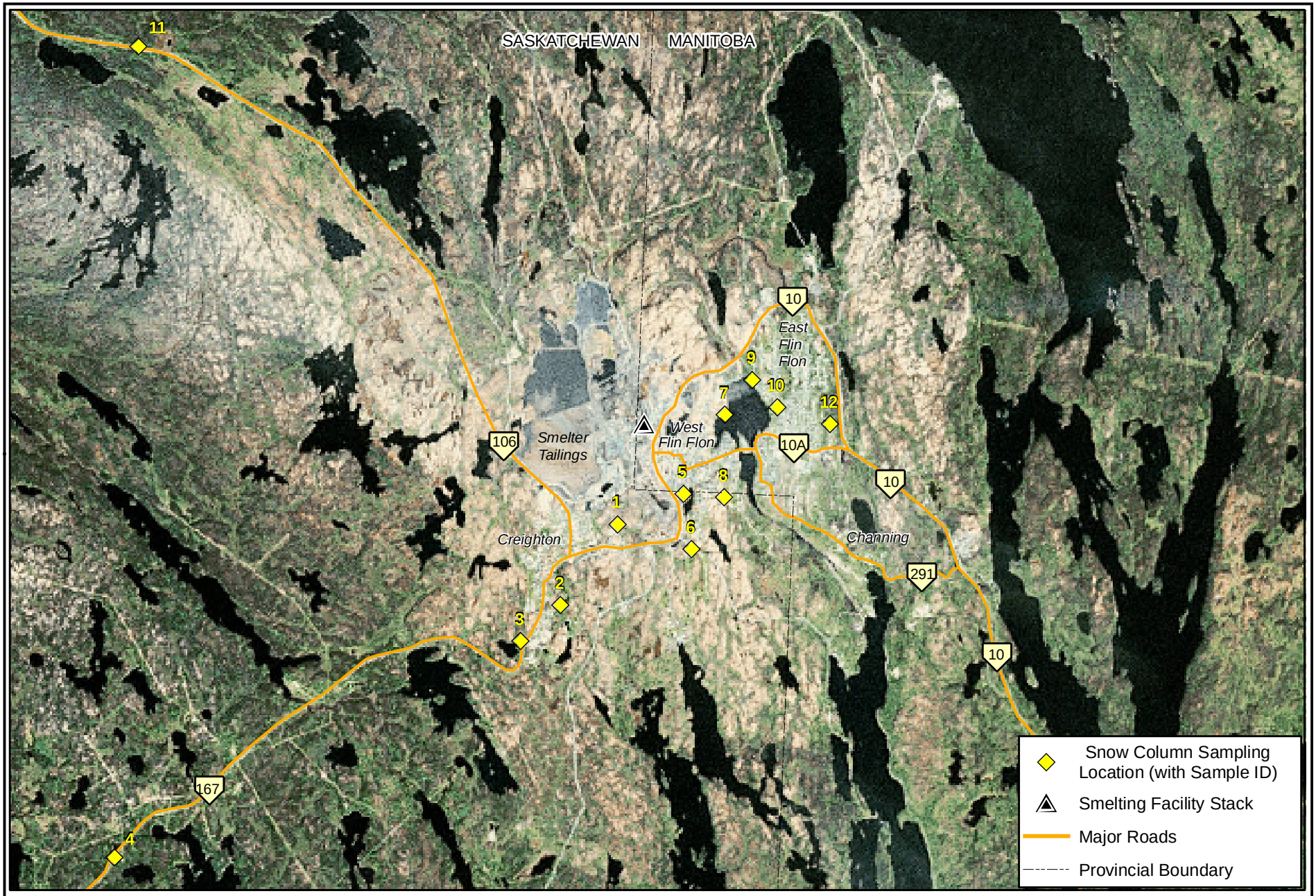
Appendix A Site Diagram



HUDSON BAY MINING AND SMELTING CO., LIMITED - FLIN FLON, MB & CREIGHTON, SK

Snow Column Sampling Locations

NORTH

700 350 0 700 1,400 2,100

Metres

Acknowledgements:
Original Drawing by Jacques Whitford AXYS Ltd.

PREPARED BY Jacques Whitford AXYS

MAP SCALE	1:80,000
DATA SCALE	N/A
DRAFT DATE	April 9, 2008
PROJECT	1032002 .03
FIGURE NO.	A-1
DRAWN	KM
CHECKED	JH
APPROVED	JH

Appendix B Quality Control

All samples were submitted under a strict Chain-of-Custody protocol. Sampling protocols adhered to include the following:

- Prior to sampling, Bodycote Testing Group (Winnipeg) washed the plastic snow columns in detergent followed by a de-ionized rinse, followed by a dilute nitric acid wash and triple rinsing in de-ionized water. The columns were allowed to dry and were double wrapped in plastic for shipping to Flin Flon in a taped, sealed cardboard container.
- A pre-cleaned plastic tube (length of 60 cm, diameter of 5.8 cm) was pushed through the snow to near the bottom of the snow profile. A rigid plastic sheet was placed below the bottom of the tube and the plastic tube was removed. Snow was allowed to flow from the tube into a pre-weighed wide mouth 500 mL container, snow was packed into the container and the container was capped. The snow was allowed to melt at room temperature and the melt water samples were preserved with nitric acid (5 mL). The sample was then swirled for a minimum of one minute to ensure any residue on the container side was brought into solution.
- Disposable nitrile gloves were worn during the collection of samples, and discarded between sampling events.
- One field blank was used for the snow column sampling. Distilled water was purchased locally and water was run through one of the pre-cleaned plastic tubes. The water was collected in a plastic bottle and preserved in the same manner as the snow column samples. The field blank was then included with the samples collected and submitted to the laboratory for analysis.
- One travel blank was used for the snow column sampling. Distilled water was poured into an identical 500 mL pre-cleaned wide mouth plastic bottle that was used for the submission of the snow column samples. The sample was then preserved with 5 mL of nitric acid, capped, and included with the Site samples for laboratory analysis.
- Samples collected for laboratory analysis were placed in coolers and transported to the laboratory via courier.
- Sample holding times were strictly adhered to, and samples were preserved for specific analyses.

All water samples were analyzed at Bodycote Testing Group (formerly Norwest Labs) in Winnipeg, Manitoba. Bodycote is a Canadian Association of Environmental Analytical Laboratories (CAEAL) accredited laboratory. All analytical reports include QA/QC reports.

Appendix C Site Photographs

Photo C-1 **Site 2 – Clean snow, ice surface in small pond away from snowmobile trail.**

Photo C-2 **Site 2 – Sampling site surrounding area.**

Photo C-3 Snow profile after removal of plastic tube.

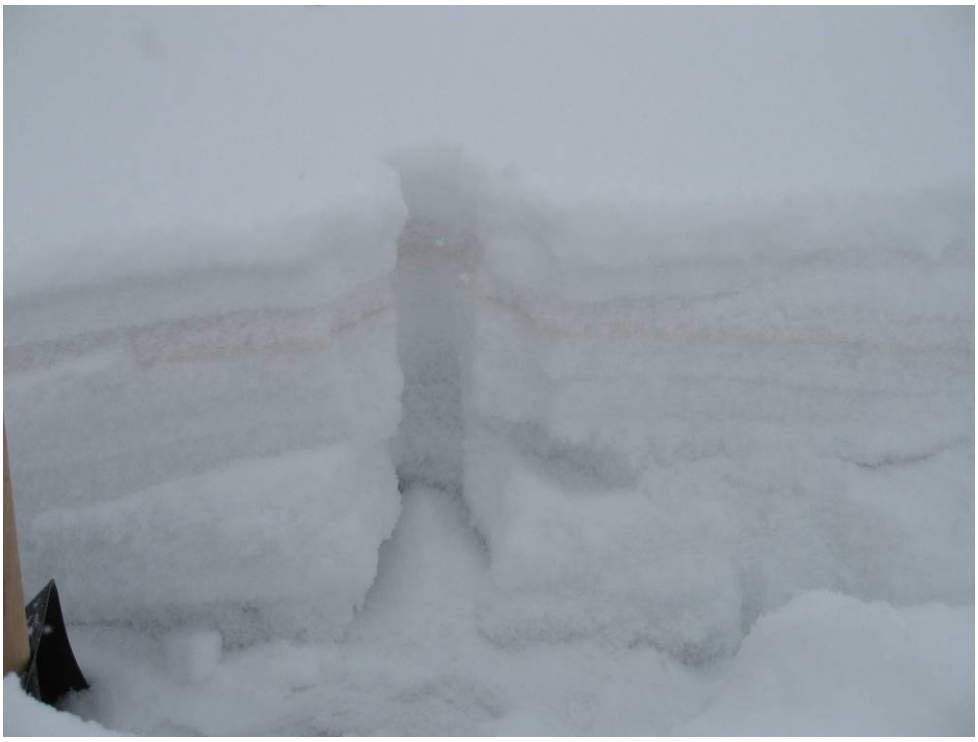


Photo C-4 Site 7 – West side of Ross Lake.

Photo C-5 Site 10 – SW of Bracken and Phelan in wetland area.

Photo C-6 Site 12 – Campground in Flin Flon.

Photo C-7 **Site 11 – Clean snow: note crystalline coarse snow in lower 26 cm of profile.**

Photo C-8 **Melted snow with moderate very fine residues.**

Photo C-9 Melted snow with low residue.

Appendix D Tabulated Analytical

Table D-1. Metals in Flin Flon Area Snow Columns

	Laboratory Lot Ref. #	1	2	3	4	5	6	7	8	9	10	11	12	2	3
	Laboratory Sample #	2608584	2608585	2608586	2608587	2608588	2608589	2608590	2608591	2608592	2608593	2608594	2608595	2623447	2623448
	Sample ID	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Field Blank Site 14	Travel Blank Site 15
	Distance from Stack (m)	1,570	3,030	3,800	10,440	1,210	2,030	1,240	1,650	1,790	2,050	9,650	2,830		
	Direction from Stack	SW	SW	SW	SW	SE	SE	E	SE	NE	E	NW	E		
Analytical Results (mg/L)	Mercury	0.0005	0.0004	0.0004	0.0003	0.0018	0.0005	0.0004	0.0006	0.0007	0.0003	0.0001	0.0002	<0.0001	<0.0001
	Aluminum	0.972	0.211	0.243	0.122	1.1	0.772	0.371	0.395	0.274	0.232	0.164	0.152	0.019	<0.005
	Antimony	0.0026	0.0019	0.0034	0.0016	0.005	0.0061	0.0026	0.0056	0.006	0.0029	0.0016	0.0031	<0.0002	<0.0002
	Arsenic	0.0653	0.0388	0.055	0.0305	0.118	0.147	0.0502	0.108	0.124	0.065	0.0297	0.0749	<0.0002	<0.0002
	Barium	0.015	0.008	0.009	0.003	0.034	0.018	0.015	0.018	0.018	0.012	0.004	0.009	<0.001	<0.001
	Beryllium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Bismuth	0.0054	0.0061	0.0119	0.0038	0.0126	0.0184	0.0034	0.0155	0.0189	0.0058	0.0033	0.0078	<0.0005	<0.0005
	Boron	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	Cadmium	0.0646	0.0463	0.0706	0.0287	0.0956	0.183	0.0426	0.132	0.165	0.0773	0.0403	0.0953	<0.00001	<0.00001
	Chromium	0.0018	0.0009	0.0012	0.0009	0.004	0.0024	0.0016	0.0033	0.0012	0.0012	0.0008	0.0008	0.0008	<0.0005
	Cobalt	0.0079	0.0014	0.0018	0.0004	0.0054	0.0055	0.0048	0.0038	0.0025	0.0024	0.0005	0.0014	<0.0001	<0.0001
	Copper	2.56	1.39	1.35	0.253	3.62	2.78	4.94	3.08	2.83	2.63	0.352	1.82	0.001	<0.001
	Lead	0.221	0.2	0.397	0.151	0.538	0.732	0.186	0.626	0.641	0.282	0.153	0.358	0.0003	0.0003
	Lithium	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Molybdenum	0.002	0.001	0.002	<0.001	0.004	0.004	0.003	0.003	0.004	0.002	<0.001	0.002	<0.001	<0.001
	Nickel	0.0013	0.0007	0.0007	0.0006	0.0027	0.0019	0.0014	0.0014	0.0011	0.001	<0.0005	0.001	<0.0005	<0.0005
	Selenium	0.0019	0.0007	0.0012	0.0003	0.0028	0.0028	0.0026	0.0025	0.0025	0.0022	0.0003	0.0016	<0.0002	<0.0002
	Silver	0.00151	0.0008	0.00105	0.00026	0.00221	0.00181	0.00229	0.00183	0.00156	0.0013	0.00034	0.00097	0.00002	<0.00001
	Strontium	0.003	0.001	0.001	<0.001	0.008	0.004	0.003	0.003	0.003	0.003	0.002	0.002	<0.001	<0.001
	Thallium	0.00032	0.00019	0.00035	0.00016	0.00056	0.00077	0.00019	0.00055	0.00055	0.00028	0.00016	0.00036	<0.00005	<0.00005
	Tin	0.001	0.001	0.002	<0.001	0.002	0.003	<0.001	0.003	0.003	0.001	<0.001	0.002	<0.001	<0.001
	Titanium	0.0312	0.0088	0.0105	0.0056	0.0578	0.025	0.0114	0.0121	0.0101	0.0102	0.006	0.0062	0.0009	<0.0005
	Uranium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
	Vanadium	0.0025	0.0008	0.0011	0.0005	0.0048	0.0035	0.0025	0.0029	0.0022	0.0017	0.0007	0.0016	<0.0001	<0.0001
	Zinc	1.34	0.955	1.39	1.01	3.77	2.91	1.72	2.49	2.23	1.05	0.285	1.18	0.01	0.002
	Zirconium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Calcium	1.3	0.6	1.1	1.5	1.8	1.1	0.5	0.5	0.4	0.4	0.4	0.4	<0.2	<0.2
	Iron	7	1.4	1.5	0.4	5.2	5	3.7	3.3	2.2	1.9	0.6	1.2	<0.1	<0.1
	Magnesium	0.9	0.2	0.3	0.1	0.8	0.7	0.3	0.3	0.2	0.2	0.2	0.1	<0.1	<0.1
	Manganese	0.044	0.008	0.009	<0.005	0.039	0.033	0.018	0.021	0.012	0.008	<0.005	0.008	<0.005	<0.005
	Potassium	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
	Silicon	1.47	0.37	0.41	0.2	1.9	1.43	0.76	0.72	0.54	0.5	0.28	0.33	<0.05	<0.05
	Sodium	<0.4	<0.4	0.7	1.7	1.3	1.9	<0.4	<0.4	<0.4	<0.4	0.4	<0.4	<0.4	<0.4
	Sulfur	3.2	1	1.3	0.6	2.5	3	1.7	2	1.8	1.2	0.7	1	<0.3	<0.3

Notes

1. There are no CCME criteria available for snow.
2. These samples were collected as a part of the Community Based Risk Assessment and do not necessarily indicate a risk to human health or the environment without further assessment.

Table D-2. Metal Deposition in Flin Flon Area Snow Columns

	Laboratory Lot Ref. #	1	2	3	4	5	6	7	8	9	10	11	12	2	3
	Laboratory Sample #	2608584	2608585	2608586	2608587	2608588	2608589	2608590	2608591	2608592	2608593	2608594	2608595	2623447	2623448
	Sample ID	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Field Blank Site 14	Travel Blank Site 15
	Distance (m)	1,570	3,030	3,800	10,440	1,210	2,030	1,240	1,650	1,790	2,050	9,650	2,830		
	Direction from Stack	SW	SW	SW	SW	SE	SE	E	SE	NE	E	NW	E		
	Container Weight (g)	64.86	65.08	66.54	64.62	66.24	64.52	65.05	64.07	64.37	64.59	63.77	64.23	63.73	64.46
	Container + Water (g)	248.1	254.36	236.38	274.42	293.38	263.01	281.73	267.34	237.7	275.22	280.63	270.04	275.91	264.24
	Volume of water* (cm3)	183.24	189.28	169.84	209.8	227.14	198.49	216.68	203.27	173.33	210.63	216.86	205.81	212.18	199.78
Deposition (mg/m^2)	Mercury	0.035	0.029	0.026	0.024	0.155	0.038	0.033	0.046	0.046	0.024	0.008	0.016	<0.010	<0.010
	Aluminum	67.413	15.116	15.621	9.688	94.567	57.998	30.426	30.390	17.975	18.495	13.461	11.840	1.526	<0.378
	Antimony	0.180	0.136	0.219	0.127	0.430	0.458	0.213	0.431	0.394	0.231	0.131	0.241	<0.013	<0.013
	Arsenic	4.529	2.780	3.536	2.422	10.144	11.044	4.117	8.309	8.135	5.182	2.438	5.834	<0.013	<0.013
	Barium	1.040	0.573	0.579	0.238	2.923	1.352	1.230	1.385	1.181	0.957	0.328	0.701	<0.080	<0.080
	Beryllium	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009
	Bismuth	0.375	0.437	0.765	0.302	1.083	1.382	0.279	1.193	1.240	0.462	0.271	0.608	<0.032	<0.032
	Boron	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172	<0.172
	Cadmium	4.480	3.317	4.538	2.279	8.219	13.748	3.494	10.156	10.825	6.162	3.308	7.424	<0.001	<0.001
	Chromium	0.125	0.064	0.077	0.071	0.344	0.180	0.131	0.254	0.079	0.096	0.066	0.062	0.064	<0.038
	Cobalt	0.548	0.100	0.116	0.032	0.464	0.413	0.394	0.292	0.164	0.191	0.041	0.109	<0.006	<0.006
	Copper	177.547	99.580	86.782	20.090	311.212	208.851	405.135	236.962	185.658	209.667	28.892	141.772	0.080	<0.080
	Lead	15.327	14.328	25.520	11.990	46.252	54.993	15.254	48.162	42.052	22.481	12.558	27.887	0.024	0.023
	Lithium	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086
	Molybdenum	0.139	0.072	0.129	<0.082	0.344	0.301	0.246	0.231	0.262	0.159	<0.082	0.156	<0.082	<0.082
	Nickel	0.090	0.050	0.045	0.048	0.232	0.143	0.115	0.108	0.072	0.080	<0.041	0.078	<0.041	<0.041
	Selenium	0.132	0.050	0.077	0.024	0.241	0.210	0.213	0.192	0.164	0.175	0.025	0.125	<0.016	<0.016
	Silver	0.105	0.057	0.067	0.021	0.190	0.136	0.188	0.141	0.102	0.104	0.028	0.076	0.002	<0.001
	Strontium	0.208	0.072	0.064	<0.080	0.688	0.301	0.246	0.231	0.197	0.239	0.164	0.156	<0.080	<0.080
	Thallium	0.022	0.014	0.022	0.013	0.048	0.058	0.016	0.042	0.036	0.022	0.013	0.028	<0.004	<0.004
	Tin	0.069	0.072	0.129	<0.082	0.172	0.225	<0.082	0.231	0.197	0.080	<0.082	0.156	<0.082	<0.082
	Titanium	2.164	0.630	0.675	0.445	4.969	1.878	0.935	0.931	0.663	0.813	0.492	0.483	0.072	<0.004
	Uranium	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
	Vanadium	0.173	0.057	0.071	0.040	0.413	0.263	0.205	0.223	0.144	0.136	0.057	0.125	<0.008	<0.008
	Zinc	92.935	68.417	89.353	80.201	324.108	218.618	141.059	191.570	146.296	83.707	23.393	91.918	0.803	0.151
	Zirconium	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086	<0.086
	Calcium	90.161	42.984	70.711	119.111	154.746	82.639	41.006	38.468	26.241	31.889	32.832	31.159	<16.062	<16.062
	Iron	485.481	100.297	96.424	31.763	447.045	375.632	303.441	253.888	144.328	151.470	49.248	93.476	<8.031	<8.031
	Magnesium	62.419	14.328	19.285	7.941	68.776	52.589	24.603	23.081	13.121	15.944	16.416	7.790	<8.031	<8.031
	Manganese	3.052	0.573	0.579	<0.410	3.353	2.479	1.476	1.616	0.787	0.638	<0.410	0.623	<0.410	<0.410
	Potassium	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388	<34.388
	Silicon	101.951	26.507	26.356	15.881	163.343	107.431	62.328	55.394	35.426	39.861	22.982	25.706	<4.015	<4.015
	Sodium	<32.804	<32.804	44.998	134.992	111.761	142.740	<32.804	<32.804	<32.804	<32.804	32.832	<32.804	<32.804	<32.804
	Sulfur	221.934	71.641	83.568	47.644	214.925	225.379	139.419	153.871	118.087	95.666	57.456	77.897	<24.092	<24.092

Notes

1. Control Sites are displayed for comparison purposes (no CCME criteria available for snow).
2. These samples were collected as a part of the Community Based Risk Assessment and do not necessarily indicate a risk to human health or the environment without further assessment.
3. The metal concentrations reported by the laboratory have been converted into units of deposition based on a calculation developed by Manitoba Conservation

Appendix E Laboratory Analytical Certificates

Bodycote TESTING GROUP

Analytical Report

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Reference Number	606165-1	606165-2	606165-3
Sample Date			
Sample Location			
Sample Description	/ Site 1 Snow Creighton Ave / Inital 64.86 g Total 248.10 g	Site 2 Bereskin Ave / Inital 65.08 g Total 254.36 g	Site 3 South Creighton / Inital 66.54 g Total 236.38 g
Matrix	Water	Water	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Metals Total						
Calcium	Total	mg/L	1.3	0.6	1.1	0.2
Iron	Total	mg/L	7.0	1.4	1.5	0.1
Magnesium	Total	mg/L	0.9	0.2	0.3	0.1
Manganese	Total	mg/L	0.044	0.008	0.009	0.005
Potassium	Total	mg/L	<0.4	<0.4	<0.4	0.4
Silicon	Total	mg/L	1.47	0.37	0.41	0.05
Sodium	Total	mg/L	<0.4	<0.4	0.7	0.4
Sulfur	Total	mg/L	3.2	1.0	1.3	0.3
Mercury	Total	mg/L	0.0005	0.0004	0.0004	0.0001
Aluminum	Total	mg/L	0.972	0.211	0.243	0.005
Antimony	Total	mg/L	0.0026	0.0019	0.0034	0.0002
Arsenic	Total	mg/L	0.0653	0.0388	0.0550	0.0002
Barium	Total	mg/L	0.015	0.008	0.009	0.001
Beryllium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total	mg/L	0.0054	0.0061	0.0119	0.0005
Boron	Total	mg/L	<0.002	<0.002	<0.002	0.002
Cadmium	Total	mg/L	0.0646	0.0463	0.0706	0.00001
Chromium	Total	mg/L	0.0018	0.0009	0.0012	0.0005
Cobalt	Total	mg/L	0.0079	0.0014	0.0018	0.0001
Copper	Total	mg/L	2.56	1.39	1.35	0.001
Lead	Total	mg/L	0.221	0.200	0.397	0.0001
Lithium	Total	mg/L	<0.001	<0.001	<0.001	0.001
Molybdenum	Total	mg/L	0.002	0.001	0.002	0.001
Nickel	Total	mg/L	0.0013	0.0007	0.0007	0.0005
Selenium	Total	mg/L	0.0019	0.0007	0.0012	0.0002
Silver	Total	mg/L	0.00151	0.00080	0.00105	0.00001
Strontium	Total	mg/L	0.003	0.001	0.001	0.001
Thallium	Total	mg/L	0.00032	0.00019	0.00035	0.00005
Tin	Total	mg/L	0.001	0.001	0.002	0.001
Titanium	Total	mg/L	0.0312	0.0088	0.0105	0.0005
Uranium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Vanadium	Total	mg/L	0.0025	0.0008	0.0011	0.0001
Zinc	Total	mg/L	1.34	0.955	1.39	0.001
Zirconium	Total	mg/L	<0.001	<0.001	<0.001	0.001

Bodycote TESTING GROUP

Analytical Report

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Reference Number			606165-4	606165-5	606165-6
Sample Date					
Sample Location					
Sample Description			Site 4 8 km S of CS / Inital 64.62 g Total 274.42 g	Site 5 End of Hapnot / Inital 66.24 g Total 293.38 g	Site 6 S of NBL / Inital 64.52 g Total 263.01
Matrix			Water	Water	Water
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Calcium	Total	mg/L	1.5	1.8	1.1	0.2
Iron	Total	mg/L	0.4	5.2	5.0	0.1
Magnesium	Total	mg/L	0.1	0.8	0.7	0.1
Manganese	Total	mg/L	<0.005	0.039	0.033	0.005
Potassium	Total	mg/L	<0.4	<0.4	<0.4	0.4
Silicon	Total	mg/L	0.20	1.90	1.43	0.05
Sodium	Total	mg/L	1.7	1.3	1.9	0.4
Sulfur	Total	mg/L	0.6	2.5	3.0	0.3
Mercury	Total	mg/L	0.0003	0.0018	0.0005	0.0001
Aluminum	Total	mg/L	0.122	1.10	0.772	0.005
Antimony	Total	mg/L	0.0016	0.0050	0.0061	0.0002
Arsenic	Total	mg/L	0.0305	0.118	0.147	0.0002
Barium	Total	mg/L	0.003	0.034	0.018	0.001
Beryllium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total	mg/L	0.0038	0.0126	0.0184	0.0005
Boron	Total	mg/L	<0.002	<0.002	<0.002	0.002
Cadmium	Total	mg/L	0.0287	0.0956	0.183	0.00001
Chromium	Total	mg/L	0.0009	0.0040	0.0024	0.0005
Cobalt	Total	mg/L	0.0004	0.0054	0.0055	0.0001
Copper	Total	mg/L	0.253	3.62	2.78	0.001
Lead	Total	mg/L	0.151	0.538	0.732	0.0001
Lithium	Total	mg/L	<0.001	0.001	<0.001	0.001
Molybdenum	Total	mg/L	<0.001	0.004	0.004	0.001
Nickel	Total	mg/L	0.0006	0.0027	0.0019	0.0005
Selenium	Total	mg/L	0.0003	0.0028	0.0028	0.0002
Silver	Total	mg/L	0.00026	0.00221	0.00181	0.00001
Strontium	Total	mg/L	<0.001	0.008	0.004	0.001
Thallium	Total	mg/L	0.00016	0.00056	0.00077	0.00005
Tin	Total	mg/L	<0.001	0.002	0.003	0.001
Titanium	Total	mg/L	0.0056	0.0578	0.0250	0.0005
Uranium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Vanadium	Total	mg/L	0.0005	0.0048	0.0035	0.0001
Zinc	Total	mg/L	1.01	3.77	2.91	0.001
Zirconium	Total	mg/L	<0.001	<0.001	<0.001	0.001

Bodycote TESTING GROUP

Analytical Report

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Reference Number		606165-7	606165-8	606165-9
Sample Date				
Sample Location				
Sample Description		Site 7 W Ross Lake / Inital 65.05 g Total 281.73 g	Site 8 Centoba Park / Inital 64.07 g Total 267.34 g	Site 9 NE Ross Lake / Inital 64.37 g Total 237.70 g
Matrix		Water	Water	Water

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Calcium	Total	mg/L	0.5	0.5	0.4	0.2
Iron	Total	mg/L	3.7	3.3	2.2	0.1
Magnesium	Total	mg/L	0.3	0.3	0.2	0.1
Manganese	Total	mg/L	0.018	0.021	0.012	0.005
Potassium	Total	mg/L	<0.4	<0.4	<0.4	0.4
Silicon	Total	mg/L	0.76	0.72	0.54	0.05
Sodium	Total	mg/L	<0.4	<0.4	<0.4	0.4
Sulfur	Total	mg/L	1.7	2.0	1.8	0.3
Mercury	Total	mg/L	0.0004	0.0006	0.0007	0.0001
Aluminum	Total	mg/L	0.371	0.395	0.274	0.005
Antimony	Total	mg/L	0.0026	0.0056	0.0060	0.0002
Arsenic	Total	mg/L	0.0502	0.108	0.124	0.0002
Barium	Total	mg/L	0.015	0.018	0.018	0.001
Beryllium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total	mg/L	0.0034	0.0155	0.0189	0.0005
Boron	Total	mg/L	<0.002	<0.002	<0.002	0.002
Cadmium	Total	mg/L	0.0426	0.132	0.165	0.00001
Chromium	Total	mg/L	0.0016	0.0033	0.0012	0.0005
Cobalt	Total	mg/L	0.0048	0.0038	0.0025	0.0001
Copper	Total	mg/L	4.94	3.08	2.83	0.001
Lead	Total	mg/L	0.186	0.626	0.641	0.0001
Lithium	Total	mg/L	<0.001	<0.001	<0.001	0.001
Molybdenum	Total	mg/L	0.003	0.003	0.004	0.001
Nickel	Total	mg/L	0.0014	0.0014	0.0011	0.0005
Selenium	Total	mg/L	0.0026	0.0025	0.0025	0.0002
Silver	Total	mg/L	0.00229	0.00183	0.00156	0.00001
Strontium	Total	mg/L	0.003	0.003	0.003	0.001
Thallium	Total	mg/L	0.00019	0.00055	0.00055	0.00005
Tin	Total	mg/L	<0.001	0.003	0.003	0.001
Titanium	Total	mg/L	0.0114	0.0121	0.0101	0.0005
Uranium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Vanadium	Total	mg/L	0.0025	0.0029	0.0022	0.0001
Zinc	Total	mg/L	1.72	2.49	2.23	0.001
Zirconium	Total	mg/L	<0.001	<0.001	<0.001	0.001

Bodycote TESTING GROUP

Analytical Report

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Reference Number			606165-10	606165-11	606165-12
Sample Date					
Sample Location					
Sample Description			Site 10 SW Bracken / Inital 64.59 g Total 275.22 g	Site 11 NW C S 10 km / Inital 63.77 g Total 280.63 g	Site 12 Campground / Inital 64.23 g Total 270.04 g
Matrix			Water	Water	Water
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Metals Total						
Calcium	Total	mg/L	0.4	0.4	0.4	0.2
Iron	Total	mg/L	1.9	0.6	1.2	0.1
Magnesium	Total	mg/L	0.2	0.2	0.1	0.1
Manganese	Total	mg/L	0.008	<0.005	0.008	0.005
Potassium	Total	mg/L	<0.4	<0.4	<0.4	0.4
Silicon	Total	mg/L	0.50	0.28	0.33	0.05
Sodium	Total	mg/L	<0.4	0.4	<0.4	0.4
Sulfur	Total	mg/L	1.2	0.7	1	0.3
Mercury	Total	mg/L	0.0003	0.0001	0.0002	0.0001
Aluminum	Total	mg/L	0.232	0.164	0.152	0.005
Antimony	Total	mg/L	0.0029	0.0016	0.0031	0.0002
Arsenic	Total	mg/L	0.0650	0.0297	0.0749	0.0002
Barium	Total	mg/L	0.012	0.004	0.009	0.001
Beryllium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total	mg/L	0.0058	0.0033	0.0078	0.0005
Boron	Total	mg/L	<0.002	<0.002	<0.002	0.002
Cadmium	Total	mg/L	0.0773	0.0403	0.0953	0.00001
Chromium	Total	mg/L	0.0012	0.0008	0.0008	0.0005
Cobalt	Total	mg/L	0.0024	0.0005	0.0014	0.0001
Copper	Total	mg/L	2.63	0.352	1.82	0.001
Lead	Total	mg/L	0.282	0.153	0.358	0.0001
Lithium	Total	mg/L	<0.001	<0.001	<0.001	0.001
Molybdenum	Total	mg/L	0.002	<0.001	0.002	0.001
Nickel	Total	mg/L	0.001	<0.0005	0.001	0.0005
Selenium	Total	mg/L	0.0022	0.0003	0.0016	0.0002
Silver	Total	mg/L	0.00130	0.00034	0.00097	0.00001
Strontium	Total	mg/L	0.003	0.002	0.002	0.001
Thallium	Total	mg/L	0.00028	0.00016	0.00036	0.00005
Tin	Total	mg/L	0.001	<0.001	0.002	0.001
Titanium	Total	mg/L	0.0102	0.0060	0.0062	0.0005
Uranium	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Vanadium	Total	mg/L	0.0017	0.0007	0.0016	0.0001
Zinc	Total	mg/L	1.05	0.285	1.18	0.001
Zirconium	Total	mg/L	<0.001	<0.001	<0.001	0.001

Bodycote TESTING GROUP

Analytical Report

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Approved by:

Patrick Visser
Operations Manager

Bodycote TESTING GROUP

Methodology and Notes

Bill To:	Jacques Whitford AXYS Ltd.	Project:	
Report To:	Jacques Whitford AXYS Ltd.	ID:	1032002.03
	103-611 Corydon	Name:	HBMS-Snow and Water
	Winnipeg, MB, Canada	Location:	Snow Samples
	R3M 0S1	LSD:	
Attn:	Jim Hicks	P.O.:	1032002.03
Sampled By:		Acct code:	
Company:			

Lot ID:	**606165**
Control Number:	
Date Received:	Mar 10, 2008
Date Reported:	Mar 14, 2008
Report Number:	1098782

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Mercury (Total) in water	US EPA	*	Determination of Hg in Sediment by Cold Vapor Atomic Absorption Spec, 245.5	13-Mar-08	BTG Edmonton
Mercury (Total) in water	US EPA	*	Determination of Hg in Sediment by Cold Vapor Atomic Absorption Spec, 245.5	14-Mar-08	BTG Edmonton
Metals ICP-MS (Total) in water	US EPA	*	Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	12-Mar-08	BTG Edmonton
Metals Trace (Total) in water	APHA	*	Inductively Coupled Plasma (ICP) Method, 3120 B	12-Mar-08	BTG Edmonton

** Bodycote method(s) based on reference method*

References

APHA	Standard Methods for the Examination of Water and Wastewater
US EPA	US Environmental Protection Agency Test Methods

Comments:

Please direct any inquiries regarding this report to our Client Services group.

Results relate only to samples as submitted.

The test report shall not be reproduced except in full, without the written approval of the laboratory.

Appendix F Assessor Qualifications

Jacques Whitford

Engineering, Scientific, Planning and Management Consultants

www.jacqueswhitford.com

ASSESSOR QUALIFICATIONS

Jim Hicks, B.Sc., P.Ag.

Manager, Agronomics Division

Jim Hicks has a Bachelor's Degree in Chemistry from the University of Winnipeg. He also holds a Professional Agrologist (P.Ag.) designation from the Manitoba Institute of Agrologists. Mr. Hicks manages contaminated site work in Manitoba and Saskatchewan for Jacques Whitford AXYS Limited and has conducted dozens of Phase I, II, and III Environmental Site Assessments and remediation programs throughout Western Canada.

Danette Sahulka, M.Sc.

Ecologist

Danette Sahulka has a Bachelor of Science Degree in Ecology from the University of Manitoba and a Master's of Science in Zoology from the University of Manitoba. Danette has over 10 years of field experience with a wide variety of expertise in the fields of ecology and agriculture. She currently focuses on Phase I and II Environmental Site Assessments and agro-environmental issues.

Kimberly Marko, B.Env.Sc.

Environmental Scientist

Kimberly Marko, B. Env.Sc., is an environmental scientist with Jacques Whitford AXYS Limited in Winnipeg, Manitoba. Kim is knowledgeable in the field of natural sciences, environmental legislation and natural resource management. She is fluent with geographic information systems and is the geomatics technician for JWA Winnipeg. Kim has extensive experience in conducting Phase I, II and III Environmental Site Assessments for residential, commercial and industrial properties throughout rural and urban Manitoba, Saskatchewan and Alberta.

Peter Reid, M.Eng., P.Eng.

Senior Service Director, Environmental Site Assessment & Remediation

Mr. Peter Reid M.Eng., P.Eng. (BC, MB, ON) is the Senior Service Director for Environmental Site Assessment and Remediation for Jacques Whitford AXYS Limited. Mr Reid has completed over 600 environmental investigations and is currently appointed to the Roster of Professional Experts in British Columbia. Mr. Reid provided senior review prior to the release of this report.