Appendix 2

Resolution Island 2009 Monitoring and Research

Appendix 2A

Resolution Island 2009 Monitoring and Research

Inuktitut Executive Summary

ᐊᐅᓚᑦᑎᔨᓄᖕᒐᐅᔪᖅ ᓇᐃᓈᖅᑕᐅᓯᒪᔪᖅ

ᐅᑯᐊ ᐅᓂᒃᑳᓕᐊᑦ ᐅᖅᑲᐅᓯᖅᑲᖅᑐᑦ ᐱᓕᕆᐊᕆᔭᐅᓯᒪᔪᓂᒃ ASU−ᑯᓐᓄᑦ ᑯᐃᓐ ᔫᓂᕗᓯᑎᖓᓂ 2008−ᒥ, ᐃᓄᓕᕆᔨᑐᖅᑲᒃᑯᓐᓄᑦ ᐱᔾᔪᔾᔨᑦᑐᑎᒃ. ᐱᓕᕆᐊᒃᓴᐃᑦ ᓱᓕ ᐊᐅᓚᑕᐅᓚᐅᕐᒥᔪᑦ ASU−ᑯᓐᓄᑦ. ᑕᐃᒃᑯᐊ ᐃᓚᖅᑲᓚᐅᖅᑐᑦ ᓈᓴᖅᑕᐅᓯᒪᖅᑲᑦᑕᕆᐊᖅᑲᓲᖑᔪᓂᒃ (ᓲᕐᓗ ᐊᐅᕚᕈᑎᒃᓴᓂᒃ, ᓂᕿᓂᒃᓴᓂᒃ, ᑐᔪᕐᒥᕕᒃᓴᖏᓐᓂᒡᓗ), ᐃᖅᑲᓇᐃᔭᖅᑎᑕᐅᓂᖓᓂᒃ ᓇᓄᕐᓂᒃ ᐅᐊᑦᑎᔨᐅᔪᒥᒃ ᐊᒻᒪᓗ ᓄᓇᒦᓐᓂᖏᓐᓂ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ. ASU−ᑯᓐᓂᖔᖅᑐᑦ ᐱᓕᕆᔨᐅᓚᐅᖅᑐᑦ ᓯᑕᒪᑦ ᐃᓄᐃᑦ ᓄᓇᒦᓱᑎᒃ 9−ᓂᒃ ᐅᑦᑐᓂᒃ. ᑕᒪᐃᓐᓂ ᖃᐅᔨᓴᖅᑕᐅᓚᐅᔪᓂ ᐱᓕᕆᓚᐅᖅᑐᑦ ᐲᖅᓯᖅᑲᑦᑕᕐᓂᕐᒥᒃ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓂᒃ a) 13-ᖑᔪᓂ ᖃᐅᔨᓴᕐᕕᖕᓂ ᐳᑐᔭᐅᓯᒪᔪᓂ/ᐃᑰᑕᖅᑕᐅᓯᒪᔪᓂᒃ ᓄᓇᒥ ᐊᒻᒪᓗ ᐊᕙᓗᐊᓂ ᐃᑉᔪᕐᓂᒃ ᐲᖅᓯᕕᐅᓯᒪᓪᓗᑎᒃ ᑕᒪᐃᓐᓂᒃ ᐱᖓᓱᓂᒃ ᐊᒃᑕᕐᕕᖕᓂᒃ, ᐊᒻᒪᓗ b) ᖁᓕᓂᒃ ᓴᓇᕝᕕᕕᓂᕐᓂᒃ ᖃᐅᔨᓴᕐᕕᖕᓂᒃ, ᐊᒻᒪᓗ c) ᐊᖏᓂᖅᐹᒥᒃ ᐱᓕᕆᕕᖕᒥ, ᐊᒻᒪᓗ ᐆᒃᑐᕋᖅᑕᐅᓯᒪᑐᐃᓐᓇᖅᑐᓂ ᓄᓇᒦᑦᑐᓂ ᐊᕕᒃᑐᖅᑕᐅᓯᒪᔪᓂ ᐊᒻᒪᓗ d) ᓴᓇᔭᐅᓯᒪᓂᖏᓐᓂ ᖃᐅᔨᓴᖅᑕᐅᓯᒪᓂᖏᓐᓄᓗ ᐱᖓᓱᑦ ᓱᕈᕐᓇᖅᑐᖅᑲᖅᑎᑦᑎᑕᐃᓕᒪᔾᔪᑎᐅᔪᑦ ᓴᓇᔭᐅᓯᒪᔪᑦ.

ᐱᒻᒪᕆᐅᓂᖅᐹᖑᔪᖅ ᐊᒃᓱᕈᕐᓇᓚᐅᖅᑐᖅ ᑕᕝᕙᓂ ᐊᕐᕋᒍᒥᒃ ᐱᔾᔪᑎᖅᑲᓚᐅᖅᑐᖅ ᓴᐅᖅᑲᕐᓂᖏᑦ ᖃᐅᔨᔭᐅᓚᐅᖅᑐᑦ ᓱᕈᕐᓇᖅᑐᖅᑲᓈᒃᑯᑎᓂ PCB−ᓕᖕᓂᒃ. ᓂᕈᐅᖕᓇᓚᐅᖁᓗᐊᕐᒪᑦ ᓯᐅᖅᑭᓯᓂᖏᑦ ᓴᓗᒻᒪᖅᓴᐅᑎᓃᑦᑐᑦ ᒥᑭᓪᓕᕚᓪᓕᐊᓂᐊᕐᓯᒋᔭᐅᓪᓗᑎᒃ ᑕᕝᕙᓂ ᓱᓕᒃᑲᓐᓂᖅ ᐊᕐᕋᒍᒥ, ᑕᒪᓐᓇ ᐃᑉᔪᖅ ᓄᓇᖓ ᓯᑎᓪᓕᕚᓪᓕᐊᓇᔭᕐᓂᖓᓄᑦ. ᑭᓯᐊᓂ, ᑕᐅᒪᖓᑦ ᐊᐅᓚᓚᖅᑎᓪᓗᑕ ᕿᒪᒃᓱᒋᑦ ᐋᒍᓯ 2007−ᒥ, ᓯᓚᓗᒡᔪᐊᖅᑐᐊᑑᓚᐅᕐᓂᖓᓄᑦ ᐅᕝᕙᓗᓐᓃᑦ ᐅᐱᖕᒑᕈᑳᓪᓚᓚᐅᕐᓂᖓᓄᑦ ᐊᒃᓯᐊᓗᒃᓄᓇ ᐊᐅᓚᓚᐅᕐᒪᑕ ᓯᐊᕋᐃᑦᓗ ᑕᐃᑲᖓᑦ ᐊᒃᑐᖅᑕᐅᕖᒃᑯᑎᓕᐊᕆᔭᐅᓯᒪᔪᓂᒃ. ᐃᓗᓕᖏᑦ ᓯᐅᖅᑲᕐᕚᑦ ᓅᑕᐅᓚᐅᖏᑦᑐᑦ ᑕᐃᑲᖓᑦ ᓴᐳᑦᑎᓂᒃ ᑕᕝᕙᓂ ᓱᓕ ᐊᕐᕋᒍᒥ, ᐱᔾᔪᑕᐅᓪᓗᓂ ᖁᓕᒥᒍᓕᒃ ᑎᑭᑦᑐᓐᓇᓚᐅᖏᓐᓂᖓ ᕿᑭᖅᑕᒧᑦ, ᐃᓂᒃᓴᑭᑦᑐᒻᒪᕆᐊᓗᓕᓚᐅᕐᒪᑕ ᓴᐳᑎᓕᐊᕆᔭᐅᓯᒪᔪᑦ. ᐊᒻᒪ ᓱᓕᒃᑲᓐᓂᖅ, ᐃᓪᓗᕐᔪᐊᕐᓄᑦ ᐱᖁᑎᕕᓂᕐᓄᑦ ᐊᒃᑕᕐᕕᖕᒥ, ᓱᕈᕐᓇᖅᑐᖅᑲᖅᑎᒋᓂᖏᑦ ᓯᐅᖅᑭᒥ ᐊᒻᒪᓗ ᓴᐳᑎᐅᑉ ᓴᓗᒻᒪᖅᓴᐅᑎᖏᓃᑦᑐᑦ ᐅᖓᑖᓂᓚᐅᖅᑐᑦ 50 ppm−ᓂᒃ ᒪᓕᒐᕐᓂ ᐅᓗᕆᐊᓇᖅᑐᒦᑦᑕᕆᐊᖅᑲᖅᑐᒥ ᒪᓕᒋᐊᓕᖕᓂ. ᐃᓄᓕᕆᔨᑐᖅᑲᒃᑯᑦ ᑲᓇᑕᒥ ᑐᓴᖅᑎᑦᑎᔭᕆᐊᖅᑲᖅᓂᐊᖅᐳᑦ ᐊᕙᑎᓕᕆᔨᒃᑯᓐᓂᒃ ᑲᓇᑕᒥ ᐱᑕᖅᑲᕐᓂᖏᓐᓂᒃ ᓯᑕᒪᐃᑦ ᖃᑦᑕᐅᔭᕐᔪᐊᑦ ᓯᐅᖅᑲᖅᑐᓂᒃ ᓱᕈᕐᓇᖅᑐᓕᖕᓂᒃ CEPA−ᓕᖕᓂᒃ ᐱᑉᔪᖅᑲᖅᑐᓂᒃ .

ᖃᐅᔨᓴᖅᑕᐅᖏᓇᖅᑐᓂᒃ ᖃᐅᔨᓴᔭᐅᔪᑦ ᓱᕈᕐᓇᖅᑐᓕᖕᓂᒃ ᐲᔾᐲᓂᒃ ᓴᐳᑎᑦ, ᐊᒃᑕᕖᑦᑐ, ᓄᓇᒥᓗ ᓴᓇᔭᐅᓯᒪᔪᑦ ᑐᑭᓯᔭᐅᓚᐅᖅᑐᑦ ᐊᔾᔨᑦᔭᐅᑐᐃᓐᓇᐊᓇᖅᓂᖏᓐᓂᒃ ᓯᕗᓂᐊᓂ ᐊᖅᑯᑖᐅᖅᑐᓂ ᖃᐅᔨᓴᔭᐅᓕᕐᒥᔪᓂ. ᖃᐅᔨᓴᔭᐅᓯᒪᔪᑦ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᓐᓂᒃ ᓴᓇᕝᕕᑦ ᓱᓕ ᑐᑭᓯᓇᓚᐅᕐᒥᔪᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓯᒪᓂᖏᓐᓄᑦ ᐊᒃᓯᒃᑲᑦᓚᒻᒪᓇᒃ ᐊᓂᓇᒃᑯᑦ/ᐊᓂᖅᓂᒃᑯᑦ ᒥᑭᓪᓕᕚᓪᓕᖅᓯᒪᓂᖏᓐᓂᒃ ᓱᕈᕐᓇᖅᑐᑦ ᐲᔾᐲᖑᔪᓂᒃ ᑕᐃᑲᓂ ᐃᖅᑲᓇᐃᔭᕐᕕᐅᕙᓚᐅᖅᑐᒥ. ᓇᑎᒃᓴᐃᑦ ᐃᓚᐅᖅᑲᖅᑕᐅᓚᐅᕐᒥᔪᑦ (Geotextiles-ᖑᓂᕋᖅᑕᐅᔪᑦ) ᓴᐳᑎᒧᑦ ᐊᖅᑯᓂ; ᑕᐃᒃᑯᐊ ᓇᑎᒃᓴᐃᑦ ᐅᓕᒃᓯᖅᑲᑦᑕᖅᒪᑦ

ᒥᑭᕞᑎᐅᓂᖅᓴᓂᒃ ᓱᕈᕐᓇᖅᑐᓕᖕᓂᒃ, ᐱᑕᕐᑲᕐᓂᖅᓴᐅᕐᑲᑦᑕᕐᒪᑕ ᓴᖏᓂᖅᓴᐅᔪᓂᒃ ᓱᕈᕐᓇᖅᑐᓂᒃ ᐲᓰᐲᓕᖕᓂᒃ. ᐳᖅᑐᓂᖅᓴᓂ PCB−ᓂᒃ ᐲᓰᐲᕐᑲᓚᐅᖅᑐ ᓯᑕᒪᓂᒃ ᑕᐃᒃᑯᓂᖕᒐ ᓴᓗᒻᒪᖅᓴᐅᑎᓂᒃ ᑭᓯᐊᓂ ᑕᒪᐃᓐᓂ ᐲᓰᐲᕐᑲᕐᓂᖏᓐᓂ ᐊᑦᑎᒃᑐᓚᕐᒥᔪᑦ, ᐱᖏᑐᑐᓪᓗᑎᒃ ᑕᐃᒃᑯᐊ ᐃᒡᓗᒥᐅᑕᓅᑦ ᐊᒃᑕᕐᕕᖕᓂ ᑕᐃᑲᓂ ᓱᕈᕐᓇᖅᑐᕐᑲᖅᑎᓂᒋᑦ ᕐᑯᑦᑎᒃᑐᒻᒪᓇᐊᓘᓚᐅᖅᑐᑦ, ᑕᐃᒪᐃᓐᓂᖏᓅᓪᓗ ᓯᒥᒃᑕᐅᓯᒪᓂᖅᓴᐅᓚᐅᖅᑐᑦ ᓇᑎᒃᓴᔭᕐᓄᑦ. ᐊᔪᕈᓐᓃᖅᓴᕐᕕᕕᓂᖅ ᐊᑐᖅᑕᐅᓚᐅᒥᔪᖅ ᑐᔪᕐᒥᕕᐅᓂᕐᒧᑦ, ᑭᓯᐊᓂ ᒫᓐᓇᐅᓕᖅᑐᖅ ᐅᕐᑯᐃᓐᓈᓘᓕᕐᒪᑦ ᐊᑐᕋᒃᓴᐅᔪᓐᓂᖅᑐᖅ. ᑖᒃᑯᓇᓂ ᐅᓂᒃᑳᓕᐊᓂᒃ ᐊᑐᓕᕐᑯᔨᕗᑦ ᐱᔾᔪᑎᕐᑲᖅᑐᓂᒃ ᐱᕐᑯᑎᒃᓴᕐᑲᑦᑎᐊᓚᕐᑲᕐᓂᖅ/ᐃᓂᒃᓴᕐᑲᑦᑎᐊᓚᐊᕐᑲᕐᓂᖅ ᖃᐅᔨᓴᕐᕕᖕᓂ ᐱᑕᕐᑲᓚᐊᕐᑲᕐᓂᖏᑦ ᐃᓱᒪᒋᔭᐅᕐᑯᔭᐅᔪᑦ ᓯᕗᓂᒃᓴᒥ, ᐊᓯᔾᔨᖅᓯᒪᓂᐊᓕᖅᑎᓪᓗᒋᑦ ᐱᓕᓚᐊᓚᔭᐅᓯᒪᔪᑦ, ᒪᓕᒃᑕᐅᓪᓗᑎᒃ ᖃᐅᔨᔭᐅᓯᒪᔪᑦ ᐊᓂᒍᖅᓯᒪᓕᖅᑐᓂ ᐱᖓᓱᓂᒃ ᐊᕐᕋᒍᓂᒃ. ᖃᐅᔨᓴᖅᑕᐅᖏᓐᓇᖅᐳᑦ ᓱᓕ ᐊᔾᔨᖏᖕᒋᑦᑐᑦ ᖃᓄᐃᓕᕖᓪᓕᕈᑕᐅᕐᑲᑦᑕᖅᓯᒪᓂᖏᑦ ᓴᐳᑎᕐᑲᓕᖅᑎᓪᓗᒋᑦ ᑕᐅᕙᓂ .







Resolution Island 2009

Monitoring and Research


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EXECUTIVE SUMMARY

This report describes this work undertaken by the ASU at Queen’s University in 2009 for Indian and Northern Affairs Canada. For the first time, the monitoring program was severely disrupted by the notorious weather at Resolution Island and was compounded by other logistical problems. This resulted in a decrease in the number of tasks that could be completed. The report contains some recommendations to try to mitigate the effects of very poor weather in the future. In addition, the scope of this year's program was different than in previous years as it had been decided that some parameters could be dropped either permanently or for one year.

The monitoring of all the landfills was completed as in previous years and there were no significant changes or surprises either in the engineering assessment or from the chemical analysis of water or soil. A limited sampling program of the in situ landfarm experiment had been planned but was not carried out due to time constraints. No plant sampling was planned this year.

All the PCB-contaminated sediment collected in the previous two years from the three PCB barrier systems was transported from the barriers by helicopter. Four drums which contained soil or barrier material at levels above 50 ppm were placed securely within building B2. A corner of the building was separated off by a chain link fence, thus establishing a new PCB storage facility. The drums were appropriately labeled. The remaining thirty four drums and seven waste wrangler containers were placed just outside building B2 near the beaching area.

Maintenance work at the barriers was limited to the sampling and analysis of the geotextile filters and their replacement with new ones. Fortunately the amount of sediment transported to the barriers over the previous winter was low and much less than the previous year so that the fact that they were not shoveled out was less important than it might have been. The geotextile filters gave some interesting insight into their operation. Some coarser 400W filter material was used in front of the normal 1200R material at two of the three barriers. At the furniture dump this material was far less efficient at trapping the PCBs whereas it performed in a similar manner at the S1/S4 beach location. Because the finer material at the site is known to contain higher levels of PCBs, this confirmed the idea that, for the furniture dump barrier, much of the PCB is

absorbed to the finer material which predominates; the drainage pathway here was vacuumed during the remediation program. The S1/S4 drainage pathway contains much more sediment with a different particle size distribution.

ACKNOWLEDGMENTS

The work was supported by Indian and Northern Affairs Canada through its office in Iqaluit, Nunavut. In particular we would like to thank Kevin McKenna for his support of the project.

Allison Rutter of Queen’s University directed the project. The on site team leader, Nathan Manion, was ably assisted by Sonja Koster, Daniel Jones, Rebecca McWatters and Lisa Tendijowski. Bear monitoring was provided by Jamesie Josephee and Jeannie Pishuktie. The engineering monitoring was conducted by Rebecca McWatters, a final year PhD engineering student at Queen’s University working with landfill liners. This report was written by John Poland and edited by Allison Rutter.

Laboratory analyses were conducted by Queen’s University Analytical Services Unit, Kingston, Ontario. Thanks are due to Paula Whitley, Mary Andrews, Rhonda Kristensen, Michele Pacey, and Kalam Mir, in addition to those listed above, who provided their usual high professional standards. Graham Cairns assisted with the maps.

Table of Contents

A. Introduction

1. General

This is the fourth year of the monitoring program operating at the site. The Analytical Services Unit (ASU) was retained by Indian and Northern Affairs Canada (INAC) through a contribution agreement to conduct this work together with a continuation of the on-going research program centered at Resolution Island.

Over the period 1993-1996, environmental work at the site was detailed in a set of reports entitled "Environmental Study of a Military Installation at Resolution Island, BAF-5". These reports[1] fully described items such as site characteristics, history, and previous investigations. Scientific investigations have continued and have been reported annually[2]. From 1997 onwards, work at the site was managed by the Qikiqtaaluk Corporation (QC) through a contribution agreement with INAC. This work started in 1997 with infrastructure improvements and expanded from 1998 onwards to include remediation activities and training. The three year plan to complete the work at the site was initiated in 2003[3] and was essentially completed in 2005. The site was demobilized in 2006 with the removal of the heavy equipment relating to the remediation project, removal of the mobile laboratory, and demolition of the camp. The monitoring program, conducted by the ASU, was started in 2006 and reports have been produced annually[4]. Map 1 shows the location and general layout of the site at Resolution Island.

This report details the tasks carried out by the ASU in 2009 both on site and at the ASU laboratories at Queen's University. This year's report is concerned primarily with monitoring of landfills and the performance of the permanent PCB interceptor

[1] Environmental Sciences Group (1994). Volume One, Analytical Services Unit (1995) Volume Two, Analytical Services Unit and Environmental Sciences Group (1996) Volume Three, and Analytical Services Unit (1997) Volume Four: Environmental Study of a Military Installation at Resolution Island. BAF-5. Prepared for Indian and Northern Affairs Canada.

[2] Analytical Services Unit (1998), (1999), (2000), (2001), (2002) (2003) (2004) (2005) and (2006). Resolution Island 1997: Scientific Investigations, Resolution Island 1998: Scientific Investigations: Resolution Island 1999: Scientific Investigations, Resolution Island 2000: Scientific Investigations: Resolution Island 2001: Scientific Investigations: Resolution Island 2002: Scientific Investigations: Resolution Island 2003: Scientific Investigations and Research: Resolution Island 2004. Scientific Investigations and Research: Resolution Island 2005. Prepared for Indian and Northern Affairs Canada.

[3] Analytical Services Unit (2003). Resolution Island Project Description and New Remediation Plan Revision 1 March 2003. Prepared for Indian and Northern Affairs Canada.

[4] Analytical Services Unit (2006a), (2007), and (2008) . Resolution Island 2006: Scientific Investigations and Research: Resolution Island 2007: Monitoring and Research. Resolution Island 2008: Monitoring and Research. Prepared for Indian and Northern Affairs Canada

barriers. It also includes sections on wildlife sightings and on health and safety precautions. While these health and safety plans have been in place for many years they have not been part of any of the ASU reports and are included here for completeness and for reference to past and future years.

2. *Logistics*

The plans for this summer's work were to take the form of two visits – a recce organized by INAC ideally in the week 6-10 July – and the monitoring visit organized by ASU in the first half of August. This is year 4 for the long term monitoring program.

a) INAC Recce

The purpose of the recce was mainly to assess the scope of the monitoring task (ie to check how much sediment there in the barrier traps) and to upgrade and assess the ground transport at the site (ATVs and Kubota). Results from the visit, which took place on 14 July 2009, are as follows:

- The plan was to examine the two S1/S4 barriers to see how much sediment there was to be removed, photograph them and, if they were dry enough, sediment samples could be taken from the material in the traps. The S1/S4 beach barrier was still under snow (see front cover) but the S1/S4 valley barrier did not appear to have much sediment in it while the furniture dump barrier had minimal sediment. Two samples were taken from the furniture dump barrier.

Two Twin Otters were used for this visit and brought personnel and 2 new ATVs to the site which were left at the airstrip. A mechanic was part of this team and was able to service and start the Kubota 310. The old green Honda ATV was left at the airstrip building but could not be started. The 2 other old ATVs at the site were returned in the Twin Otter to Iqaluit. An ATV trailer, broken during the 2008 field season, was also to be repaired by the mechanic, however he was unable to get one of the monitoring camp generators running to supply the electricity required to do so.

- Building B2 was examined with the intent to establish a PCB storage facility for the 4 drums containing CEPA soil (3) and barrier waste (1). Materials in the form of a chain link fence, fittings and a small generator were placed in B2 for the monitoring team to assemble as there was no time to accomplish this.

- Supplies for ASU for the monitoring visit, which had been sent to Iqaluit, were transported to the camp. It was found that all the tools had been pilfered from the main camp though the seacan did not seem to have been opened.

- The site had sustained some damage over the winter. The airstrip building had some polar bear damage but was structurally sound and fairly weatherproof. The bay doors of the garage were blown in. Photographs of this damage are on the front cover along with a picture of the corridor, to the Dew Drop, which collapsed in the previous winter.

- The old INAC sleeping quarters (cold and freezer room) were assessed as a possible place for sleeping and meeting for the monitoring team and the number and location of waste wranglers and overpack drums was determined.

b) <u>ASU Monitoring Visit</u>

This was to be done using a helicopter which was based in Iqaluit for INAC for various projects. The Resolution Island first day trip was to be on the day after the helicopter arrived in Iqaluit. It was planned that a team would be on site for about 7-10 days (given the relatively small amount of sediment observed during the Recce trip) and then a second helicopter trip would be arranged for on site work and return trip for personnel. On the first day the team would come in by helicopter and the helicopter would be used to transport containers of PCB contaminated material from the barriers to B2. The team would set up camp on day 2.

All did not go according to plan due to four factors.

- Weather: Over the past few summers we have been very fortunate to have had good weather but this year the weather at the site lived up to its reputation. As will be outlined below, the helicopter was only able to get in and out of the site on 5 days during the period 13 to 25 August and only for half a day on one of these. It also rained on occasion during most of the 5 days at the site. A fuel cache on route would allow for access in a wider range of weather conditions since the range of a B212 with one auxiliary tank is not sufficient to round trip RI from Iqaluit.

- Equipment: When the team arrived at the site only one of the ATVs was functional; a second worked for about 2 hours. None of the generators worked either and the propane heater did not work. As a result the team spent a very uncomfortable first night at the site and thereafter made three one day visits.

- It had been planned to have Nasittuq handle the accommodations and supply a caketaker/bear monitor for the visit but five days before the planned field trip they failed to sign the contract.

- When the Nasittuq support was unavailable the new plan involved using a twin otter to bring in the additional supplies required. No twin otter was available on Day 1 to transport the team to the site. Two trips were made by the helicopter on Day 1, which therefore did not have time to sling barrels on Day 1.

The ASU team was on site on 17, 18, 19 (½ day), 22 and 25 August 2009 and overnighted on the 17 August. Photographs 1-4 show the setup of the new overnight accommodation in the original cold food storage area that was used during the remediation project as the sleeping quarters and office area of the Qikiqtaaluk site supervisor. However since there was no power generation or heating available this approach was abandoned in favour of daily visits. The building is unlikely to have problems with mould as was the case with the training centre due to its structural design and therefore the area may be useable for site visits in the future. Doors to the new accommodation area were secured with plywood. A visit by INAC personnel on 5 September 2009 found that a bear had broken into the camp and scattered supplies around (Photographs 5 and 6). A pre-visit recce will be essential to assess the damage caused by the bear break in and the subsequent weather damage.

The old training center was also found to have some minor external bear damage as was the airstrip building (Photograph 7). The road system was satisfactory for ATV travel though a large hole (Photograph 8) was present near the old water lake. There were signs that vegetation was returning to some of the worked areas which should help to stabilize the loose soil and sediment. The ATVs were serviced by Frontec personnel on 19 August. Frontec personnel also made the necessary repairs to the ATV trailer damaged the previous year.

Photograph 1: The Food Preparation Area in the New Accommodation Facility

Photograph 2: The Kitchen Area in the New Accommodation Facility

Photograph 3: The Dining and Relaxation Areas in the New Accommodation Facility

Photograph 4: One of the Sleeping Areas in the New Accommodation Facility

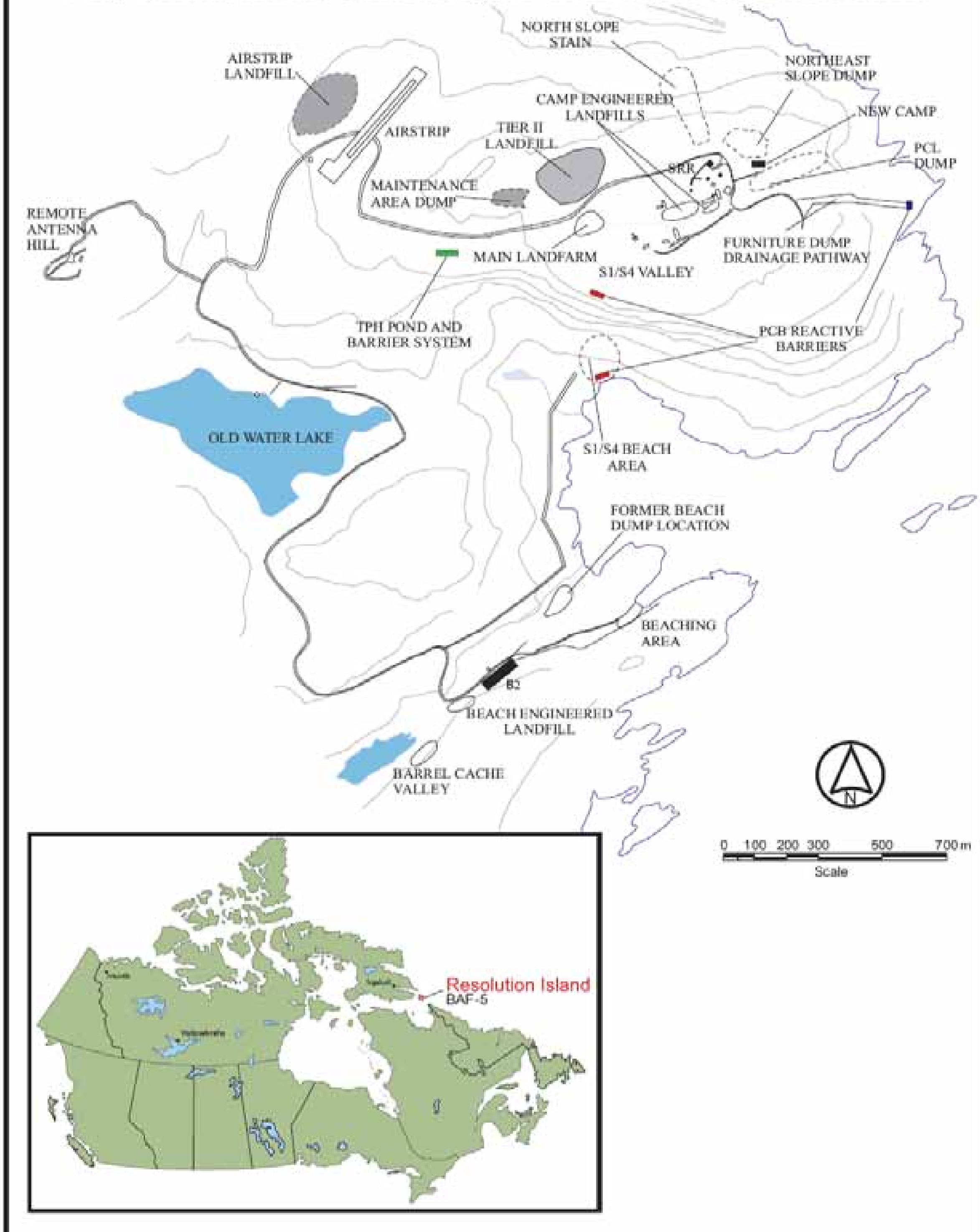
Photograph 5: The Window Broken by the Polar Bear

Photograph 6: Polar Bear Damage to the New Accommodation Facility as seen in Early September 2009

Photograph 7: Jamesie Josephee (JJ), One of Our Bear Monitors, Passing the Side of the Airstrip Building Where Polar Bear Damage was Cleary Visible

Photograph 8: A Hole in the Road Near the Old Water Lake

Map 1: Location and General Layout of the Site at Resolution Island



3. Scientific Investigations

As a result of the above problems not all the tasks that had been planned could be accomplished due to lack of time. In addition, moving the waste wranglers and barrels to building B2 from the barriers took 2 days which was longer than anticipated. The first three days were spent mostly landfill monitoring, establishing the PCB storage facility and camp set up, while on the last two days, the PCB barriers were sampled and the containers of PCB contaminated soil were moved to building B2. There was no time to monitor the in situ landfarm experiment or to remove sediment from the PCB barriers. This year some items such as monitoring the main landfarm and TPH barrier system and plant sampling for PCBs, which had been part of the monitoring program in previous years, were not included in the program. The rationale for this was detailed in last year's ASU report on pages 7 and 8.

The Analytical Services Unit, Queen's University conducted the following tasks this year for the Resolution Island program:

- Provided scientific and engineering support for the project as required
- Sampled the Tier II landfill monitoring wells and associated soil monitoring points. Sampled the monitoring wells and associated soil points at the airstrip and maintenance dumps. Analysed water and soil samples for metals, TPH and PCBs with low detection limits.
- Inspected the Tier II landfill and analysed the data from the Tier II landfill thermisters. Data was collected by INAC personnel.
- Inspected, and monitored the S1/S4 valley barrier, the furniture dump barrier and the S1/S4 beach barrier.
- Sampled and analyzed the sediment trapped in all three barriers. Sampled and analyzed water and soil monitoring points for all barriers.
- Replaced the geotextile filters and sampled and analyzed the filters that were removed

- Revised proposals regarding barrier monitoring logistics and the long term monitoring plan as necessary.

- Planned the 2010 CFG7 meeting in Kingston. Acted as a scientific resource to INAC and attend meetings as required. Liaised with Australian Antarctic Division.

4. Long Term Monitoring Plan

The long term monitoring plan recommends continuing annual monitoring for 5 years followed by monitoring in year 7, 10, 15 and 25. These time intervals were the same as those used by DND on their DEW Line sites and are based on the premise that after five years trends in the monitoring results should have been established. Clearly if any problems were noted the frequency of future visits might be increased. Conversely some measurements have become stable and predictable while others are no longer required and were therefore dropped this year. There were logistical difficulties this year but some progress was made in terms of future accommodation and transport at the site. Unfortunately the new camp area and any supplies have been compromised by the open window and bear damage. All functional ATVs were removed from the Island to overwinter in Iqaluit. ATVs will not be left on site and gasoline will be brought in from Iqaluit. Next year is year 5 of the monitoring program. Therefore the following points outline some steps that might be taken in regard to the 2010 monitoring program.

- The Recce undertaken this year was extremely valuable in planning and executing the monitoring program and should be repeated in some form in 2010.

- The use of daily transport to and from the site is not recommended because too much time is lost in transport and in securing bear monitors. The working time during the day is therefore too short.

- Part of the Recce must be to ensure that the camp is usable for accommodation. Fuel, electricity generation, heating, food, water, sewage disposal and transport must be adequate for the length of the site visit. The first day of the monitoring visit should be devoted to ensuring this is so and in establishing the camp. A thorough check of all health and safety related equipment (including heaters and generators) should be conducted prior to arrival on site.

- The scope of the monitoring visit should be clearly defined in terms of the overall monitoring plan given that 2010 represents year 5 of the plan. This is a milestone year when the program's first 5 years should be reviewed and future year's activities determined.

B. Methodology

1. Sampling

Soil samples for metals and PCBs were collected using plastic scoops and placed in WhirlPak bags. Soil samples for TPH were placed in 250 mL glass amber jars which were completely filled to allow no headspace. Water samples for PCBs were collected in 1 L Teflon bottles or 1 L glass bottles with teflon lined lids. Water samples for metals were collected in 250 mL plastic bottles and water samples for TPH in 250 mL glass amber bottles with Teflon lined lids. Soil and water samples were kept at 4 °C prior to analysis.

Samples were shipped by air freight to Queen's University for testing. In order to conform with regulations regarding sample control, a rigorous chain of custody was maintained. Chain-of-custody forms were filled out and checked for each sample before shipment from the North, and the contents of shipments were verified upon receipt in the laboratory. The relevant documentation is available on request.

2. Chemical Analysis

a) Metals

Soil samples were air-dried and ground to a fine powder with a mortar and pestle; large stones were removed as they would not be expected to contain any anthropogenic environmental contamination. Approximately 0.5 g of this dried material was heated with 2 ml nitric acid and 6 ml hydrochloric acid overnight so that the volume was reduced to 1-2 ml. This solution was then made up to 25 ml, and analyzed by inductively coupled plasma atomic emission spectroscopy (ICP/AES). The ICP/AES analysis was conducted using a Varian Vista Pro Spectrophotometer with axial configuration.

Metals in water may be analysed for total metals or dissolved metals.

If analysis is required for total metals, the sample is vigorously shaken to ensure an even distribution of any suspended matter. A 50 ml aliquot is measured into a graduated Digiprep tube along with 2 mL of trace grade nitric acid and 1 ml trace grade hydrochloric acid, The tube is covered with a disposable watch glass and placed in a vented Digiprep digestion block and heated at 90°C for 300-400 minutes. The tubes are removed from the block and 0.2ml of trace grade hydrogen peroxide is added. The sample is then made back up to 50ml with distilled water. The resulting solution is then analyzed by ICP-AES using the ultrasonic nebulizer for the arctic suite elements. Note that the digestion method has been modified from previous years. It is based on USEPA method 200.7 and was shown to be equivalent to the previous method.

If analysis is requested for dissolved metals, (eg for the monitoring well samples) the sample is filtered through a 0.45 micron filter prior to the acid addition. A 50 ml aliquot is measured into a graduated Digiprep tube along with 2 mL of trace grade nitric acid, 1 ml trace grade hydrochloric acid and 0.2 ml of trace grade hydrogen peroxide. The resulting solution is then analyzed by ICP-AES using the ultra sonic nebulizer for the arctic suite elements.

b) Total TPH Analysis

Soil samples were homogenized and sub-samples dried for moisture determination. A wet sample (10 g dry equivalent weight) was mixed with anhydrous sodium sulphate and Ottawa sand in an Erlenmeyer flask. Pesticide grade hexane (40 mL) was added, and the flask ultrasonically agitated. For wet samples additional hexane and sodium sulphate was added. A 1-mL aliquot of the hexane extract was pipetted from the flask in a manner ensuring no transfer of solid material, and sealed in a gas chromatography (GC) vial.

For water samples, 100 mL was accurately measured and transferred to a clean, 125 mL glass separatory funnel. Hexane, 10 mL, was added and the mixture shaken vigorously and then allowed to separate. If emulsions formed, the funnel was briefly sonicated to ensure adequate phase separation. An aliquot of the hexane phase was then transferred to a GC vial. The hexane extracts were analysed by GC/FID using a Hewlett Packard gas chromatograph with flame ionization detector. TPH was quantified by comparing the chromatogram peak area of the sample with that of the standard; standards of fuel oil and lubricating oil were prepared in hexane.

c) PCBs

The standard analytical procedure for the analysis of PCBs, namely gas chromatography with an electron capture detector (GC/ECD) was used. These analyses were performed at the Analytical Services Unit, Queen's University by one of the two following procedures. For all procedures a separate sample (soil, gravel or GAC) was first taken for the determination of wet weight/dry weight ratio. Geotextiles were air dried before analysis. The samples were analyzed by using approximately 10 g (dry weight equivalent), spiking with an internal standard solution (decachlorobiphenyl) and extracting. The soxhlet method used approximately 250 mL dichloromethane in a soxhlet extractor for four hours. The DCM shaker method used 3 times 50 mL dichloromethane with agitation on a platform shaker for 20 minutes for each extract.

The shaker methods were used for most soil and gravel samples while the soxhlet method was generally used for other solid matrices. The solutions obtained from the soxhlet and DCM extraction methods were concentrated to 1-2 mL and the solvent exchanged for hexane. This concentrate was then applied to a Florisil column (Supelco SPE tube) and the resulting eluent analyzed using an Agilent 6890 chromatograph equipped with electron capture detector and a 30 m SPB-1 capillary column and calibrated with Aroclor 1260 standards.

Water was analyzed by using approximately 800 mL of sample, spiking with internal standard and extracting three times with dichloromethane. The extract was filtered through sodium sulphate and concentrated to 1-2 mL and the solvent exchanged for hexane. This concentrate was then applied to a Florisil column for cleanup of the extract and the resulting eluent analyzed by GC/ECD. For samples requiring a lower detection limit, extracts were concentrated to 0.5 mL before analysis on the GC.

3. Barrier Materials

a) Gravel

A pea gravel with a particle size of roughly 6.4 – 9.5 mm, which was quarried locally near Kingston, Ontario and was distributed through Pyke Farms, was available on-site having been brought there by sea previously.

b) GAC

Granulated activated charcoal (CNS 612) which has a particle size range of 2.00 to 3.35 mm was obtained through A.C. Carbone, Saint-Jean-Sur-Richelieu, Quebec.

c) Geotextiles

A vertical non-woven needle-punched geotextile, 1200R, a woven geotextile 400W were used in the barriers. They were supplied by Terrafix, Toronto. The 1200R has a pore size between 0.05 and 0.15 mm while the 400W has a pore size of 0.6 mm.

d) Overpack drums and waste wranglers

Standard metal overpack drums were used as the receptacles for the PCB contaminated soil from the barriers at the S1/S4 valley and furniture dump this year. Waste Wrangler containers purchased from Quatrex Inc. were used as well as the overpack drums at the beach barrier.

4. Landfill Monitoring Criteria

The Tier II landfill was assessed for its physical stability using the following indicators:

- Settlement
- Erosion
- Frost action
- Staining
- Seepage/Ponded Water
- Debris

The indicators were graded with the following descriptors for severity and extent as was carried out for assessments of the landfill in previous years.

a) <u>Severity</u>

- Acceptable – features noted are of little consequence, requires no attention

- Marginal – lower limits of acceptability for performance. Attention to areas in future inspections required. The potential for failure of the landfill is low to moderate.

- Significant – landfill stability is affected by significant or potentially significant changes, such as slope geometry, significant erosion or differential settlement. The potential for failure is imminent.

- Unacceptable – landfill stability is compromised, such that the ability to contain waste is compromised. Examples include slope failures, liner or debris exposure, erosion channels or areas of differential settlement.

b) <u>Extent</u>

- Isolated – singular feature

- Occasional – features of note occurring in irregular intervals/locations

- Numerous – many features of note, impacted less than 50% of the surface of the landfill

- Extensive – impacting greater than 50% of the surface area of the landfill.

5. Health and Safety

a) <u>General</u>

A Health and Safety Plan for the Clean Up of the Abandoned Military Site on Resolution Island was produced by Phoenix OHC Inc, Kingston in 1998 for the remediation mission[5]. Copies of this document, which is available at the ASU, Queens University and the INAC office in Iqaluit, forms the basis of the current ASU Health and Safety Plan related to the monitoring program at Resolution Island. All Queen's personnel who visit the site are required to read the relevant sections of the Phoenix

[5] Phoenix OHC Inc (1998) Project Health and Safety Plan: Clean Up of the Abandoned Military Site on Resolution Island.

report as outlined below. They are also required to read and sign the Queen's field safety forms as per Queen's University policy. A copy of this year's form is in the appendix. The following sections summarise the ASU Health and Safety Plan.

(1) Purpose

The purpose of this Health and Safety Plan is to minimize the risk of occupationally related exposures and accidents to personnel during the performance of their work associated with the monitoring of the remediated abandoned site on Resolution Island. The objective is to ensure that an effective occupational health and safety management system is available and that this plan is effectively communicated to all site staff. This plan will assist in the creation of a working environment where risks and potential hazards are properly identified and mitigated.

(2) Application

This plan applies to the abandoned military site at Resolution Island, Nunavut, and all personnel involved with the project on-site, whether it be for the entire duration of the project or for intermittent work on-site.

(3) Dry Camp Policy

With the utmost priority of ensuring the safety of camp personnel, the possession, importation, consumption and/or usage of alcohol is prohibited at Resolution Island. The policy established is Zero Tolerance and any person that violates this policy can be removed from the Resolution Island site and can have their contracts terminated immediately.

(4) General Safety Rules

a) Report all work injuries and illnesses immediately

b) Report all unsafe acts or unsafe conditions to your supervisor

c) Use, possession or sale of alcohol is not permitted on site. Misuse of prescription and non-prescription drugs is not permitted on site.

d) Only authorized and trained employees may repair or adjust machinery and equipment.

e) Only authorized and trained employees may work on or near exposed energized electrical parts or electrical equipment. Follow Electrical Safety Rules when working with electrically powered machinery and equipment.

f) Only authorized and trained employees may dispense or use chemicals. It is your responsibility to know where Material Safety Data Sheet (MSDS) are located and that they are available for your use and review.

g) Wear and use the prescribed personal protective safety equipment. This includes foot protection, head protection, gloves, etc.

h) Only authorized individuals may enter the PCB storage facility. Only authorized and trained individuals may enter contaminated or restricted site areas.

i) Failure to follow the above rules may cause serious injury and/or illness. Please use common sense and think before you act. If you are not sure how to complete a job or task safely or have any questions, ask your supervisor.

j) There shall be no eating, drinking or smoking inside contaminated work areas or while working with or near other hazardous materials, and personnel will wash-up prior to any eating, drinking or smoking, which is to be conducted away from these areas.

k) There shall be no work conducted on a steep incline where there is a risk of a fall that could result in serious bodily injury.

l) Personnel shall take every reasonable precaution to protect against sun exposure.

m) Drinking water will be obtained from Old Water Lake.

n) Drums are to be handled and opened in a manner consistent with the guidelines for Handling Drums and Other Containers published in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH, 1985), appended.

o) Waste currently packed in drums will be identified and prepared for movement.

(5) General Working Hazards & Procedures

a) Shoveling, digging and manual materials handling shall be conducted in a manner that minimize the risk of injury (Phoenix Report Appendix H).

b) There are steep, rocky sloped areas, including sections of road connecting the beach to the upper site, where the shoulder drops off abruptly to a cliff. Strict adherence to ATV safety rules and speed limits will be necessary to minimize the risk of fatal accidents. Anyone working at the base of rocky sloped terrain will be at risk of injury from falling rock. Work will not be performed where there is a significant risk of rock slides (including freeze thaw periods).

c) Most, if not all of the work will be outdoors. There are risks of heat stress, cold stress and exposure to ultraviolet radiation from the sun (Phoenix Report Appendices D, E and F)

d) Where vehicles are driven on uneven terrain, there is a risk of roll-over accidents.

e) Personnel will operate All Terrain Vehicles (ATVs) and be exposed to the associated physical hazards (see Section d –ATV Safety)

(6) Hazard Characterization

The most significant hazards will be those associated with ATV operation, work with the Kubota loader and helicopter, and polar bears. These are covered in separate sections below.

(7) Chemical Hazards

Hazards are also associated with fuel and PCB contamination; diesel, gasoline and oils are present at the site.

(a) Flammable/Combustible Liquids

MSDS for these are found in the Phoenix Report, Appendix J)

a) Flammable and combustible liquid storage vessels and areas, as well as the dispensing activities and usage of these liquids, shall also be in accordance with the National Fire Code of Canada and the N.W.T. Fire Prevention Act and regulations.

b) Suitable equipment and materials shall be used wherever there may be flammable liquid/vapour.

c) Fuel for vehicles and generators, etc. and any other flammable liquid shall be stored, handled and dispensed in a manner appropriate for flammable liquids.

Fuelling and flammable liquid handling shall be done in a place where the vapours are readily dissipated and in the absence of ignition sources (including engines off and no smoking).

d) Flammable liquid containers will be opened slowly at the appropriate access port or bung, allowing for a controlled release of any pressure.

Flammable liquids (flash point less than 37.8^{o}C) shall not be used for decontamination or other types of cleaning.

(b) Contaminated Site Hazards & Procedures

During excavation of barriers, soil and barrier materials contaminated with up to 200 ppm PCBs may be encountered at the furniture dump barrier. PCB contamination is much lower at the other barriers. Immediately Dangerous to Life and Health (IDLH)/acute toxicity conditions should not exist with sampling or soil excavation from barriers, as high levels of contamination was removed from the site during the site remediation. Chronic toxicity associated with exposure to high airborne dust levels or volatile chemicals (e.g. repeated and/or continuous overexposure to soils contaminated with hydrocarbons or PCBs) should not be a concern due to low levels and short periods of exposure. Other physical/chemical injury such as cuts from sharp objects, or contact with corrosive material could occur during site investigations.

Exposure routes relevant to this project include:

a) Inhalation

Airborne contaminant levels are not anticipated to be hazardous to personnel unless standing in the path of significant dust clouds or other direct downwind plume during heavy excavation of PCB-contaminated soil. It is assumed that outdoors and above grade any contaminant gases and vapours will be adequately diluted. The average dust levels from soil excavations can be maintained well below 10 mg/m3 (total particulate, or 3 mg/m^3 respirable particulate) based on damp soil and/or that excavation will be by hand. Based on peak PCB contamination levels of PCB in soil concentrations can be expected to be no more than 100 ppm in soil (and likely much lower following remediation of the site. Average airborne PCB levels based on typical PCB-soil levels would be much lower. Metal contaminated soils are likely to only be encountered at the maintenance dump drainage monitoring wells, where peak soil levels of 0.038% cobalt were found. Based on similar values for dust, and the fact that excavation will not be occurring in this area, it is not anticipated to be of any hazard.

b) Ingestion

Hand to mouth conveyance can result in ingestion of chemical and biological contaminants. This will be controlled with appropriate protective clothing and hygiene practices. Proper labeling and the training of personnel in accordance with WHMIS regulations will also minimize the risk of accidental ingestion of chemicals brought to, or stored at, the site.

c) Skin Contact

PCBs (associated with soil contamination) can be absorbed through intact skin. Diesel, gasoline and jet fuel, as well as other solvents will defat the skin and may cause dermatitis. Any corrosive material that may be discovered or stored at the site (e.g. acid or alkali) may irritate or burn the skin, depending on the type and concentration of chemical and degree of exposure. Skin exposure is to be minimized with the prescribed protective clothing.

d) Eye Contact

A splash of corrosive liquid to the eye may permanently damage eye tissue. A splash of diesel, gasoline or jet fuel, as well as many other solvents (e.g. methanol) to the eye may cause slight to severe irritation. Eye protection is required within designated work areas of this project.

(c) Personal Protection

Personnel shall be equipped with clothing appropriate for the time of year and the remote Arctic location. Exposure is a significant hazard, not just for cold, but for UV exposure and heat stress. Safety boots (green patch) should be worn outside at all times. Where materials containing > 50 ppm PCBs are known to occur, Saranex-coated disposable overalls or equivalent should be worn. These disposable overalls will not be permitted in the camp and should be removed before entering or left in a designated change area. Contaminated soil in the barriers should be wetted if it is dry before excavation so as to avoid excessive dust. Alternatively masks should be worn. Work gloves should be worn for excavation of the barriers. (Phoenix Report pages 17-20)

b) Polar Bear Safety

The site has been identified as inhabited/visited by polar bears. An armed bear monitor, bear deterring procedures and bear deterring devices are intended to minimize this risk.

a) Armed and experienced bear monitors shall oversee the outdoor activities. Bear monitors will also inspect the site, including all work areas, immediately prior to the regular day's activities.

b) Each group of workers must be accompanied by a bear monitor when working at an isolated area.

c) At least one person in every group will wear an appropriate bear deterring device while outdoors, and all site personnel will be familiar with bear deterring tactics.

For further bear safety, refer to Phoenix report Appendix B

c) Helicopter Safety

The helicopter pilot will normally brief passengers concerning safety before flying. Passengers and ground personnel shall follow the guidelines outlined below in order to minimize risks associated with riding and approaching a helicopter:

a) Secure any loose articles of clothing before approaching or departing a helicopter

b) On level terrain approach and depart the helicopter from the front (avoiding the rear rotor) and always within view of the pilot.

c) On uneven terrain, wait for instructions from the pilot. Never approach or leave a helicopter on the uphill side

d) Always walk in a crouched position and keep you head down. (If your hands are free, hold the front of your knees).

e) Exercise extreme caution when loading and unloading equipment from a running helicopter. Wear impact resistant safety glasses or goggles. The equipment to be loaded/unloaded must be carried horizontally below waist level in a secure manner (must not be adversely susceptible to the rotor downwash).

f) Fasten seat belt and secure doors before take off.

g) Be equipped with a life jacket when operating over water.

h) Smoking is not permitted in or around the helicopter

i) Never throw anything from the helicopter

j) Keep clear of the landing area when a helicopter is landing or taking off

k) Remove any object from the landing area that may be swept up by the helicopter downwash air stream.

General safety practices and guidelines are detailed below which apply to helicopter operations with particular attention to abating hazards associated with transport of materials by an externally-loaded helicopter:

a) The pilot of a helicopter that is hoisting materials shall be competent to fly an externally-loaded helicopter.

b) The pilot shall be in charge of hoisting operation and shall determine the size and weight of loads to be hoisted and the method by which they are attached to the helicopter.

c) Ground personnel including signalers for a helicopter being used to hoist materials shall be competent workers

d) While transporting an external load, the helicopter pilot shall follow a flight path that minimizes the risk to ground personnel and structures.

e) The Site Leader or his/her designate shall take precautions against hazards caused by helicopter rotor downwash.

d) ATV Safety

ATV riders must read Tips for the ATV Rider (Phoenix report Appendix G). Helmets (as provided) are to be worn at all times when riding an ATV. If the helmets are not equipped with visors, then impact resistance safety glasses are also to be worn by the riders(s). ATV riders should also be familiar with the vehicle operators' manual. All Queens University employees who will be using an ATV on site, are required to take an ATV course prior to the site visit. The ATV rider certification course is put on by Vanridge ATV tours and trails and generally takes about 5 hours to complete.

e) Emergency Response Procedures

Emergency response procedures will be planned in advance of the work activities. Methods and routes of evacuation and liaison with off-site medical rescue personnel will be pre-established.

A list of current emergency phone numbers will be produced each year. A satellite phone will accompany the field team and can be used to transmit messages concerning any accidents, illnesses or any site emergencies. If the satellite phone is not working (the site is on the fringe of the service area) ASU team members have permission to use the direct line to North Warning Station Operations (NWSO) center in North Bay. A team member will be dispatched to use this emergency line located within the unlocked vestibule of the North Warning Station on site—the large blue building.

'Check in' communication via satellite phone with the south is to be carried out daily. If contact is not made for over 24 hours, redoubled effort to communicate with contacts in the south will be made over the next 24 hours. A courtesy notification of our presence and activities on Resolution Island has been given to NWSO staff via a Third Party Support Form.

In the event of an emergency the following procedures will be implemented:

a) Work at the site will stop.

b) A predetermined person (e.g. Site Leader) will coordinate site control which may include: moving personnel to a safe location, preparing for extrication and/or evacuation, and contacting off-site resources such as medical support personnel.

c) Emergency response/treatment personnel will evaluate the incident and implement the necessary action. This may include contacting medical emergency personnel, INAC officials or other rescue resources.

d) In the case of a bear, the bear monitor will respond. All other personnel will act in a manner consistent with bear avoidance tactics (Phoenix report Appendix B), including moving to a safe location if this can be accomplished without aggravating the situation.

e) Fires that can be easily controlled will be extinguished immediately. Spills may be similarly controlled by the nearest trained person(s), if feasible.

f) Where the fire (or other emergency) produces a serious and imminent danger (e.g. where there is a risk of explosion) everyone will be evacuated to a safe location and if appropriate, off-site resource personnel will be contacted.

Following an emergency and prior to recommencement of work, there shall be:

a) notification of regulatory authorities as required

b) an incident investigation including documentation of the event

c) review of work procedures for the purpose of preventing similar events

d) review of emergency response plan for the purpose of improvement, and

e) replacement of emergency equipment and supplies where necessary

C. Tier II Landfill Monitoring Program

The long-term, post-remediation monitoring program contained provisions for monitoring wells and associated soil points at the Tier II landfill. The landfill was constructed over the period 2003-2005 at a somewhat contaminated location as was evidenced by the discovery of TPH in the sub-surface soils at the site location. Four monitoring wells and associated soil monitoring points were established in 2003 and 5 additional monitoring wells added in 2004. These were sampled up to seven times during the 2004 and 2005 seasons in order to establish baseline data. No water could be obtained from the two wells, 1B and 3B, and thus the Tier II monitoring well system was comprised of 7 wells and 6 associated soil monitoring points: soil monitoring point 5 is adjacent to both wells 5A and 5B. Four thermister strings were placed in the landfill during construction. The landfill was inspected on 18 August 2009 and data was downloaded from the thermister data loggers by INAC personnel on 5 September 2009. Results of this aspect of the work are presented in the next two sections. Analytical results for the water and soil samples collected this year are presented in the next section in two tables which are followed by a discussion of these results including a comparison to the results obtained in previous years.

1. Visual Inspection

The results of the physical inspection are presented in Table 1 and their location shown on Map 2. Generally there was little change from the previous year. The main difference was that rain had recently fallen and so 4 new ponded areas were added and those previously noted were larger.

a) <u>Settlement</u>

Three small sinkhole pockets were noted as in previous years near the north west area of the landfill (close to the bedrock wall). These sinkholes had not increased in size from the previous years.

b) <u>Erosion</u>

The areas of erosion were unchanged from those observed in 2008.

c) Staining

This year there was an area of standing water at the start of the stain (Photograph 9). The stain continues for 30 m towards the service road and this portion of the stain was dry. It was no larger than previous years and its severity is considered acceptable.

d) Seepage

As in 2008 no seepage was noted.

e) Ponded Water

As noted above there was much more water above ground than in 2008 due to recent rain events. Previously noted ponded areas had generally increased in size. Four new ponded areas were observed. There are 5 ponded areas to the east of the landfill two of which two are new as shown in Photograph 10. The other 2 new areas are to the south of the landfill at locations shown on Map 2.

f) Other Features

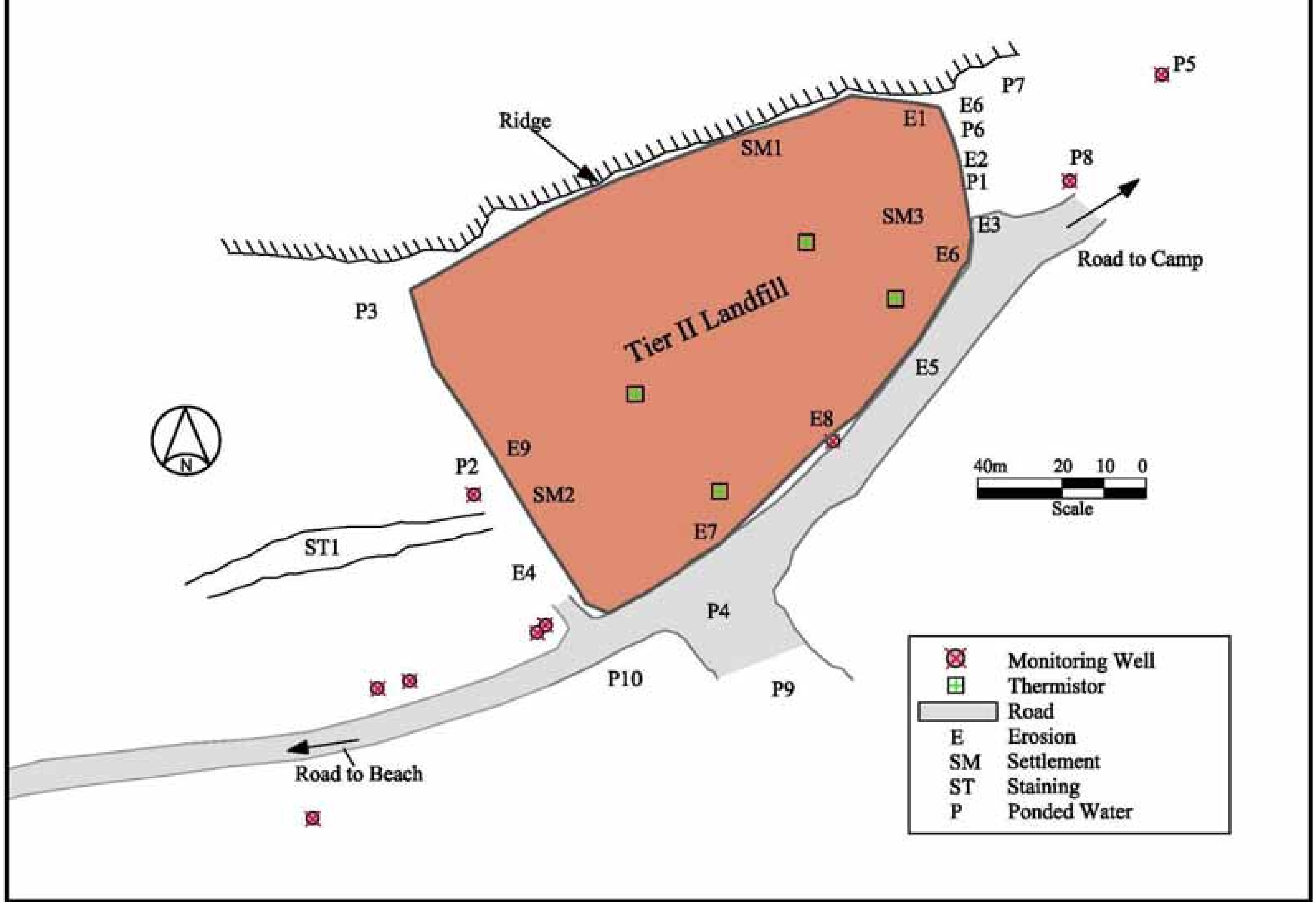
The mouth of the culvert near the service road at east corner of the landfill was crushed as noted in previous years. The severity is marginal as the culvert does not drain surface water.

Table 1: Tier II Landfill Engineering Assessment Visual Check List

Item	Location	Previously Observed	Dimensions (L, W, D) (m)	Description	Comment
Settlement	SM1- north west area near bedrock wall	yes	0.2-1.0 x 0.2-0.5 x 0.2-0.5	pockets not significant	acceptable
	SM2- south west berm	yes	0.3 x 0.2 x 0.1	not significant	acceptable
	SM3- north east area	yes	0.5 x 0.5 x 0.1	gradual sinking, maybe present from construction	acceptable
Erosion	E1- NE corner	yes	minimal, if any	no additional erosion, from surface water runoff on road	acceptable
	E2- 3m from east toe	yes	-	no additional erosion	acceptable
	E3- SE toe next to road	yes	-	no additional erosion	acceptable
	E4- toe of SW corner	yes	30-40 x 0.3-2.0 x 0.2	several erosion channels from runoff. Appear stable.	acceptable

Item	Location	Previously Observed	Dimensions (L, W, D) (m)	Description	Comment
	E5- south side adjacent to road	yes	50 x 1.0 x 0.5	small channel from surface water runoff, not significant	acceptable
	E6-largest drainage gully near NE corner	yes	-	small amount of erosion on steep slope. Not significant	acceptable
	E7- south berm area, near thermister 1311	yes	3 x 1 x 0.1	surface water runoff extends down landfill slope. Smaller than previous year.	acceptable
	E8- middle east berm	yes	10 x 15 x 0.1 (top berm) 0.5 (bottom berm)	surface water runoff. Similar to previous year.	acceptable
	E9- along west berm	yes	8.0-10 x 1.0-2.0 x 0.1-0.2	water runoff from west middle of landfill to west berm. Small finger gullies. Same as previous year.	marginal
Staining	ST1- west toe, adjacent to landfill berm	yes	5 x 1 x 0.05 (wet) 30 x 1 (dry)	30 m old rust stain, stable, same size as previous year.	acceptable
Ponded Water	P1- middle of east berm, 1-3m from berm	yes	6 x 2 x 0.06	3m east of berm, ponded water observed.	acceptable
	P2-west toe of berm (near MW4)	yes	2.0 x 0.5 x 0.04	water observed.	acceptable
	P3- NW corner	yes	1.0 x 1.5 x 0.09	no water observed, dry ponds	acceptable
	P4- south of landfill adjacent to landfarm	yes	3.0 x 1.0 x 0.05	small water pond	acceptable
	P5- 30 m east of landfill surrounding MW1A	yes	27 x (2-15) x 0.3	larger pond than last year. from rain, not landfill area	acceptable
	P6- north east berm, 4 m from berm	yes	4.6 x 3 x 0.08	small pond, evidence of larger pond	acceptable
	P7- north east berm, 10 m from berm	no	8 x 12 x 0.13	ponded water from rain	acceptable
	P8- surrounding MW1B	no	12 x 11 x 0.07	ponded water. Low area where MW1A exists.	acceptable
	P9- 40 m south of landfill	no	20 x 15 x 0.3	large pond from rain, not landfill area	acceptable
	P10- parallel to P4 on opposite side of the road.	no	2 x 30 x 0.04	ponded water in ditch adjacent to road	acceptable
Other	Culvert near service road at east corner	yes	-	culvert crushed	marginal

Map 2: Locations of Areas of Interest From the Engineering Assessment of the TIER II Landfill in 2009



2. *Thermal Monitoring*

The locations of the four thermister strings are given in Map 3. All thermisters were in good working order and the data was successfully downloaded on 5 September 2009. Batteries were replaced on Sept 5 by INAC. The data logger is setup to overwrite old data if memory is full. This setting eliminates the need to delete any data in the field.

Temperatures were recorded every 12 hours. Temperature data for each month were averaged and these were plotted to give temperature curves for the 13 months from July 2008 to July 2009 for each depth. These are presented in Figures 1-4 and have similar profiles to the last two years. Data has now been compiled for 4 years and shows a steady rise in the permafrost layer within the landfill. A temperature regime has now become established with the 0 °C isotherm reaching its lowest penetration in the fall. By examination of the raw data and selecting the minimum value of the temperature at the depth where the freezing point is not quite reached, the lowest depths for the 0 °C isotherm were calculated to be 1.9 m, 2.7 m and 3.1 m from the surface of the East Landfill, West Landfill and West Berm thermister locations respectively. Temperatures recorded at the East Berm where the depths of the thermisters are from 3.4 m to 6.9 m below grade, were all below zero for the whole year. Table 2 shows the change in the maximum depth of the 0°C isotherm obtained from 3 of the thermister strings for the last 3 winters. The depth has again decreased this year though not evenly. The dates when the maximum depth is reached are late November, mid-September and mid-October for the East Landfill, West Landfill and West Berm thermister locations respectively. The locations with respect to degree of shade, snow depth and other related weather conditions are likely responsible for these differences. From the engineering design, the depth of fill above the Tier II contaminated material is 2.7 m whereas the lowest depths of the 0 ºC isotherms within the landfill were 1.9 m and 2.7 m. Thus the contents of the landfill are now likely all within the permafrost.

Table 2: Maximum Depth of the 0°C Isotherm as Determined by the Thermisters

	Maximum Depth of 0°C Isotherm			
Winter - Year	Landfill East	Landfill West	Berm East	Berm West
2008-2009	1.9	2.7	-	3.1
2007-2008	2.5	2.8	-	3.3
2006-2007	2.9	3.5	-	3.6

Photograph 9: The Start of the Stain ST1 near MW4

Photograph 10: The Area to the East of the Landfill by Monitoring Wells 1A and 1B Showing the Location of the Ponded Areas

Figure 1: Thermister Data from Landfill East – Cable 1312 – Data Logger 61

Average Monthly Temperatures From July 2008 to July 2009

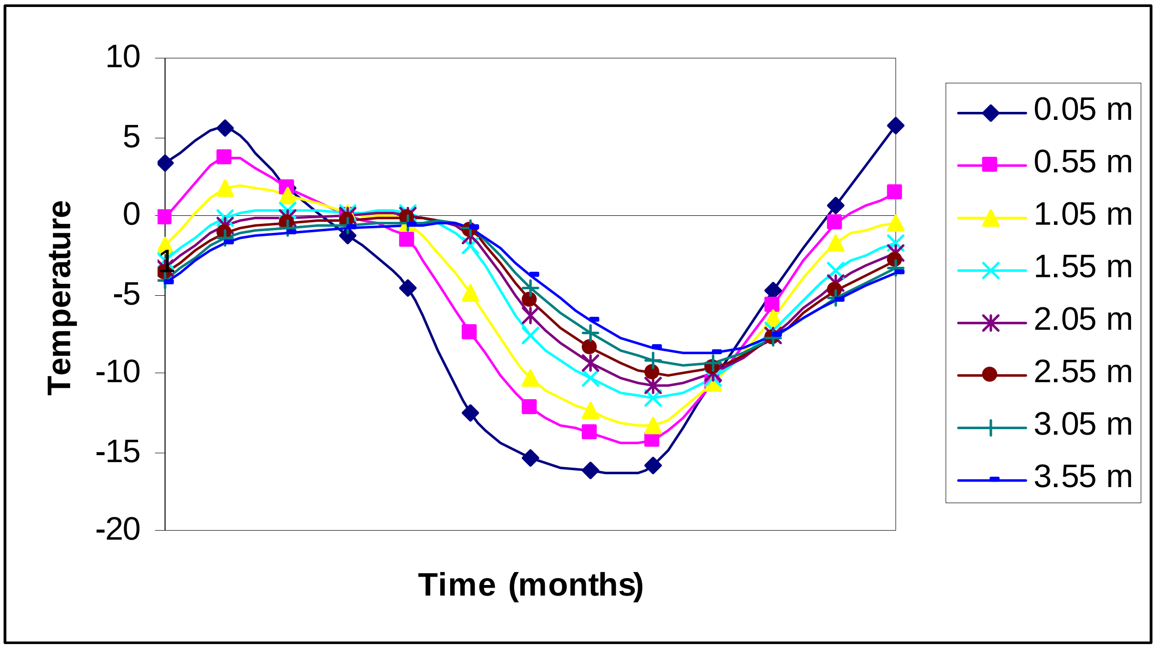


Figure 2: Thermister Data from Landfill West – Cable 1318 – Data Logger

Average Monthly Temperatures From July 2008 to July 2009

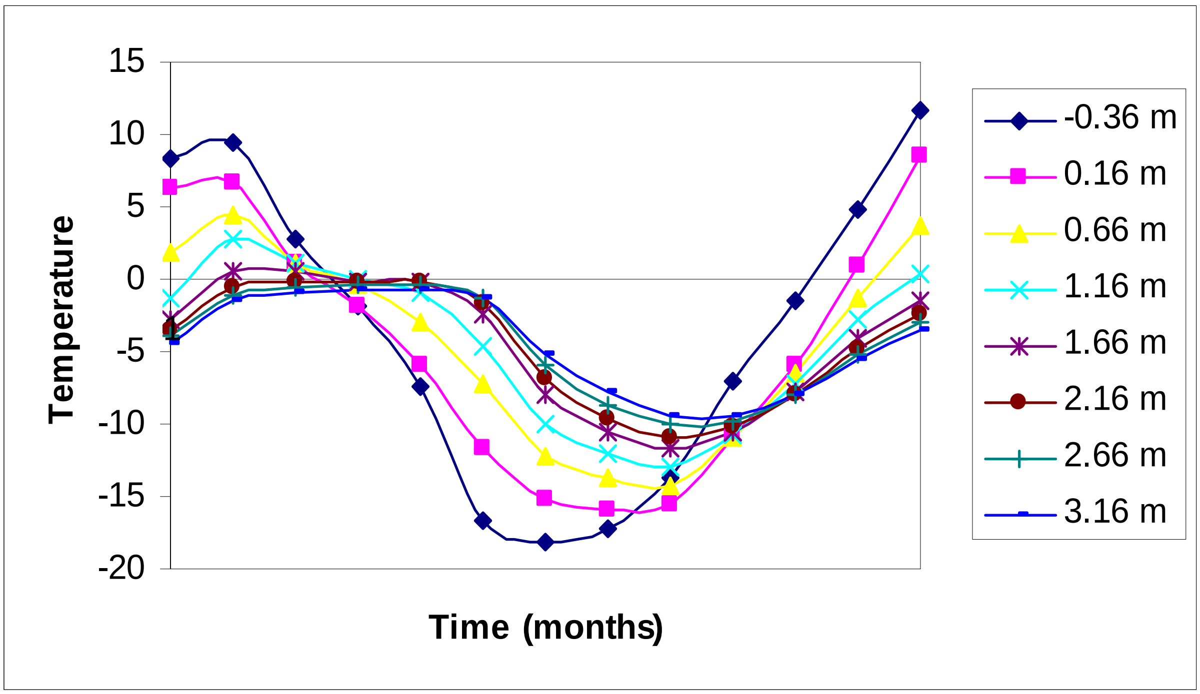


Figure 3: Thermister Data from Berm West – Cable 1311 – Data Logger 40

Average Monthly Temperatures From July 2008 to July 2009

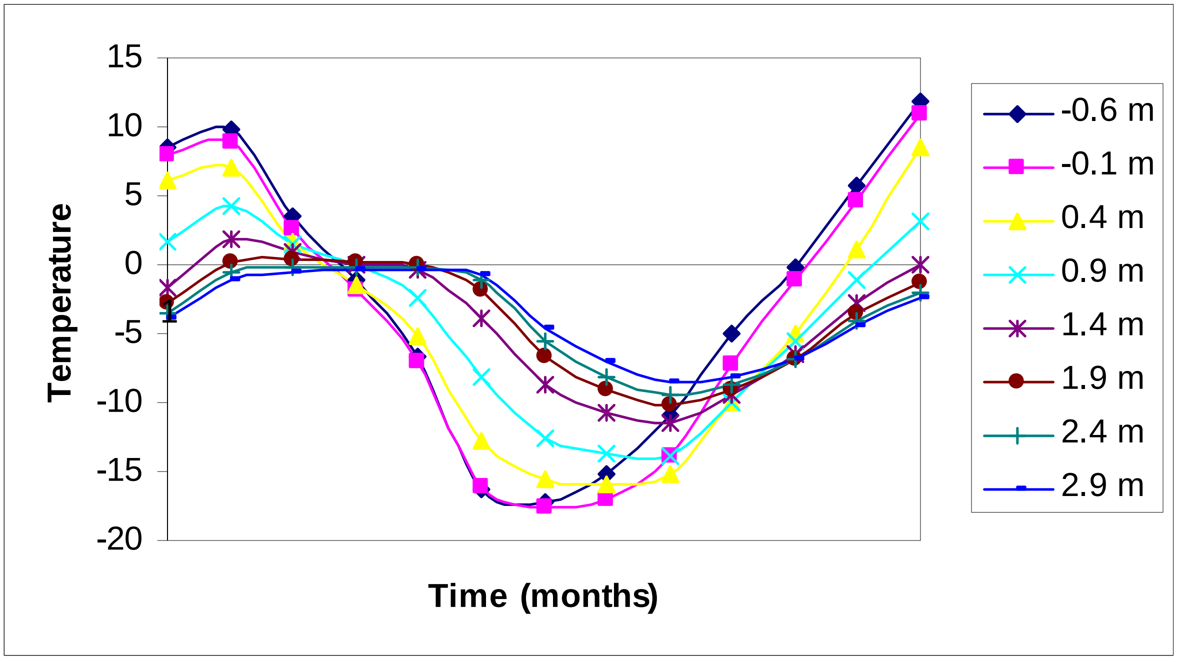
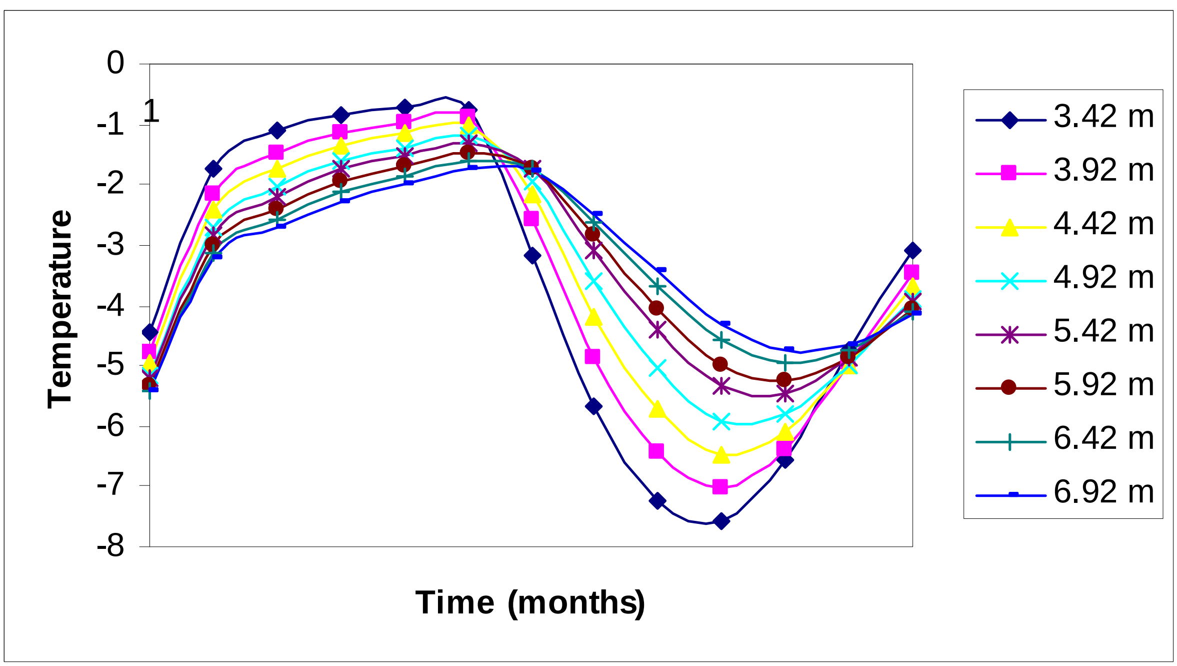


Figure 4: Thermister Data from Berm East – Cable 1316 – Data Logger 1

Average Monthly Temperatures From July 2008 to July 2009



3. *Water and Soil Monitoring*

The position of the monitoring wells and their associated soil monitoring locations is given in Map 3. Wells were all purged three times to dryness prior to sampling. After sampling, the Waterra tubing was removed from the wells and discarded. Well caps and lids were replaced and secured with zip ties. No water was present in MW5A again this year. Wells MW1B and MW3B were frozen. Soil and water samples were collected on 18 August 2009. Results of the analysis of the soil and water soil samples are given in Tables 3 and 4 respectively.

Map 3: Monitoring Well and Associated Soil Sample Locations at the Tier II Landfill Site

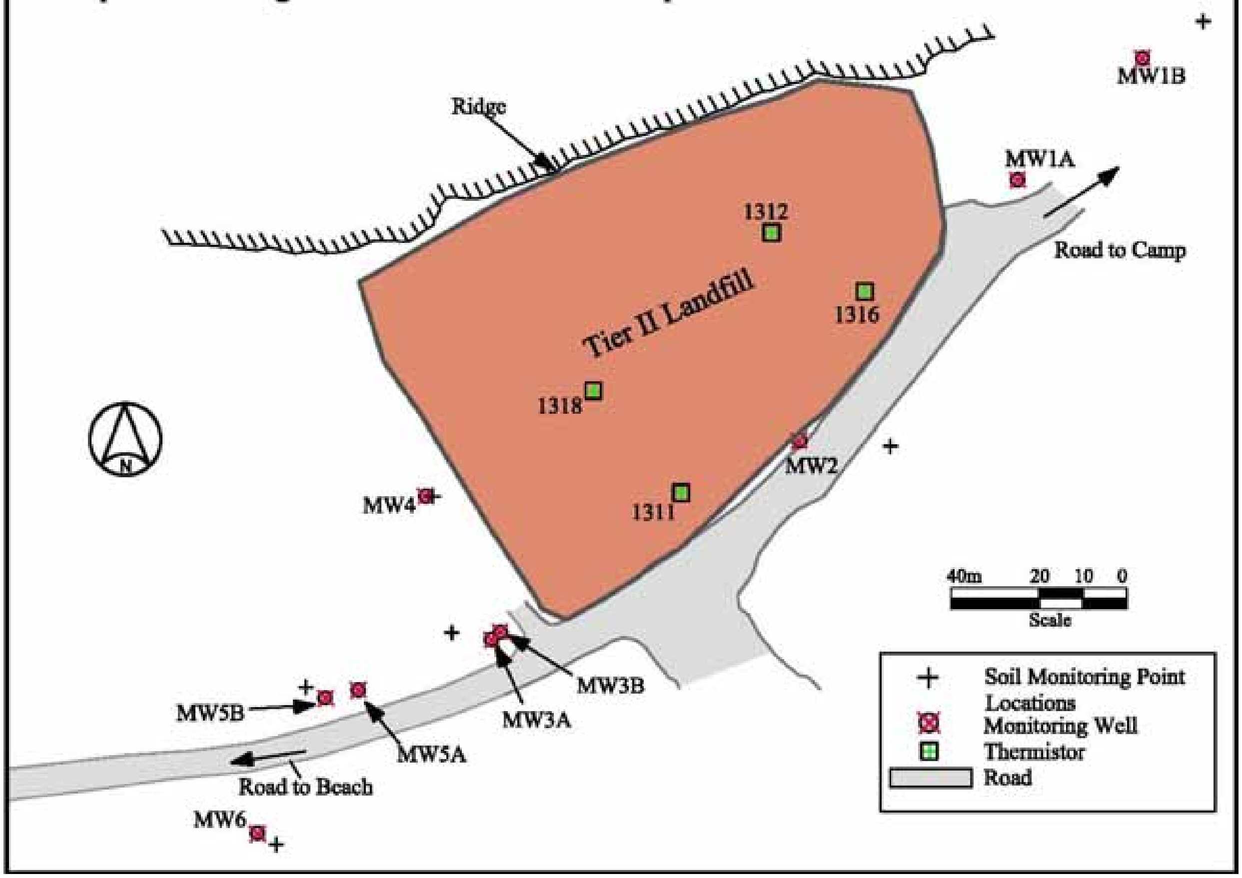


Table 3: Results of Analyses of Soil Samples Taken From Close to the Monitoring Wells at the Tier II Landfill Site

Location		MW1	MW2	MW3	MW4	MW5	MW6
Prefix RI09		001/220	002/219	003/221	004/218	005/217	006/216
Arsenic	ppm	<1.0	1.6	<1.0	<1.0	<1.0	<1.0
Cadmium	ppm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	ppm	37	47	43	47	47	39
Cobalt	ppm	7.9	13.7	13.3	19.5	19.3	6.5
Copper	ppm	54	81	67	66	88	66
Lead	ppm	<10	11	32	10	16	<10
Nickel	ppm	37	60	60	79	80	31
Zinc	ppm	43	58	75	65	81	36
PCBs	ppb	35	29	147	29	220	16
TPH (lube)	ppm	<40	<40	<40	<40	<40	<40
TPH (fuel)	ppm	<40	<40	<40	<40	<40	<40

Table 4: Results of Analyses of Water Samples Taken From the Monitoring Wells at the Tier II Landfill Site

Location	Unit	MW1A	MW2	MW3A	MW4	MW5B	MW6
Arsenic	ppm	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cadmium	ppm	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	ppm	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	ppm	0.010	0.037	0.010	0.017	0.014	0.054
Copper	ppm	<0.005	<0.005	0.019	<0.005	0.019	0.011
Lead	ppm	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Nickel	ppm	0.021	0.168	0.042	0.032	0.040	0.212
Zinc	ppm	0.020	0.085	0.014	0.018	0.154	0.196
PCBs	ppb	<0.020	0.082	0.041	0.024	0.20	0.022
TPH (lube)	ppm	<1.0	<1.0	<1.0	-	<1.0	<1.0
TPH (fuel)	ppm	<1.0	<1.0	<1.0	-	33	<1.0

4. Discussion of Analytical Results

The objective of the monitoring wells and associated soils program was to initially establish baseline values for levels of parameters in the soil and water and thus any increases in the levels of these parameters in time might then be attributed to failure of the landfill to have contained the contaminants placed within it. Unfortunately the Tier II landfill site was situated on a site contaminated at levels that one might expect at an industrial site and the variability of some of the initial baseline levels was larger and more variable than desired.

a) <u>Metals</u>

Table 5 summarizes the soil baseline sample data obtained in previous years while Table 6 summarizes the results for this year. Elements for all samples were within the baseline ranges developed in 2004 and 2005. Similar results were obtained in 2006 and 2007. No results exceeded the DCC II criteria this year.

Table 5: Summary of Baseline Results for Elemental Levels in Soil Samples Collected From the Tier II Landfill Soil Monitoring Points in 2004 and 2005 (ppm)

	Arsenic	Cadmium	Chromium	Cobalt
Mean	1.1	<1.0	40.0	11.1
Standard Deviation	0.4	0.0	9.4	4.9
Range	<1.0-2.0	<1.0	32-70	5.6-25
# samples > det limit	22	0	28	28
	Copper	Lead	Nickel	Zinc
Mean	61	13.4	48	57
Standard Deviation	19	14.0	19	18
Range	35-118	<10-63	24-106	33-103
# samples > det limit	28	11	28	28

Table 6: Summary of Elemental Levels Found in Soil Samples Collected From the Tier II Landfill Soil Monitoring Points in 2009 (ppm)

	Arsenic	Cadmium	Chromium	Cobalt
Mean	1.1	<1.0	43.3	13.4
Range	<1.0 – 1.6	0.0	37-47	6.5-19.5
	Copper	Lead	Nickel	Zinc
Mean	70	17.3	58	60
Range	54-88	<10-32	31-80	36-81

Table 7 summarizes the water baseline sample data obtained in previous years. Results from this year show values similar to those obtained in previous years. No arsenic, cadmium, chromium, or lead were detected in any samples. Copper was detected in 3 of the wells but at very low concentrations.

Cobalt, nickel and zinc were detected in all wells this year. Cobalt and lead levels were all within the established baseline range but two nickel results were outside the normal range (0.168 ppm and 0.212 ppm as compared to <0.010 – 0.091 ppm). Well MW2 was dry in 2007 but MW6 was outside the normal range in 2008 as well (0.164 ppm).

Table 7: Baseline Summary of Elemental Levels in the 86 Water Samples Collected from the Tier II Landfill Monitoring Wells in 2004 and 2005 (ppm)

	Arsenic	Cadmium	Chromium	Cobalt
Mean*	<0.003	<0.001	<0.005	0.017
Standard Deviation*	0.000	0.000	0.000	0.019
Range	<0.003-0.05	<0.001	<0.005-0.367	<0.003-0.073
# samples > det limit	1	0	2	51
	Copper	Lead	Nickel	Zinc
Mean	0.006	0.006	0.037	0.021
Standard Deviation	0.006	0.003	0.042	0.027
Range	<0.005-0.033	<0.010-0.022	<0.010-0.091	<0.010-0.286
# samples > det limit	26	7	71	41

* Excluding outliers

b) TPH

TPH was not detected either as fuel oil or oil and grease in soil this year. TPH was only detected in the water from Well 5B again this year but at a much higher level (33 ppm). The level was 1.6 ppm in 2008 and 1.3 ppm in 2007. In 2005, fuel was detected in 10 of the 39 water samples analysed. The sample from well 4 was broken in transit.

c) PCBs

PCB levels in the soil samples at the monitoring points ranged from 16 to 220 ppb which are somewhat higher than the values obtained in 2008. MW3 and MW5 gave the highest results which is consistent with previous data. The average value found this year from the 6 samples was 79 ppb as compared to 46 ppb last year, however, in 2007 the average was 78 ppb.

Given the level of PCBs in the nearby soil, any soil contamination in the water is likely to give measurable PCB levels in the water. The water cannot be filtered since this process would remove the PCBs from the water. In the laboratory, the samples were allowed to stand for at least 24 hours and then the water to be analysed was carefully decanted. However several samples in the past contained soil particles floating on the surface and, in others, colloidal material was present. Thus, the results where PCBs were found in the water may well have been a measure of the soil contamination rather than actual levels in the water. This is particularly likely since PCB molecules tend to partition on to solid surfaces and to absorb on to particles rather than to dissolve in water.

This argument has been used to explain anomalously high readings in previous years. In 2007, PCBs were only detected above 0.020 ppb in one of 5 samples whereas, in 2008, all 4 samples contained measurable levels with an average level of 0.057 ppb. This year 5 out of 6 samples contained measurable levels of PCBs. The water sample from MW5 contained 0.20 ppb PCBs but had a detection limit of 0.05 ppb due to hydrocarbon interference. The average PCB level in the other 5 samples was 0.038 ppb.

D. Airstrip Landfill Monitoring Program

The remediation of the airstrip dump was completed in 2003. Four monitoring wells were placed around it, one above and three in the leachate channel leading away from it (Map 4). However, it should be noted that the drainage channel for MW12, MW13 and MW14 is extremely narrow and the staked area for the soil samples straddles the channel.

1. Visual Inspection

The surface of the airstrip landfill is in good condition with minimal erosion. There was no ponding at the time of the site visit despite the heavy rains and several areas showed signs of revegetation over and above the vegetation that remained after remediation (Photograph 11). On the north west berm, there is evidence of erosion. The gravel berm was built with large boulders on the top surface. Some of these boulders have recently migrated down the slope. Gravel is also migrating down the slope. Several large shallow gullies have formed from the erosion, 15-20m down the slope, 1-2m wide and 0.5m deep in some areas. The extent of the erosion is noted as marginal and should be investigated again next year. On the north berm, there is a local area of erosion and settling between MW12 and MW13, close to the vegetation and visible debris. There are several deep gullies in the sand/gravel that extend over an area 3m down the slope, 2m wide and 0.2m deep (Photograph 12). Some debris is located beside the gullies, including an old pipe. This area should be monitored for increasing erosion in future years. It is also deemed marginal because it is localized.

Photograph 11: Revegetation Was Visible at the Airstrip Landfill

Photograph 12: Erosion Channels Have Developed in Some Areas of the Toe of the Airstrip Landfill

2. *Water and Soil Monitoring*

Monitoring well 11 was again dry this year and MW12 was frozen. Results of the analyses are shown in Table 8 and Table 9 for water and soil respectively. A soil sample was inadvertently not taken at MW11 this year.

Elemental results in the soil samples were consistent with results found in previous years. The elevated levels of most metals found last year in MW12 were not found this year so the explanation that they were from metallic contamination in solid material in the ground rather than from migration from the landfill was correct; no contamination was found in MW12 in 2005 or 2006. The metal levels in water were consistent with results from previous years and all within the normal ranges given in Table 7.

For the soil samples this year, TPH (lubricating oil and grease) was high in MW 12 as usual. In contrast no TPH was found in the other soil samples and no TPH was found in the water samples. These results are consistent with results from previous years.

PCB levels in the soil samples were low ranging from 12 to 44 ppb. For water samples, the PCB results levels of were very low (0.020 and <0.020 ppb) whereas in previous years values ranged from 0.021 to 0.108 ppb.

Map 4: Monitoring Well and Soil Monitoring Sample Locations at the Airstrip Landfill

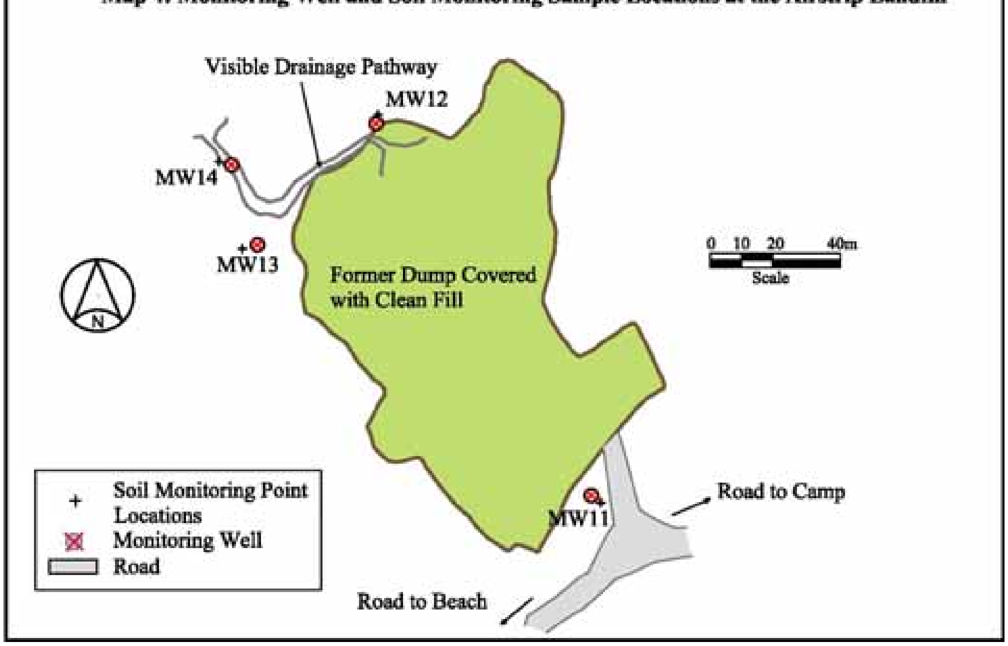


Table 8: Results of Analyses of Water Samples Taken From the Monitoring Wells at the Airstrip Landfill

		MW11	MW12	MW13	MW14
		dry	frozen		
Arsenic	ppm	-	-	<0.003	<0.003
Cadmium	ppm	-	-	<0.001	<0.001
Chromium	ppm	-	-	<0.005	<0.005
Cobalt	ppm	-	-	<0.003	<0.003
Copper	ppm	-	-	0.006	0.007
Lead	ppm	-	-	<0.010	<0.010
Nickel	ppm	-	-	0.016	<0.005
Zinc	ppm	-	-	0.015	<0.010
PCBs	ppb	-	-	0.020	<0.020
TPH (lube)	ppm	-	-	<1.0	<1.0
TPH (fuel)	ppm	-	-	<1.0	<1.0

Table 9: Results of Analyses of Soil Samples Taken From Close to the Monitoring Wells at the Airstrip Landfill

		MW12	MW13	MW14
Prefix RI09-		009/211	010D/212	011/213
Arsenic	ppm	<1.0	2.4	<1.0
Cadmium	ppm	<1.0	<1.0	<1.0
Chromium	ppm	35	48	60
Cobalt	ppm	11.9	14.8	19.6
Copper	ppm	54	87	93
Lead	ppm	16	20	<10
Nickel	ppm	58	78	99
Zinc	ppm	89	215	141
PCBs	ppb	44	12	16
TPH (lube)	ppm	370	<40	<40
TPH (fuel)	ppm	<40	<40	<40

E. Maintenance Dump Monitoring Program

The remediation of the maintenance dump was completed in 2005 and two monitoring wells and two soil monitoring points established (Map 5).

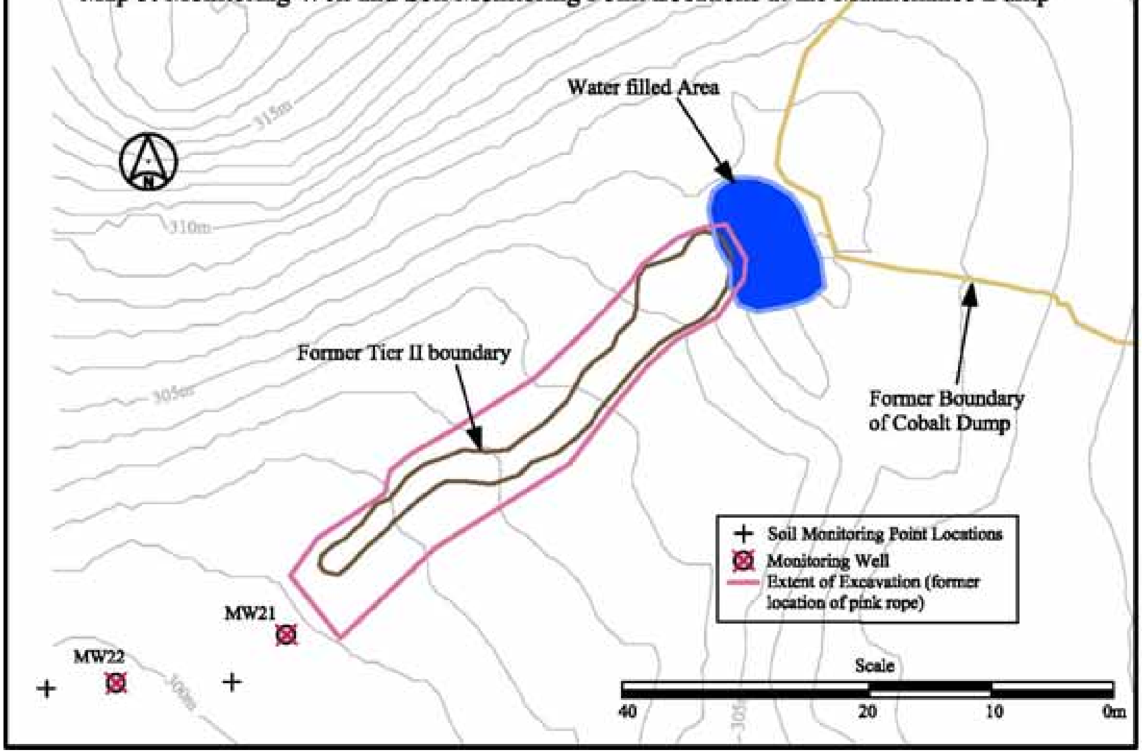
1. *Visual Inspection*

The area was regraded as part of the remediation program. There appears to be no erosion in the area which contains more vegetation than last year.

2. *Water and Soil Monitoring*

Monitoring well 21 was frozen this year. Water and soil samples were collected this year and results of their analyses are shown in Table 10.

Map 5: Monitoring Well and Soil Monitoring Point Locations at the Maintenance Dump



Elemental results from soil samples were consistent with those obtained in previous years. For the water samples, all metal results were below the method detection limit. Again these results are consistent with the results from the previous two years.

No hydrocarbons were detected in either the water or soil samples again this year. The PCB levels in the two soils were very low this year. Last year the level in MW22 soil was 56 ppb. Water from well MW21 was found to contain 0.079 ppb PCBs which is somewhat higher than in previous years.

Table 10: Results of Analyses of Water and Soil Samples Taken From the Monitoring Well Locations at the Maintenance Dump

Location	Units	Water		Soil	
		MW21	MW22	MW21	MW22
Prefix RI09-		frozen		007/215	008/214
Arsenic	ppm	-	<0.003	<1.0	<1.0
Cadmium	ppm	-	<0.001	<1.0	<1.0
Chromium	ppm	-	<0.005	39	54
Cobalt	ppm	-	<0.003	14.2	37
Copper	ppm	-	<0.005	55	101
Lead	ppm	-	<0.010	<10	14
Nickel	ppm	-	<0.005	69	100
Zinc	ppm	-	<0.010	93	216
PCBs	ppb	-	0.079	9	6
TPH (lube)	ppm	-	<1.0	<40	<40
TPH (fuel)	ppm	-	<1.0	<40	<40

F. Non-Hazardous Landfills

The long term monitoring program includes an inspection of the two non-hazardous landfills for any deterioration.

1. Station Landfill

The landfill was in good condition and no deterioration was observed. (Photograph 13).

2. Beach Landfill

This landfill is situated near the junction of the road from the camp and the barrel cache valley. It was well graded and firmly packed. There were no signs of erosion, water ponding or any vegetative growth (Photograph 14).

Photograph 13: The Station Non-Hazardous Landfill Was in Excellent Condition

Photograph 14: The Beach Non-Hazardous Landfill Was Also in Excellent Condition And Showed No Signs of Erosion, Settling or Ponding

G. Hydrocarbon Remediation

No sampling of any of the hydrocarbon remediation systems in place at the site were taken this year due to lack of time on site. The main landfarm (Photograph 15) was in good shape and showed no signs of erosion. The ponding and barrier system down gradient from this facility was also in excellent condition (Photograph 16) with water flowing freely through the filter system at the second ponded area (Photograph 17). The in situ landfarm experiment appeared unchanged from the previous year but there was no time to take samples.

Photograph 15: The Main Hydrocarbon Landfarm Showed No Signs of Erosion

Photograph 16: The Ponding and Barrier System Put in Place to Remove Hydrocarbons From the Drainage Channel Leading From the Camp and Main Landfarm was in Excellent Condition

Photograph 17: Water Was Flowing Freely From the Base of the Filter Box

H. PCB Barriers

In 2003, the first barrier was installed at the top of the cliff in the S1/S4 valley. Laboratory studies were conducted by the ASU in order to support the design and construction of this barrier system. As a result of these studies and field observations, the barrier was modified and two others were constructed at the S1/S4 beach adjacent to the shore and at the end of the furniture dump drainage channel. The barriers consist of a lined funnel formed by rock gabions through which all drainage must flow and a gate which contains various filters. Coarse sediment is trapped in the funnel while finer material is collected by the filters in the gate which also may remove dissolved material.

The original remediation of PCB contaminated soils at Resolution Island was carried out in the same manner as would be done elsewhere in Canada. However, it was not possible to excavate all the PCB contaminated soil because some soil was trapped in fractured bedrock, or located on very steep terrain that could not be accessed for logistical and safety reasons. The soil surface prior to the cleanup was stabilized by lichens and dwarf plants and by compaction. The soil remaining after excavation was loose and subject to erosion, particularly during runoff. In order to control the PCB migration from these two factors, it was decided that permanent barrier systems were required as a long term solution. The ASU was contracted to conduct the necessary research, design and development of these barrier systems.

Figure 5 shows the change in volume of sediment collected at the three barriers with time. The surprise in 2008 was the large volume of sediment in the barriers which was expected to fall with time as the loose soil generated during remediation excavations became stabilized. This year all three barrier systems were inspected and sampled but there was no time to dig out the trapped sediment. The volumes of sediment given in Figure 5 for 2009 are therefore estimates based on observation and sediment depth. The volumes for the two barriers in the S1/S4 drainage system were much lower this year and slightly lower than 2007 levels. Revegetation of some areas at the site were noted which should lead to lower sediment levels in the future, though major rain storms may lead to exceptions. The furniture dump barrier contained less sediment than was collected in 2008. The maintenance of the barriers this year involved only replacement of the geotextiles filters in the filter boxes. The gravel and GAC filters were not sampled or recharged with new material due to lack of time at the site.

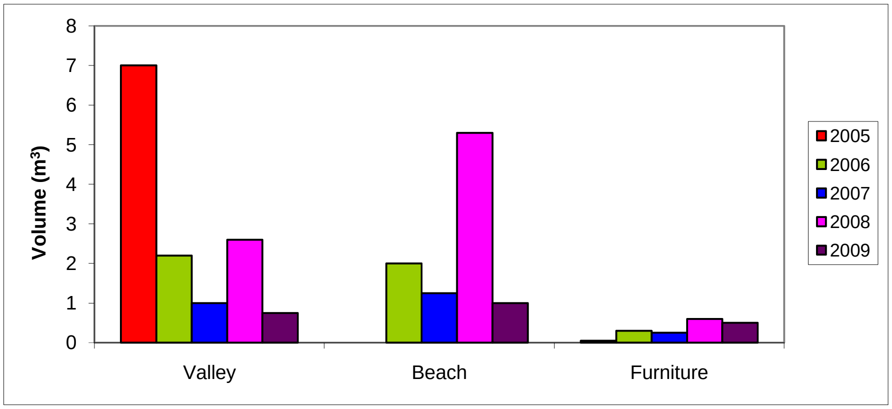


Figure 5: Change in Volume of Sediment Collected at the Three Barriers With Time

Four drums containing sediment and barrier material above the CEPA (50 ppm PCB) level were placed inside building B2. The south west corner of the building, the side furthest from the beach, where the roof is intact, was chosen as the location for this PCB storage facility. It was divided off from the rest of the area with a chainlink fence and appropriate signs posted (Photograph 18). PCB labels were affixed to each drum in accordance with the September 2008 PCB Regulations signage requirements.

The overpack drums and waste wranglers containing PCB-contaminated sediment (below the 50 ppm level) were moved from near the barriers this year to just outside building B2 near the beaching location. This was done by slinging the containers with the helicopter (see front cover). There were 7 waste wrangler containers on pallets and 34 overpack drums placed at this location (Photograph 19). The estimated soil volume is 10.2 m^3. Details of the contents of the containers are shown in the 2008 Resolution Island Report (Table 22). The majority of the 64 empty overpack drums, most of the clean gravel and all of the GAC were distributed from building B2 to the 3 barriers and camp storage for ease of use in future years.

Photograph 18: The PCB Storage Facility Nearing its Completion Within Building B2: Only the Four Drums Containing CEPA Soil Were Left in the Building on its Completion

Photograph 19: Waste Wrangler Containers on Pallets and Overpack Drums Filled in 2007 and 2008 With PCB Contaminated Soil from the Barriers. This Photograph Was Taken When 15 of the 34 Drums Had Been Moved to the Area. Building B2 Lost an Additional Panel of Cladding by the Door Over the Past Winter

Work at each of the three barriers is discussed in detail below followed by a section which summarises the results.

1. *S1/S4 Valley Barrier*

a) General

Filters containing fresh gravel, GAC and 1200R geotextile were placed in the filter box in 2008 as shown in Figure 6.

Figure 6: Arrangement of Filters and Sorbents in the S1/S4 Valley Filter Box at the End of the 2008 Field Season

1200R	1200R
1200R	1200R
GAC	GAC
GAC	GAC
Gravel	Gravel

Direction of Flow

b) 2009 Field Work

Upon preliminary inspection of the valley barrier in August it was noted that the sediment loading was very much less than in 2008. There was virtually no sediment in the trap between the curlex trap and the gabions in the center of the barrier (Photograph 20). It was estimated that 3 overpack drums of sediment was present between the gabions and the filter box. When the site was visited on 14 July water was observed to be flowing over the barrier (Photograph 21). It had been assumed that this might happen during spring runoff but this was the first time it had been recorded. This might appear, at first sight, to be a major design flaw. However, when this event occurs the ground is considered to be frozen and little sediment is thought to be mobilized at this time. In any event a much larger barrier is impractical. In August during the site visit (Photograph 20) water was flowing nicely through the barrier gate. The uncontaminated sediment in the first clean cell had been mostly washed away but the second cell was in good condition. No repairs were necessary at the barrier. Sediment and water samples were taken from the various monitoring points around the barrier. The 1200R units were sampled and replaced with new ones leaving the arrangement as shown in Figure 7 at the end of the site visit.

Figure 7: Arrangement of Filters and Sorbents in the S1/S4 Valley Box at the End of the 2009 Field Season

1200R	1200R
1200R	1200R
GAC	GAC
GAC	GAC
Gravel	Gravel

Direction of Flow

c) <u>Monitoring Results</u>

(1) Water

Water was collected from 5 locations in the valley. Their locations and PCB concentrations are given in Table 11 and Map 6. These results are lower than in the previous two years. The average levels from the 5 monitoring locations were 0.057 ppb in 2007 and were 0.072 in 2008. This may be a sign that levels are decreasing or that the collection later in the season this year had a lowering effect.

Table 11: PCB Concentration in Water From the S1/S4 Valley

Monitoring Point	PCB (ppb)	Location
VWP1	0.023	In front of chevrons
VWP2	0.021	In front of filter box
VWP3	0.023	After filter box
VWP4	0.025	20 m downstream of barrier
VWP5	0.029	Near cliff

(2) Sediment

Results of the analysis for PCBs from sediment collected from within the barrier are shown in Table 12 and Map 6.

The average PCB level within the barrier was 1.6 ppm (Tier I). This is significantly lower than the concentrations found in the previous three years (2.9 ppm, 4.8 ppm and 6.1 ppm) and show a steady decline over the period. The estimated amount of sediment in the barrier was 0.75 m^3. The amount of pure PCB in this sediment is calculated to be 2.1 g. This is considerably less than in the previous three years (13.6 g, 8.6 g and 25.0 g). The other four PCB results are consistent with previous years results.

Table 12: PCB Concentration of Sediment From the S1/S4 Valley Barrier

Monitoring Point	PCB (ppm)	Location
VSP1	1.9	In front of chevrons
VSP2	1.7	Between chevrons and first gabion fence
VSP3	1.2	Between first gabion fence and filter box
VSP4	no sample	In front of filter box
VSP5	2.3	First clean cell
VSP6	4.4	Between the two clean cells
VSP7	4.2	Second clean cell
VSP8	12.8	20 m downstream

(3) Filters

The 1200R filters were removed from the filter box on 25 August 2009.

Samples were collected from each filter for PCB analysis. Photograph 22 shows one of the 3 filter box sets from the S1/S4 beach barrier just prior to sampling. For each filter a rectangle of the geotextile material was cut from the filter and dimensions taken and recorded as shown in the Figure 8 for the S1/S4 valley barrier. The mass of PCB in the sample was determined by GC/ECD and from the dimensions recorded the mass of PCBs in the filter calculated. The set of filter samples are shown for the furniture dump on the front cover.

Results of analysis for the S1/S4 valley are presented in Table 13, which also gives the location from which the sample was taken. The total amount of pure PCBs trapped by the geotextile filters was 13.9 mg. This compares to 8 mg collected in the previous year. The PCB levels are about double those of last year (range 1.2 to 2.5 ppm). A possible explanation is than the particles collected were finer and therefore higher in concentration. This might well be the case since the amount of coarse sediment reaching the filters was likely much less than in previous years.

Table 13: PCB Concentration of the Geotextile Materials From the S1/S4 Valley Barrier System in Operation From 16 July 2008 to 25 August 2009

Sample No	Medium	Location	PCB (ppm)	PCB (mg) per filter
RI09-120	1200R	left first filter	4.1	4.5
RI09-122	1200R	right first filter	4.3	1.2
RI09-121	1200R	left second filter	5.4	3.1
RI09-123	1200R	right second filter	4.6	5.1

Photograph 20: The S1/S4 Valley Barrier in August Operating Normally

Photograph 21: The S1/S4 Valley Barrier on 14 July Overflowing Due to Snow Melt

Photograph 22: A Set of Filters From the S1/S4 Beach Barrier Just Prior to Sampling

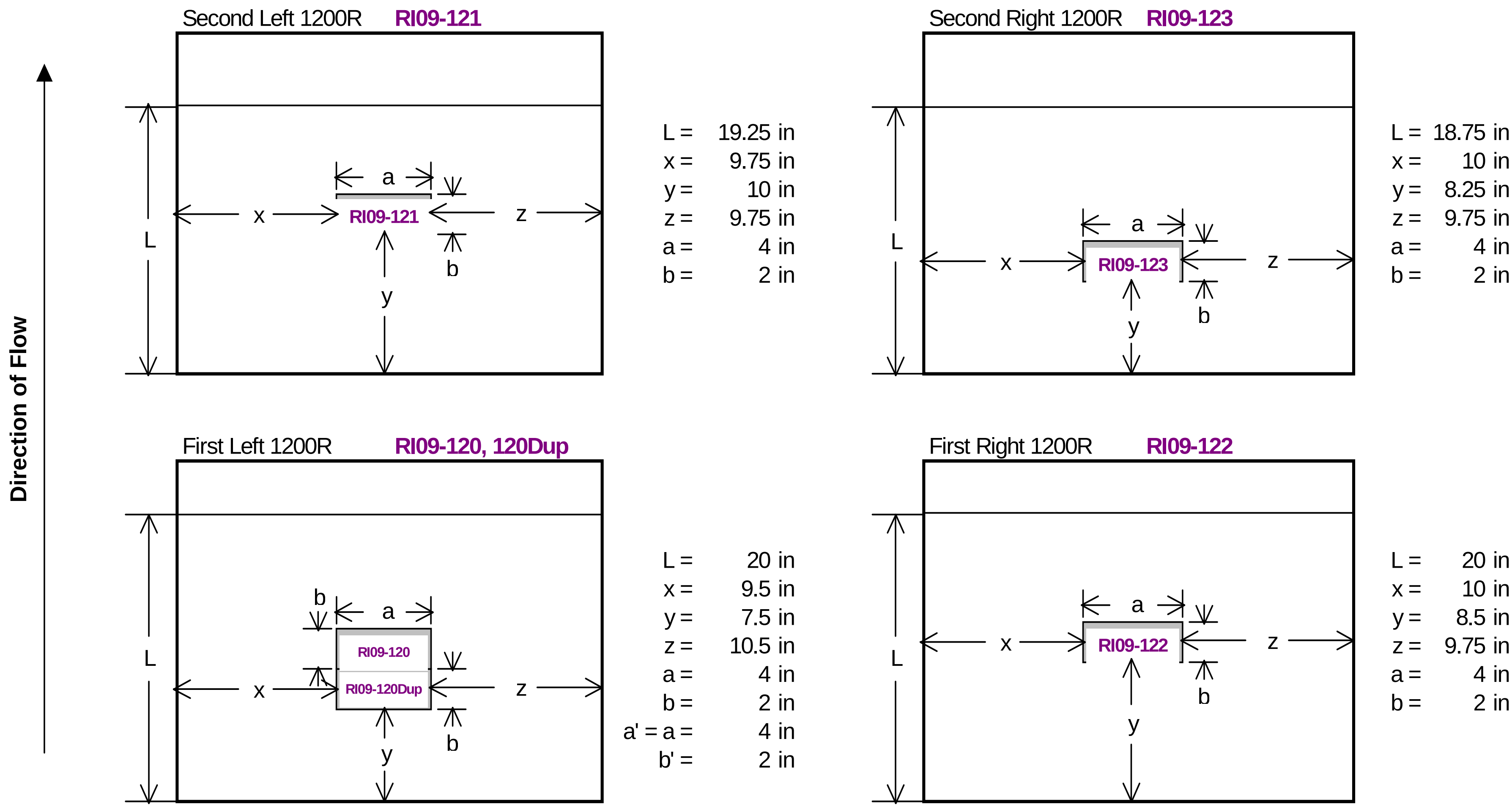
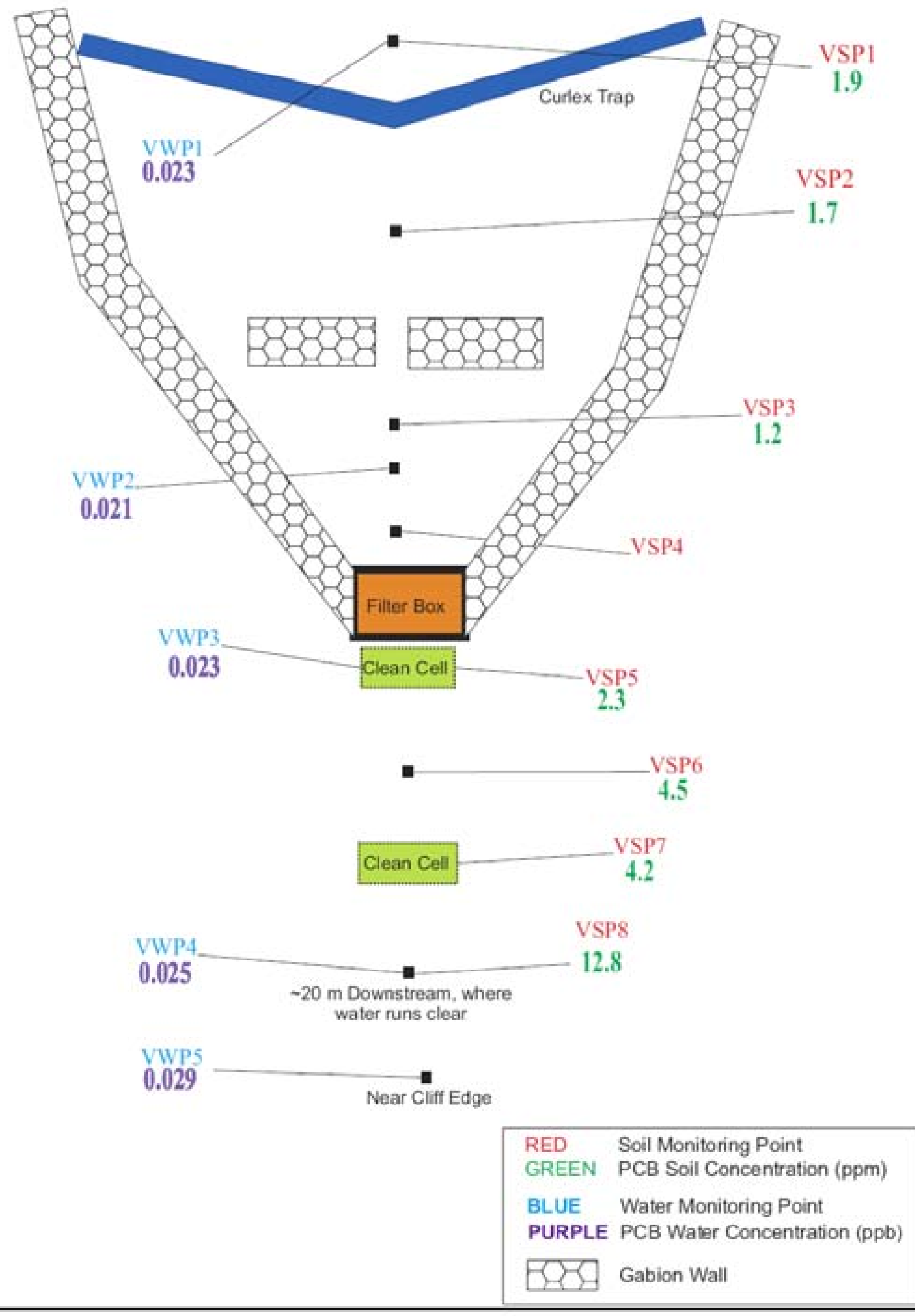


Figure 8: The Completed Template From the Sampling of the Geotextile Filters From the S1/S4 Valley Barrier

Map 6: Locations and PCB Concentrations of Soil and Water Samples at the S1/S4 Valley Barrier in 2009



2. S1/S4 Beach Barrier

a) <u>General</u>

An interceptor barrier was designed and constructed at the bottom edge of this area adjacent to the sea in 2005. Figure 9 shows the arrangement of filters in the filter box at the end of the 2008 field season.

Figure 9: Arrangement of Filters and Sorbents in the S1/S4 Beach Filter Box at the End of the 2008 Field Season

1200R	1200R	1200R
1200R	1200R	1200R
1200R	1200R	1200R
400W	400W	400W
GAC	GAC	GAC
GAC	GAC	GAC
¾ full Gravel	¾ full Gravel	¾ full Gravel

Direction of Flow

b) <u>2009 Field Work</u>

Photograph 23 is a closeup aerial view of the barrier at the start of the monitoring field trip showing the distribution of containers of contaminated sediment from previous years. Photographs 24 and 25 shows the barrier functioning well with water flowing from the filter box. Most of the sediment present in the barrier is from the previous year when only sediment was partially removed from the area between the central gabion and the filter box. Very little sediment appeared to have been added to both the areas above and below the gabion. The sediment level above the central gabions was at the level of the top of the gabion. Between the central gabions and the filter box the hole from which sediment had been taken in 2008 was still clearly visible. The filled containers were removed to B2 on 22 August and the barrier monitoring points and geotextile filters sampled on 25 August 2009. The geotextile filters were then recharged with four 1200R filters and replaced within the filter box as shown in Figure 10. The top black wooden plate was replaced securely on top of the filters.

Figure 10: Arrangement of Filters and Sorbents in the S1/S4 Beach Filter Box at the End of the 2009 Field Season

1200R	1200R	1200R
1200R	1200R	1200R
1200R	1200R	1200R
1200R	1200R	1200R
GAC	GAC	GAC
GAC	GAC	GAC
¾ full Gravel	¾ full Gravel	¾ full Gravel

Direction of Flow

c) Monitoring Results

(1) Water

Water was collected from 3 locations in the beach area. Their locations and PCB concentrations are given in Table 14 and Map 7. These values are lower than last year's results. In 2008 there was a larger volume of sediment in the trap and the barrier was overflowing.

Table 14: PCB Concentration (ug/L) in Water From the S1/S4 Beach Area

Monitoring Point	PCB Concentration	Location
BWP1	0.072	Effluent from barrier filter box
BWP2	0.025	Effluent from barrier filter box
BWP3	0.037	Below cliff at the sea edge

(2) Sediment

Five sediment samples were collected in and around the barrier. Results of analysis of these for PCBs and their locations are given in Table 15 and Map 7. The results for BSP 1 and BSP 2 of 0.6 ppm and 0.9 ppm respectively are about half the levels found last year (1.7 ppm and 1.9 ppm). The PCB levels in BSP 3 and BSP 4 last year were <0.5 ppm and 1.3 ppm respectively. Therefore the PCB level in the sediment as a whole is now slightly above 1 ppm or just in the Tier I level.

Table 15: PCB Concentration of Sediment From the S1/S4 Beach Barrier

Monitoring Point	PCB (ppm)	Location
BSP1	0.6	Between top gabions and Curlex trap
BSP2	0.9	In front of Curlex trap
BSP3	no sample	Between edge of liner and central gabion
BSP4	no sample	In front of filter box
-	0.2	Directly after the filter box but not a clean cell
BSP5	0.5	new clean cell location
RI09-124	0.4	Between filters

(3) Filters

The filters were removed from the filter box on 25 August 2009. Samples were collected from each geotextile filter and analysed for PCBs. Results of analysis are presented in Table 16. The total mass of PCBs collected by the 12 geotextile filters was 9.4 mg as compared to 22 mg in the previous year; 0.6 mg was collected over the winter of 2006 when 6 filters were used. Much more sediment was washed down the valley in 2007 than 2006 and this could explain the increase between these. However, the value this year is about half that of 2007 but represents an increased efficiency of the filters as less sediment was carried by the drainage water and therefore, finer material, which contains higher levels of PCBs, could be trapped: the PCB levels in the filters were similar this year with an average level in the 1200R filters of 1.9 ppm in comparison to an average of 2.8 ppm in the previous year. The mass and concentration of PCBs collected by the coarser 400W filter was variable but on average similar to that of the 1200R filters

Table 16: PCB Concentration of the Geotextile Materials From the S1/S4 Beach Barrier System in Operation From 17 July 2008 to 25 August 2009

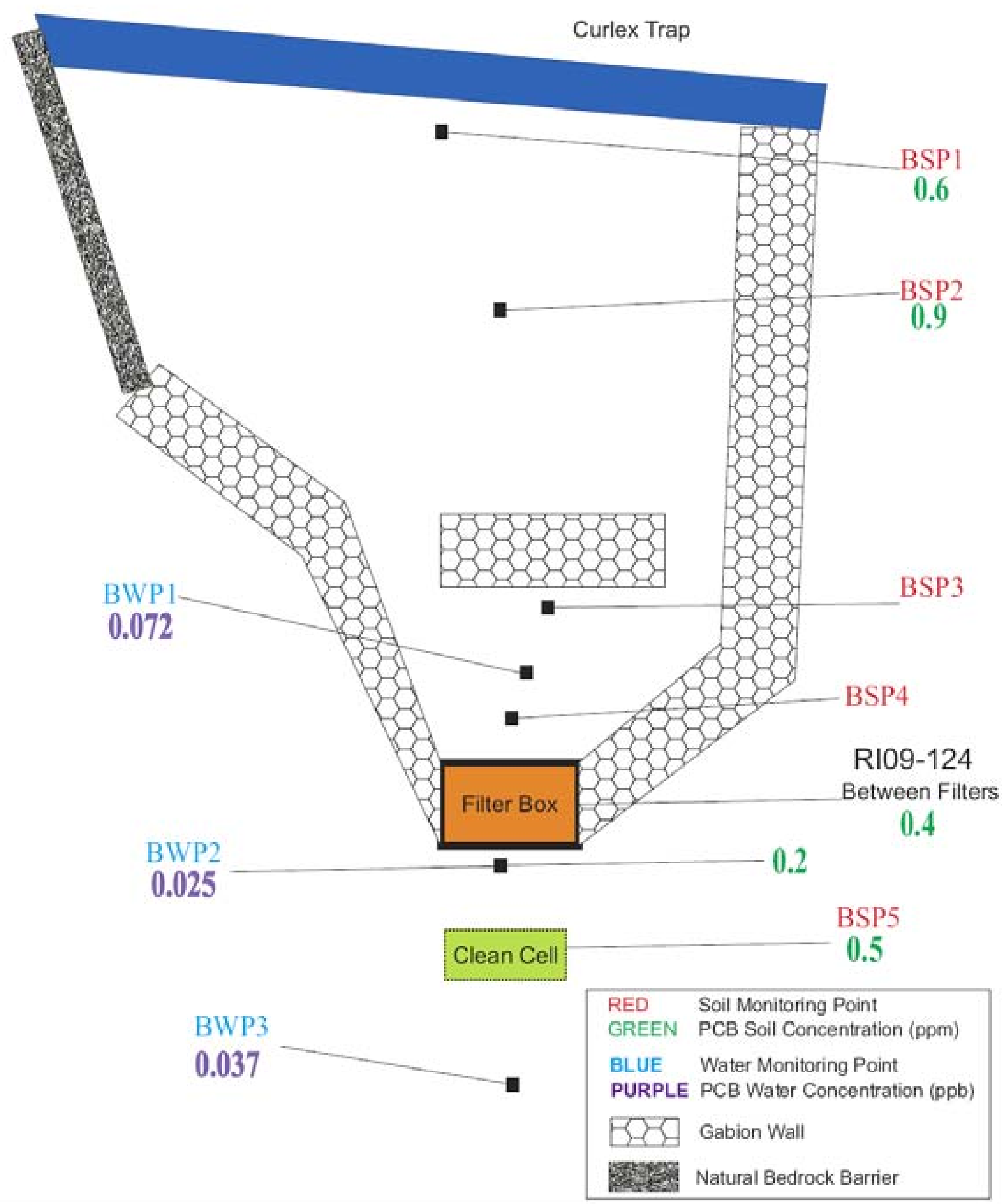
Sample No	Medium	Location	PCB (ppm)	PCB (mg) per filter
RI09-108	400W	left first filter	3.2	1.1
RI09-112	400W	center first filter	<0.1	<0.1
RI09-116	400W	right first filter	0.7	0.1
RI09-109	1200R	left second filter	10.0	0.6
RI09-113	1200R	center second filter	0.9	0.7
RI09-117	1200R	right second filter	0.7	0.9
RI09-110	1200R	left third filter	0.6	0.6
RI09-114	1200R	center third filter	0.3	0.2
RI09-118	1200R	right third filter	0.7	1.0
RI09-111	1200R	left fourth filter	1.0	0.8
RI09-115	1200R	center fourth filter	0.6	0.7
RI09-119	1200R	right fourth filter	0.5	2.7

Photograph 23: The S1/S4 Beach Barrier From the Helicopter Showing Drums and Waste Wranglers Filled in 2007 and 2008 With PCB Contaminated Sediment

Photograph 24: The S1/S4 Beach Barrier in 2009

Photograph 25: Water Was Flowing Freely From the Base of the Filter Box

Map 7: Locations and PCB Concentrations of Soil and Water Samples at the S1/S4 Beach Barrier in 2009



3. *Furniture Dump Barrier*

a) General

The furniture dump and its drainage pathway were excavated in 1999. Transformers containing nearly pure PCBs were removed from the dump. All soil containing > 1 ppm PCB was removed from the original dump and its drainage pathway and large areas of exposed boulders were washed and vacuum cleaned. In 2003, a wooden experimental barrier was designed and constructed. This was replaced by a stainless steel one in 2005. Results of analyses of barrier sediment and filters in the period 2004-2006 showed that PCBs were being transported in the drainage pathway and were still present in the area previously occupied by the furniture dump and in the drainage pathway leading from it. This was despite considerable effort to remove any soil found to contain > 1 ppm PCBs with the vacuum truck; normally vacuuming was only undertaken for CEPA areas. Figure 11 shows the arrangement of filters in the filter box at the end of the 2008 field season.

Figure 11: Arrangement of Filters in the Furniture Dump Filter Box at the End of the 2008 Field Season

1200R	1200R
1200R	1200R
1200R	1200R
400W	400W
GAC	GAC
GAC	GAC
¾ full Gravel	¾ full Gravel

Direction of Flow

b) 2009 Field Work

Photograph 26 shows that an estimated 250 L of sediment had collected above the silt fence during the previous 12 months and Photograph 27 shows a similar quantity within the barrier. Water was flowing through the barrier this year as it rained several times during the field season. A water sample was collected from within the barrier and five soil samples were collected from in and around the barrier on 25 August; two sediment samples were also taken on 14 July 2009. The geotextile units of the barrier were removed and sampled. They were replaced by 4 layers of 1200R geotextile as shown in Figure 12.

Figure 12: Arrangement of Filters in the Furniture Dump Filter Box at the End of the 2009 Field Season

1200R	1200R
1200R	1200R
1200R	1200R
1200R	1200R
GAC	GAC
GAC	GAC
¾ full Gravel	¾ full Gravel

Direction of Flow

4. *Monitoring Results*

(1) Water

A level of (FWP1) 0.208 ppb PCBs was found in water above barrier this year. This is lower than the high level of 0.535 ppb found in 2007 but higher than the level of 0.125 found in 2008.

(2) Sediment

Five sediment samples were collected and analysed from the locations given in Table 17 and Map 8. High levels of PCBs were once again found at the furniture dump barrier. The estimated volume of sediment in the barrier was 0.48 m^3. The average concentration of PCBs in the barrier was 43 ppm compared to 78 ppm last year. The amount of PCB collected is calculated to be 37.3 g. This compares to 76 g, 16.9 g and 15.4 g in the previous three years but the volume estimate was visual and therefore has a large error associated with it. PCB levels are close to the 50 ppm CEPA level.

Table 17: PCB Concentration of Sediment Samples From the Furniture Dump Barrier System After Spring Runoff

Monitoring Point	Sampling Date	PCB (ppm)	Location
FSP1 (FDS)	14 July	39	In front of silt fence
FSP1	25 August	26	In front of silt fence
FSP2 (FDB)	14 July	80	In funnel of barrier
FSP2	25 August	28	In funnel of barrier
FSP3	25 August	13.2	Downstream next to filter box (not a clean cell)
-	25 August	10.8	Between the barrier and the cliff
FSP4	25 August	9.5	New clean cell near cliff edge

(3) Filters

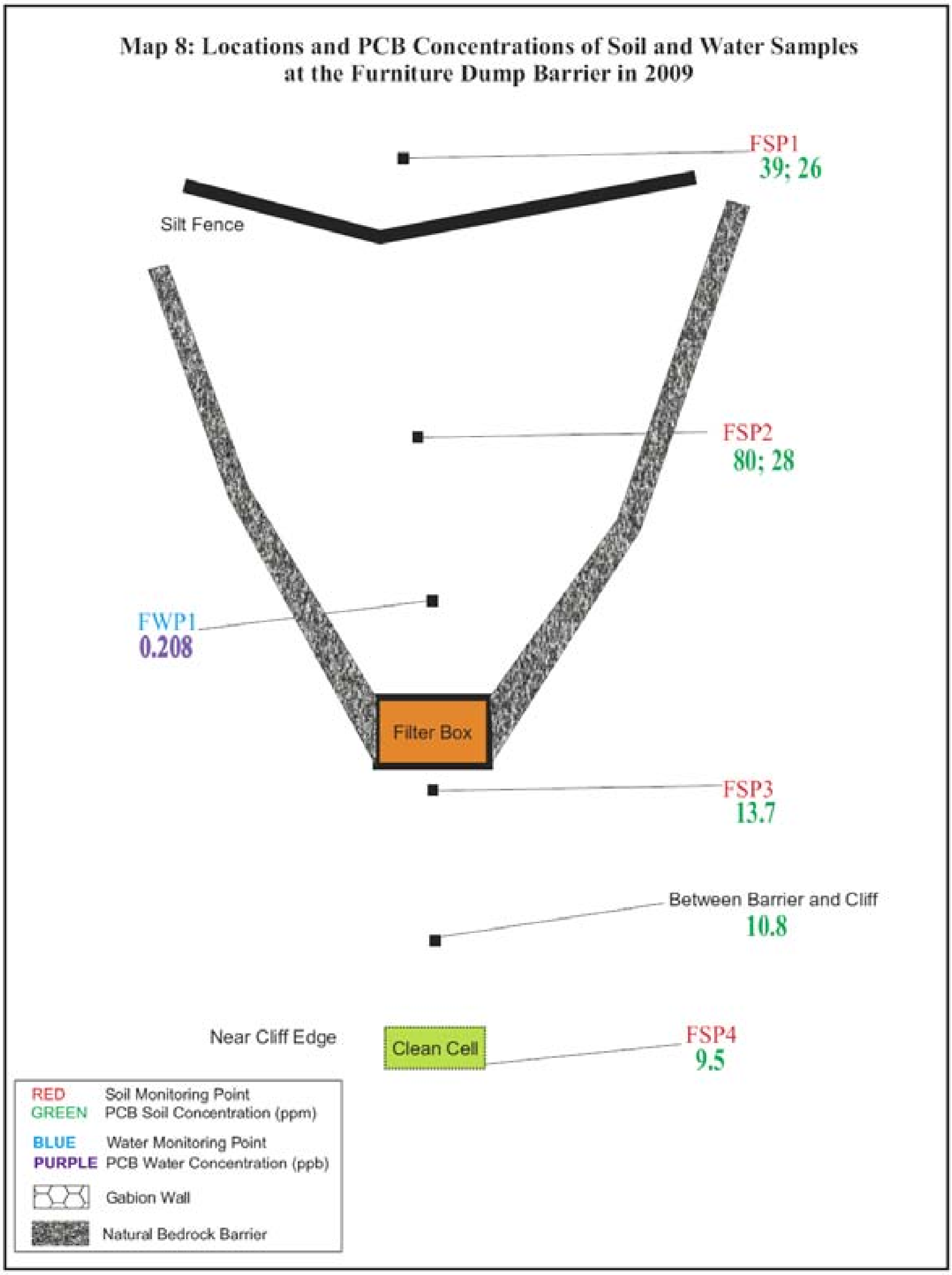
The filters were removed from the filter box on 25 August 2009. Samples were collected from each geotextile filter and analysed for PCBs. Results of analysis are presented in Table 18. The concentrations of PCBs in the samples, based on wet weight, were between 51 and 132 ppm for the 1200R filters compared with an average of 190 ppm last year. The mass of PCBs collected the 400W filters was much less as the concentration in the 2 samples was 17.7 and 17.0 ppm. The total mass of PCBs collected by the 8 geotextile filters was 317 mg as compared to 540 mg in the previous year. The 400W filters were replaced with 1200R filters this year.

Table 18: PCB Concentration of the Geotextile Materials From the Furniture Dump Barrier System in Operation From 2 August 2007 to 15 July 2008

Sample No	Medium	Location	PCB (ppm)	PCB (mg) per filter
RI09-100	400W	left first filter	17.7	1.4
RI09-104	400W	right first filter	17.0	1.4
RI09-101	1200R	left second filter	74	57
RI09-105	1200R	right second filter	85	49
RI09-102	1200R	left third filter	86	74
RI09-106	1200R	right third filter	58	29
RI09-103	1200R	left fourth filter	132	66
RI09-107	1200R	right fourth filter	51	40

Photograph 26: Sediment Collected Above the Silt Fence at the Furniture Dump

Photograph 27: Sediment Captured in the Furniture Dump Barrier


Map 8: Locations and PCB Concentrations of Soil and Water Samples
at the Furniture Dump Barrier in 2009
FSP1
39; 26
Silt Fence
FSP2
80; 28
FWP1
0.208
Filter Box
FSP3
13.7
Between Barrier and Cliff
10.8
Near Cliff Edge
Clean Cell
FSP4
9.5
RED Soil Monitoring Point
GREEN PCB Soil Concentration (ppm)
BLUE Water Monitoring Point
PURPLE PCB Water Concentration (ppb)
Gabion Wall
Natural Bedrock Barrier

5. *Summary of Barrier Results*

This year much less sediment was collected in the traps in the S1/S4 drainage system. While this may be a sign of the stabilization of the soil in the catchment area it could also be due to a slower snow melt or the lack of any violent summer storms this year. However, there are signs of revegetation of some areas at the site.

PCB levels in the water samples in the S1/S4 valley and beach area were generally lower this year hopefully indicating stabilization of soils.

Due to the logistical problems encountered this year, sediment was not removed from the traps and the GAC and gravel filters were not regenerated with fresh material but left in place.

The geotextile filter were removed, sampled, analyzed and replaced. The analytical results showed that the 400W coarser filters behaved similarly to the 1200R filters at the S1/S4 beach trap but very differently at the furniture dump. Here the levels and mass of PCBs collected by the 400W was very much less than by the 1200R finer filters. This result shows that the finer sediment in the furniture dump drainage pathway contains much higher PCB levels and also that there is a higher fraction of this particle size. This confirms previous data but shows this directly for the first time. The data for the S1/S4 valley and beach geotextiles also generally show an increase in PCB levels in the finer material trapped by the 1200R filters compared to previous years.

I. Wildlife Observations

During each summer field season wildlife has been observed at the site but not recorded. As per the revised INAC Abandoned Military Site Remediation Protocol 2009 part of the long term monitoring is to include observations of wildlife and the natural environment including direct sightings, other evidence (droppings, tracks, etc.) as well as vegetation observations. At the request of INAC wildlife these observations will now form part of the monitoring report.

1. Land

The following wildlife was observed on land: Ptarmigan, ravens and arctic fox. Polar bear paw prints were also seen. On Sept 5 INAC staff observed a lone polar bear on the east coast of Resolution Island approximately 25 km south of the site.

2. Sea

The following were observed on and in water: harp seal, humpbacked whale, beluga whale, polar bear and black guillemot.

Photograph 28: Jeannie Pishuktie, One of Our Bear Monitors Pointing Out Polar Bear Tracks

J. Appendix

This appendix contains the QA/QC data for this report and is followed by the Queens University Off-Campus Activity Safety Planning Record.

The ASU is accredited by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. Quality control was maintained through the analysis of standards, duplicates, and blanks.

The tables given below are self explanatory and show good quality of the results. The number of results for each parameter are small so no average numbers have been calculated.

Table 19: PCB Concentrations in Blank and Spiked QA/QC Soil Samples

Sample	Units	PCB Concentrations		
Blank	ppm	<0.1	<0.1	<0.1
Control	ppm	3.5	0.10	0.10
Control Target	ppm	5.0	0.10	0.10

Table 20: PCB Concentrations in Laboratory and Field Duplicate Soil Analysis

Sample Number (prefix: RI09-)	Type	PCB Concentrations (ppm)	Standard Deviation
VSP5	field	4.5; 4.3	0.14
FSP1	field	26.9; 25.0	1.34
BSP4	laboratory	0.3; 0.7	0.28
FSP4	laboratory	9.4; 12.2	2

Table 21: PCB Concentrations in Blank and Spiked QA/QC Low Level Soil Samples

		PCB Concentration	
Blank	ppb	<3.0	<3.0
Control	ppb	9.1	9.9
Control Target	ppb	10.0	10.0

Table 22: PCB Concentrations in Laboratory and Field Duplicate Low Level Soil Analysis

Sample Number (prefix: RI09-)	Type	PCB Concentrations (ppb)	Standard Deviation
219	Laboratory	33; 24	6.4
220	laboratory	39; 31	5.7
221	Field	147; 147	0

Table 23: PCB Concentrations in Field Duplicate Geotextile Analysis

Sample Number (prefix: RI09-)	PCB Concentrations (ppm)	Standard Deviation
100	15.5; 19.8	3
110	0.56; 0.72	0.11
120	4.6; 3.5	0.78

Table 24: PCB Concentrations in Blank and Spiked Geotextile Analyses

Sample	Units	PCB Concentrations
Blank	ppm	<0.1; <0.1; <0.1
Control	ppm	4.6; 3.8; 4.3
Control Target	ppm	5.0

Table 25: PCB Concentrations in Blank and Spiked QA/QC Water Samples

Sample	PCB Concentration (ppb)			
Blank	<0.020	<0.020	<0.020	<0.020
Control	0.067	0.069	0.063	0.068
Control Target	0.063	0.063	0.063	0.063

Table 26: PCB Concentrations in Field Duplicate Water Samples

Sample Number	PCB Concentrations (ppb)	Standard Deviation
RI09-MW4	0.038; <0.020	0.01

Table 27: TPH Concentrations in Blank and Spiked QA/QC Soil Samples

		TPH Concentration (ppm)	
Blank	ppm	<40	<40
Control	ppm	80	73
Control Target	ppm	75	75

Table 28: TPH Soil Concentrations in Laboratory Duplicates

Sample Number	TPH (Fuel) Concentrations (ppm)	TPH (Lube) Concentrations (ppm)
RI09-211	<40 ; <40	390; 350
RI09-215	<40 ; <40	<40 ; <40

Table 29: TPH Concentrations in Blank and Spiked QA/QC Water Samples

	TPH Concentrations (ppm)	
Blank	<1.0	<1.0
Control	12.1	13.0
Control Target	13.3	13.3

Table 30: TPH Water Concentrations in Laboratory Duplicate Analysis

Sample Number	Type	TPH Concentrations (ppm)
RI09-MW13	Fuel	<1.0 , <1.0
RI09-MW13	Lube	<1.0 , <1.0

Table 31: Metal Water Concentrations in Laboratory Blank Determinations and QC Control Samples

		Blank	QC	QC Target
Arsenic	mg/L	<0.003	0.81	0.80
Cadmium	mg/L	<0.001	0.84	0.80
Chromium	mg/L	<0.005	0.89	0.80
Cobalt	mg/L	<0.003	1.7	1.6
Copper	mg/L	<0.005	1.8	1.6
Lead	mg/L	<0.010	8.6	8.0
Nickel	mg/L	<0.005	1.7	1.6
Zinc	mg/L	<0.010	3.2	3.0

Table 32: Metal Water Concentrations in Laboratory and Field Duplicates (ppm)

Parameter	Laboratory		Field	
	RI09-MW22	RI09-MW22	RI09-MW4	RI09-MW4D
Arsenic	<0.003	<0.003	<0.003	<0.003
Cadmium	<0.001	<0.001	<0.001	<0.001
Chromium	<0.005	<0.005	<0.005	<0.005
Cobalt	<0.003	<0.003	0.018	0.016
Copper	<0.005	<0.005	0.006	<0.005
Lead	<0.010	<0.010	<0.010	<0.010
Nickel	<0.005	<0.005	0.031	0.033
Zinc	<0.010	<0.010	0.011	0.024

Table 33: Metal Soil Concentrations in Blank and Reference Material (ppm)

	Blank	Blank	Mess-3	QC Control	SS2	QC Control
Arsenic	<1.0	<1.0	16.6	13.9-17.3	75	54.8-103
Cadmium	<1.0	<1.0	<1.0	-	1.6	0.1-3.0
Chromium	<20	<20	42	31-49	44	35.8-55.5
Cobalt	<5.0	<5.0	12.1	10.7-13.7	14.0	11.5-17.2
Copper	<5.0	<5.0	29.9	29.8-37.4	185	158-225
Lead	<10	<10	17	16.6-20.5	112	99.4-130
Nickel	<5.0	<5.0	39.2	35.0-40.8	54	49.2-60.8
Zinc	<15	<15	138	125-147	424	392-544

Table 34: Metal Soil Concentrations in Laboratory and Field Duplicate Analysis (ppm)

Parameter	Laboratory		Field	
	RI09-006	RI09-006	RI09-010	RI09-010D
Arsenic	<1.0	<1.0	2.4	2.5
Cadmium	<1.0	<1.0	<1.0	<1.0
Chromium	39	38	43	53
Cobalt	6.6	6.5	13.9	15.6
Copper	69	64	83	92
Lead	<10	<10	24	17
Nickel	31	31	71	85
Zinc	37	36	225	204

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

Pursuant to the Queen's University Off-Campus Activity Safety Policy, this form is to be completed by the Principal Investigator/Activity Coordinator and submitted to the Department/Unit Head (Person in Authority) ***prior to the start of a "higher risk" off-campus activity****, as defined in the Policy. Department/Unit Heads may set requirements regarding how far in advance of an activity the form must be submitted.*

NOTE: *A single Safety Planning Record may be used for multiple off-campus activities in the same calendar year, or in a single offering of an academic course, provided the activities and safety provisions are similar and all participants are identified. Additional sheets should be appended as necessary to capture the features of individual activities and any special safety provisions, as trips may be impacted by changes of season (monsoon, hurricane, etc.), changes in political landscape (armed conflict, civil unrest), changes in health and safety of the region (e.g., SARS epidemic, Avian Flu outbreak), etc.*

DEPARTMENT/UNIT:
Analytical Services Unit

PRINCIPAL INVESTIGATOR/ACTIVITY COORDINATOR:
Dr Allison Rutter

CATEGORY OF OFF-CAMPUS ACTIVITY:
☒ Research ☐ Athletic
☐ Academic ☐ Other extracurricular

OFF-CAMPUS ACTIVITY LEADER:
Dr Allison Rutter; Nathan Manion

NATURE OF OFF-CAMPUS ACTIVITY:
Scientific Studies and Environmental Monitoring at a Former Military Base at Resolution Island, Nunavut

Student group if applicable (*e.g.,* Course # or Team Name): n/a

LOCATION OF OFF-CAMPUS ACTIVITY:

Country: Canada

Geographical Site: Resolution Island, Nunavut

Nearest City: (name, distance to) Iqaluit, Nunavut 310 km

PLEASE ATTACH A COMPLETE TRAVEL ITINERARY (LOCATIONS, DATES)
Itinerary for arctic travel is subject to frequent weather delays, as such, the best information that can be provided at this time is presented below.

OUTGOING
Depart (ASU Van) Kingston, ON 5:50AM July 14, 2009-Arrive Ottawa, ON 8:00AM July 14, 2009. Depart (First Air) Ottawa, ON 9:05AM July 14, 2009-Arrive Iqaluit, NT 12:15PM July 14, 2009. Depart (Ken Borek Air) Iqaluit July 14, 2009-Arrive Resolution Island, NT July 14, 2009.

INCOMING
Depart (Ken Borek Air) Resolution Island, NT July 23, 2009-Arrive Iqaluit, NT July 23, 2009. Depart (First Air) Iqaluit, NT 1:45PM July 23, 2009-Arrive Ottawa, ON 4:50PM July 23, 2009. Depart (ASU Van) Ottawa, ON 5:45PM July 23, 2009-Arrive Kingston, ON 7:45PM July 23, 2009.

MODE(S) OF TRANSPORTATION (check all that apply): For complete transportation information and restrictions, see Section 6.5 of the Off-Campus Activity Safety Policy.

☐ private vehicle*_______________ ☐ Other (please specify_______________

☒ commercial carrier First Air, Ken Borek Air

*The ASU work van will be used. The driver will be selected from the list of ASU employees on the ASU private insurance policy.

DATE OF DEPARTURE:
14 July 2009

DATE OF RETURN:
23 July 2009 (all dates are weather dependent)

CHAIN OF RESPONSIBLE LEADERSHIP: List all those who have a leadership role (including alternates); attach additional sheet if necessary.	Leadership Role (specify)	Trained First Aider (current)	Other Special Training
Dr Allison Rutter	Principal Investigator		*
Nathan Manion	On site team leader	X	*

Page 1 of 6

Form 1

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

*ATV Safety Training Course			

NUMBER OF PARTICIPANTS (other than the leadership team listed above):____3__

RISK ASSESSMENT:
List identified hazards associated with activities or environment (*e.g.*, extreme heat or cold, wild animals, endemic disease, firearms, explosives, transportation, crime, violence, political instability), and risk-management measures planned or taken for eliminating or reducing risks to acceptable levels. Please see the attached examples. **Append additional pages as required.**

Hazard Identification	Risk Analysis	Risk-Management Plan
1. Site Isolation and rugged environment	Evacuation to a hospital if medical attention is required may be impossible due to poor weather conditions on site. There are steep cliffs and rugged terrain on site, which increases risk of injury if care is not taken.	Staff, are warned of hazards and are required to read the Health and Safety Plan written for Resolution Island. An orientation meeting for all staff involved is held before leaving for the site and a site orientation is provided by the Health and Safety Officer on site for all new staff.
2. Polar Bears	Polar bear attacks are a possibility in the arctic. Polar bears are frequently sited at Resolution Island.	A bear monitor is on site at all times. Personnel do not work alone. If there are no trucks or heavy equipment in the area the bear monitor will accompany staff at all times.
3. Poor weather	Cold, rainy and foggy days are common even in the summer months.	All staff are advised of weather conditions before leaving for the site as well as every day on site. Additional rain gear and coats etc are provided on site. No one works alone outside and if weather conditions are very poor outdoor work is not performed.
4. Heavy Equipment, ATVs	Personnel are often working around heavy equipment and ATVs are used periodically on site as transportation around site.	All staff are warned about the dangers of working around heavy equipment and read the appropriate sections of the health and safety plan regarding appropriate conduct and use of hard hats etc. ATV training is provided on site before any use of the ATVs is allowed. Site rules regarding ATV use are also outlined in the H & S plan and ATV training provided for key personnel.
5. Contaminants on site	There are soils and oils containing high levels of PCBs on site at Resolution Island. There are also soils containing high metal content. Contact with PCBs and metals, is potentially a health hazard.	All personnel are instructed in the use of appropriate protective equipment as necessary. The appropriate use of the equipment is described in the Health and Safety Plan.

Form 1

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

Examples of Hazard Identification, Risk Analysis and Management

The examples given below relate primarily to international activities, but similar hazards may arise in domestic situations.

HEALTH:

List hazards associated with personal health or health insurance, and the measures of eliminating or reducing the risks to acceptable levels. Examples to consider are: What diseases are prevalent? Do you have any personal health factors that could constitute a risk (*e.g.*, allergies)? Do you have appropriate health-insurance coverage? Is medical help available in the region you will visit? Are English-speaking doctors available? etc…

A. HAZARD IDENTIFICATION	B. RISK ANALYSIS	C. RISK-MANAGEMENT PLAN
Example: Increased reports of Dengue Fever in parts of the country you are going to – as well as cholera, hepatitis A, malaria (regional) tuberculosis, typhoid fever, and yellow fever (regional).	I/we could get sick, temporarily or permanently. The trip could be cut short. I am not yet sure of which regions are affected so I don't know if I/we will be exposed. There is potentially a lot of risk. The risk is high if I/we go to those regions, but less if I/we avoid them. The warnings on DFAIT have confirmed this. I don't know how all these diseases are transmitted.	I will visit a Travel Health Clinic to research and get necessary immunizations and learn how diseases are transmitted. I/we will try to avoid areas where there is greater risk of infection. I will research area affected.

ENVIRONMENTAL HAZARDS:

List identified hazards associated with the environment, *e.g.*, issues relating to weather; extreme heat/cold; water potability; natural disasters such as earthquakes; wild animals.

A. HAZARD IDENTIFICATION	B. RISK ANALYSIS	C. RISK-MANAGEMENT PLAN
Example: Typhoon warnings from October – January.	Safety is threatened. Typhoons occur regularly all over the country. They will be difficult to avoid during the rainy season. Some areas will be at more risk than others. People living in less built up regions at more risk. Homes are often destroyed, and people can be injured by flying debris. Driving during typhoons is not recommended. Uncertain when a typhoon will hit.	I will talk to local Embassy to find out what steps need to be taken in case of a typhoon and plan accordingly. I will pay close attention to weather reports. I will contact my travel agent or tour representatives and hotels to ensure that all services are available.

LEGAL CONSIDERATIONS:

List identified hazards associated with the laws and legal system of the country in which you will be living, *e.g.*, laws relating to drugs/alcohol, sexuality; severity of punishment for crimes; nature of the legal system; obtaining legal assistance.

A. HAZARD IDENTIFICATION	B. RISK ANALYSIS	C. RISK-MANAGEMENT PLAN
Example: Photography at airports, railway stations, naval bases, air bases, military installations, public water and energy plants, police stations, harbors, mines and bridges is prohibited in the host country. Laws are strictly enforced and all restrictions should be observed. If in doubt, look for an official and ask for permission.	Traveler could be fined or jailed. Travel could be delayed. Traveler could be deported. Risk is very preventable. Awareness of the laws is the key to avoiding trouble. Foreigners are more likely to be at risk than locals. It is likely I/we will visit one of these locations at some point during the activity.	I/we will avoid taking photos at such locations. I/we will observe locals for behavioural etiquett I/we will research penalties and other laws. I/we will ask permission before taking pictures.

PERSONAL RISKS AND EMERGENCIES:

List any identified hazards that may not have been covered in other sections, *e.g.*, hazards arising from regarding personal choices, language differences, recreational activities, sexuality, accidents, violence.

A. HAZARD IDENTIFICATION	B. RISK ANALYSIS	C. RISK-MANAGEMENT PLAN
Example: Crime is an ongoing concern in your host country. Violent crimes, such as car hijacking, assault, and armed robbery are frequent. There have been cases of short-term kidnapping where the victim was forced to withdraw money from an automatic teller machine.	I/we could be a victim of any of the crimes mentioned. There is a very high risk of encountering this hazard. This is likely to happen to a lone traveler alone, or one who looks as though they have a lot of money, is wearing flashy clothes, *etc.* Women and travelers are probably more at risk. Impacts could be financial, or threat to personal safety. DFAIT warns Canadians about this risk.	I/we will avoid travel alone. I/we will consider other forms of currency, *e.g.*, traveler's cheques. I/we will avoid areas known for crime. I/we will dress conservatively. I/we will be aware of surroundings and people.

Form 1

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

TRAINING REQUIRED: All terrain vehicles (ATV) are often used on site. Personnel will be instructed (on site) on how to operate ATV vehicles. The team leader will ensure the competency of any team members before allowing them to ride unsupervised. All rules pertaining to ATV use in and around the camp (as specified in the Resolution Island Health and Safety Plan) will be observed.

IDENTIFICATION OF DISABILITIES / SPECIAL NEEDS / MEDICAL NEEDS:

Do any of the off-campus activity participants have a disability or medical need that would affect their safe participation? ☐ yes X☐ no

If so, please provide details of the arrangements that have been made to accommodate the special/medical needs:

Do any of the participants have allergies (*e.g.*, to bee stings, food, drugs)? ☐ yes X☐ no

If so, please indicate the provisions that will be made to deal with allergic reactions should they arise.

TRAVEL IMMUNIZATION/PROPHYLAXIS REQUIREMENTS:

☐ Altitude sickness medication	☐ Polio	Other (specify):
☐ Diphtheria	☐ Rabies	☐ ______
☐ Hepatitis A	☐ Rubella	☐ ______
☐ Hepatitis B	☐ Tetanus	☐ ______
☐ Japanese encephalitis	☐ Tuberculin testing prior to departure and 3 months after return	☐ ______
☐ Malaria		☐ ______
☐ Measles	☐ Typhoid.	X☐ Not Applicable
☐ Meningococcal	☐ Yellow Fever	

EMERGENCY PROCEDURES: Please see Emergency Procedures Checklist below.

Detailed Emergency Plan for Activity location (communication and evacuation)

These are outlined in the Resolution Island Health and Safety Plan and are reviewed by the Health and Safety Officer during on site orientation which is required for all new personnel on site. A copy is located in two three inch binders in room 0625.

University Contacts and Phone Numbers (people at Queen's who are designated as emergency contacts for the field party):	**Local Contacts and Phone Numbers (contact information for the field party):**
1. See attached phone list provided to all participants. 24h hour mobile contact available for principal investigator.	1. See attached phone list provided to all participants.
2.	2.

EMERGENCY PROCEDURES CHECKLIST (ITEMS TO CONSIDER – ALL MAY NOT APPLY)

Communications

1.	Handout listing emergency numbers & mobile phone with group	X☐
2.	Emergency contact number for Campus Security Services (613-533-6111)	n/a
3.	Alternate address/numbers/information for off-campus emergency contacts including nearest Canadian embassy	n/a
4.	Identify if transport also has radio/phone & number	X☐

Procedures

5.	Outline process for contacting Emergency Support	X☐
6.	Emergency rendezvous site address	X☐
7.	Team Leader & line of authority	X☐
8.	Identification of First Aid certified participants	X☐
9.	Identification of translators	n/a
10.	Identification of alternate/emergency driver(s)	n/a
11.	Outline use of special equipment	n/a

Form 1

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

ACKNOWLEDGEMENT and CONSENT

I, the undersigned, acknowledge that:
(a) I have been advised of the known/reasonably foreseeable risks associated with this off-campus activity and I consent to assume them;
(b) I have been advised that I have certain responsibilities as a Participant under the Off-Campus Activity Safety Policy and I consent to assume them;
(c) I am in a satisfactory state of health to undertake the off-campus activity and I have received all of the prescribed immunizations;
(d) I have been informed that I will need supplementary health insurance and that I am responsible for obtaining required visas and travel documents for my participation in international activities;
(e) I will comply with safety instructions from activity leaders; and
(f) I will act in a safe and responsible manner throughout the course of the off-campus activity, taking into account instructions received and the welfare of others.

PARTICIPANTS (add additional pages as necessary to include all participants):

Name (please print)	Signature	Date
Nathan Manion	[signature]	11-Aug-09
Rebecca McWatters	RMcWatters	11-Aug-09
Sonja Koster	Sonja Koster	11 Aug 09
Daniel Jones	[signature]	Aug. 11/09
Lisa Tendijowski	[signature]	Aug 11/09

Form 1

Queen's University Off-Campus Activity Safety Policy
Safety Planning Record

I certify that in my capacity as Off-Campus Activity Leader I will ensure that the Activity described above will be conducted in accord with the Queen's University Off-Campus Activity Safety Policy and this Safety Plan.
I affirm that I will file a Post-Activity Incident Report (Form 3) within two weeks of the completion of the off-campus activity if any critical or non-critical incidents have occurred during the conduct of the activity.

Nathan Manion
Name & Title (Off-Campus Activity Leader)

Signature

10 - August - 2009
Date

I certify that this Safety Planning Record accurately describes the scope of the Off-Campus Activity, identifies the foreseeable hazards, and documents the plans that have been put in place to manage the associated risks.
I affirm that I will ensure that, in accord with the Queen's University Off-Campus Activity Safety Policy, the participants are appropriately briefed and have received appropriate training prior to participating in the activity.

Allison Rutter
Name & Title (Principal Investigator/Activity Coordinator)

Allison Rutter
Signature

6 Aug 09.
Date

I certify that I have reviewed and approved the above Off-Campus Activity Safety Plan:

PETER HODSON, HEAD, ENVL STUDIES
Name & Title [Department/Unit Head (Person in Authority)]

Signature

12/08/09
Date

- Once completed, this Form is to be forwarded to the Department of Environmental Health and Safety, where it will be retained for a period established by the University's Records Management System.
- A copy is to be retained in the office of the Department/Unit Head (Person in Authority).
- In the case of an undergraduate student activity involving international travel, a copy is to be forwarded to the International Centre <u>at least</u> three weeks prior to the planned departure.