Quality Assurance / Quality Control Plan

for

Long Term Monitoring

of the

BAF-5, Resolution Island Remediation Project

Prepared For

Indian and Northern Affairs Canada

By

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Executive Summary

This Quality Assurance / Quality Control Plan applies to the continuing long-term post remediation monitoring of the BAF-5 military radar site located on Resolution Island, Nunavut. The Plan details the quality criteria used for Long-Term Monitoring (LTM) of the site, as well as sampling locations, sampling methodology, analytical parameters, test methods, detection limits, and other measures and procedures used to ensure high quality data are collected.

Sampling locations for long-term monitoring of the site have been established based on a variety of considerations including, establishment of baseline characteristics using pristine sites, the combined topographical and hydrological characteristics of the landscape, relative distance to sites of known or suspected contamination or containment infrastructure.

This Plan was developed in accordance with the *Quality Assurance (QA) and Quality Control (QC) Guidelines For Use by Class "B" Licensees in Collecting Representative Water Samples in the Field and for Submission of a QAQC Plan"* (INAC 1996). This Plan ensures conditions and quality measures are in place that conform to the standards and best laboratory practices outlined by ISO/IEC 17025. It also assures that all sampling, analytical methods and related procedures are conducted by trained staff according to the applicable recognized standards as described in the relevant reference documents including Module 7 of the U.S. Environmental Protection Agency Standard Operating Procedures, and the Soil Science Society of America's (SSSA) standard publication *Methods of Soil Analysis (1996 edition)*.

Introduction

Remediation operations at the abandoned military radar station, BAF-5, on Resolution Island, NU were carried out from 1993 through 2005. Monitoring of the site has occurred on a yearly basis from 2006 to the present. This quality assurance plan pertains to the continuing post remediation monitoring of Resolution Island (Long Term Monitoring or LTM) and it details the quality criteria used to assure thorough assessment of the site over time. Pertinent information is presented regarding sampling locations, sampling methodology, analytical parameters, test methods, detection limits, and the overall quality measures employed in handling and analysis of the collected samples.

Sampling Plan Quality Control

The objective of the Long Term Monitoring Program at Resolution Island is to ensure and verify the containment of various contaminants and the performance of remediation infrastructure. Field sampling plans must therefore address specifics of the site and incorporate what is known about the nature of the contaminants. To achieve the appropriate quality control several references have been consulted including the 2005 edition of *Standard Methods for the Examination of Water and Wastewater,* numerous USEPA documents as well as the Soil Science Society of America (SSSA) standard publication *Methods of Soil Analysis (1996 edition).* While there are no set international standards or definitive consensus on what constitutes best field sampling practices, these documents do provide a number of guidelines that are adhered to when and where applicable.

Sampling Locations

Sampling locations for continuous monitoring of the site have been established to coincide with the large scale remediation operations and associated infrastructure. Monitoring wells, for example were set up with the establishment of the landfill sites at the Airstrip and Maintenance dumps and the engineered Tier II landfill constructed on site. The locations for point sampling of surface waters, soil and plants have been determined with consideration to a number of factors: 1) establishment of baseline characteristics using pristine sites, 2) the combined topographical and hydrological characteristics of the landscape, 3) relative distance to sites of known or suspected contamination, 4) level of contamination, 5) changes in geomorphology and surface water due to weather 6) with respect to surface waters, variation in flow i.e. significant areas of pooling and sedimentation, or conversely entrainment, and variation with depth. Repeated sampling at the same locations gives the clearest picture of changes over time and is in accordance with *QA/QC Guidelines – Class B* (INAC 1996).

While most samplings sites have been established and constitute the primary step of the sampling plan it should be noted that some flexibility with regard to location is both advantageous and necessary. In some instances where sampling over a period of years has shown no changes in conditions, continued sampling would represent an inefficiency and financial waste. Alternatively new situations may arise, such as the breakdown of a barrier or erosion that would in turn create new sites of interest.

Figures 1-3 provide locations of the various point sampling sites associated with the Tier II Landfill, Airstrip Landfill and Maintenance Dump monitoring wells. GPS coordinates for each of these monitoring points are provided in Table 1. Figures 4-7 show sampling locations associated with the plant and barrier monitoring points. GPS coordinates of these points were not available at the time of printing, but will be collected during the 2010 field season and will be included in the 2010 Annual Report to the NWB for license 1BR-RES0916.

Sampling Methodology and Handling

Soil, water and plant samples are collected using methods, equipment and containers that insure no contamination, cross contamination or deterioration of the samples occur. A number of aspects regarding sample integrity are considered. First the sampling tool, be it a corer, scoop or another piece of equipment must be clean and free of contaminants for each sampling. Methods to ensure pristine samples will vary with the matrix and the analytes of interest. In surface water sampling for example, use of a new container repeatedly submerged to depth (3 times) with the final sampling directly into the container will normally ensure sample integrity, whereas when soil sampling, use of individually wrapped new scoops and minimal preliminary disturbance improve the probability of a representative sample.   Container materials must be evaluated for appropriateness according to analytes of interest. For example soil samples being analyzed for TPH are collected in glass jars with Teflon lined lids whereas water samples being analyzed for arctic suite metals may be collected in plastic bottles.

Where analytes can deteriorate over time, preservatives may be added to samples, and or/ storage conditions such as refrigeration would specified, along with holding times. Handling, storage conditions and container types for the various analytes and matrices are detailed in Table 2.

Along with the integrity of samples, sufficient quality control measures must be in place to adequately assess the particular site of interest. Control measures include use of field blanks and duplicates. In general a set of field duplicates for every 10 samples, and a field blank would be generated for a given analysis at a particular site

Sample Tracking and Subsequent Handling

Samples are all uniquely identified and labeled at the time of sampling – in most cases containers are pre-labeled before going into the field according to the sampling plan. Unique identifiers must be cross referenced with (or labels themselves must indicate) the intended analysis, the date of sampling, sample location, the technician doing the sampling, and any pertinent conditions that may affect the sample collection such as damage at the site, erosion etc.

In order to conform to required holding time limits and conditions of storage, a rigorous sample chain of custody is maintained and is recorded on Chain of Custody forms. Special conditions for subsequent handling of the samples (e.g. refrigeration) are marked on the containers (usually coolers) holding the set of samples.

Samples are shipped by air freight for testing. The completed Chain of Custody forms are checked for each sample before shipment from the North, and the contents of shipments are verified upon receipt in the laboratory.

Chemical Analysis Quality Control

Samples are analyzed at Analytical Services Unit, (ASU at Queen's University), a CALA (formerly CAEAL) accredited laboratory. When necessary analyses may be subcontracted (through ASU) to the CALA accredited laboratory at RMC, Analytical Services Group. Methods used for analysis of samples are included in the accreditation scopes of either ASU or ASG. The scopes for both labs may be accessed and viewed on the CALA website at:

http://www.cala.ca/

Samples are stored, processed and analyzed according to the accredited documented methods and reports are generated according to the quality system requirements. Both the methods and the overall quality systems employed by the laboratories have undergone review through the CALA assessment process. This process ensures conditions and quality measures are in place that conform to the standards and best laboratory practices outlined by ISO/IEC 17025. Accreditation requirements including proficiency testing participation are outlined on the CALA website and a copy of the ASU Quality Manual is available upon request.

For a list of various methods, method references, and detection limits please refer to Table 3. Short summaries of the methods are included in this table.   For more extensive summaries consult previous reports of the Resolution Island: Monitoring and Research project published by Analytical Services Unit and Indian and Northern Affairs Canada.

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Figures

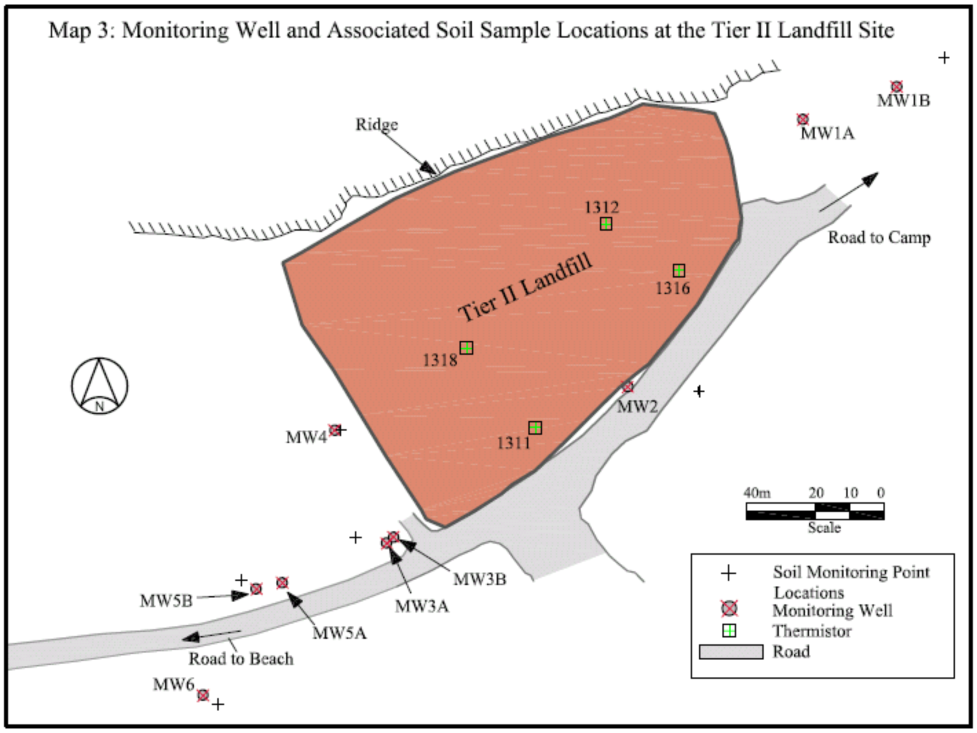

Figure 1 Tier II Landfill Soil and Water Monitoring Point Locations

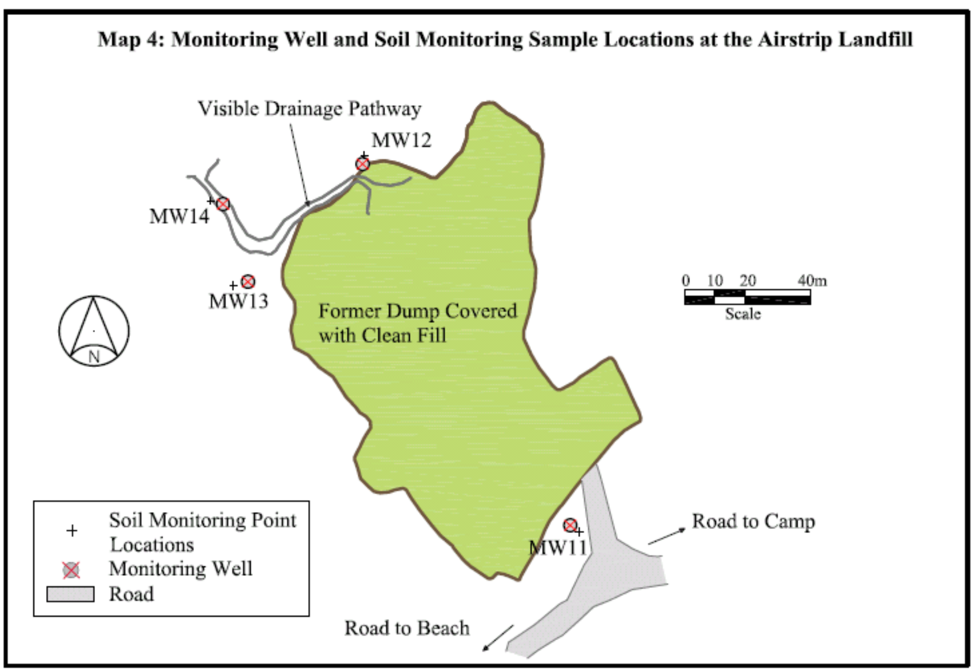

Figure 2 Airstrip Landfill Soil and Water Monitoring Point Locations

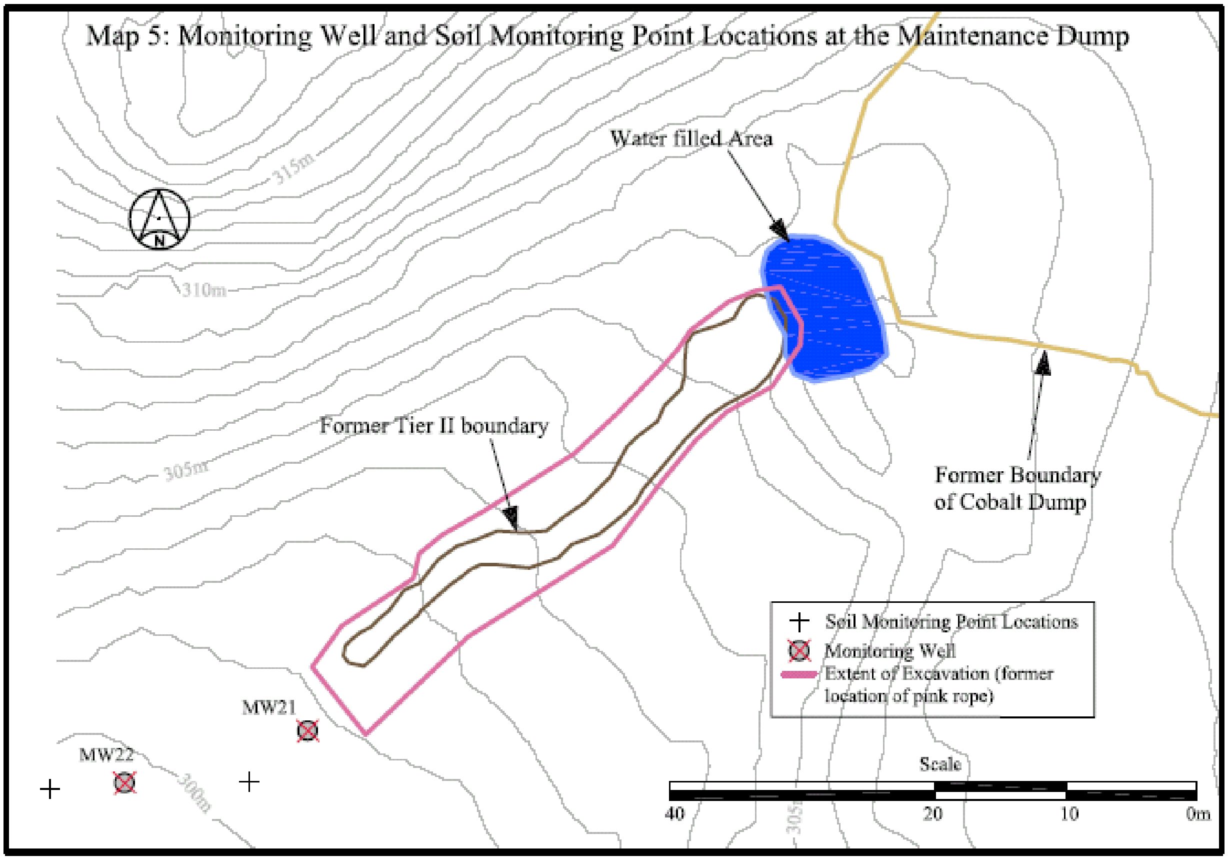

Figure 3 Maintenance Dump Monitoring Point Locations

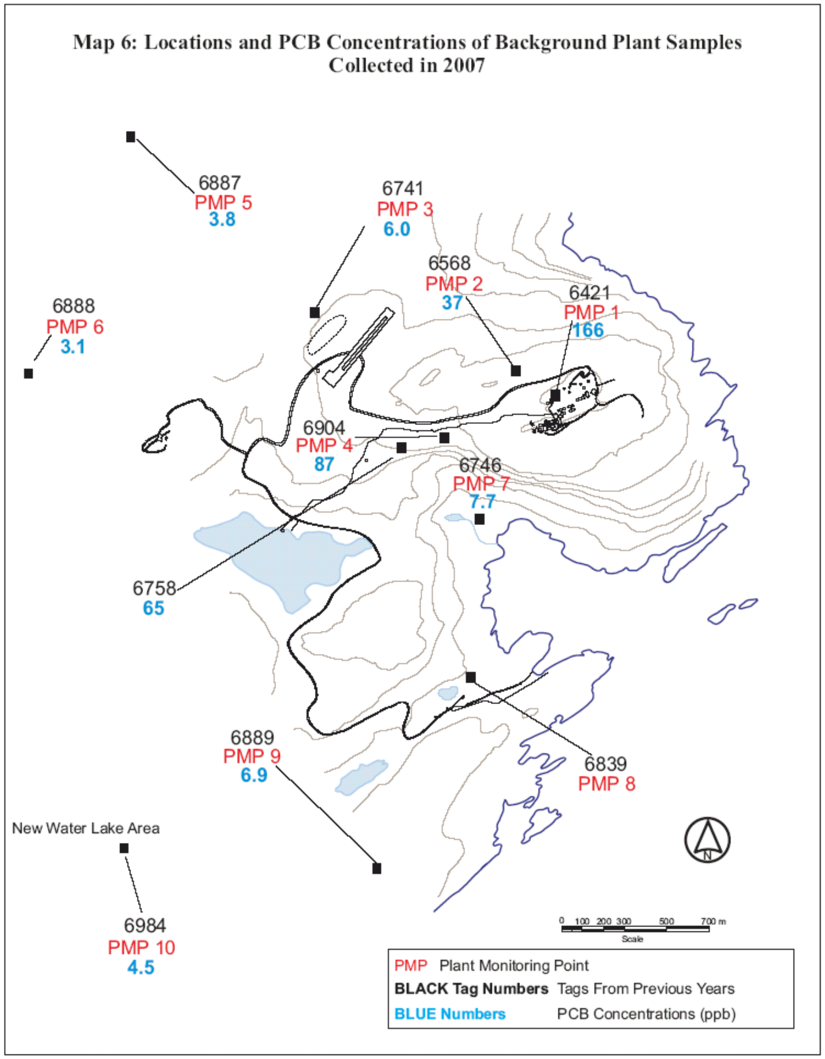

Figure 4 Background Plant Sampling Point Locations

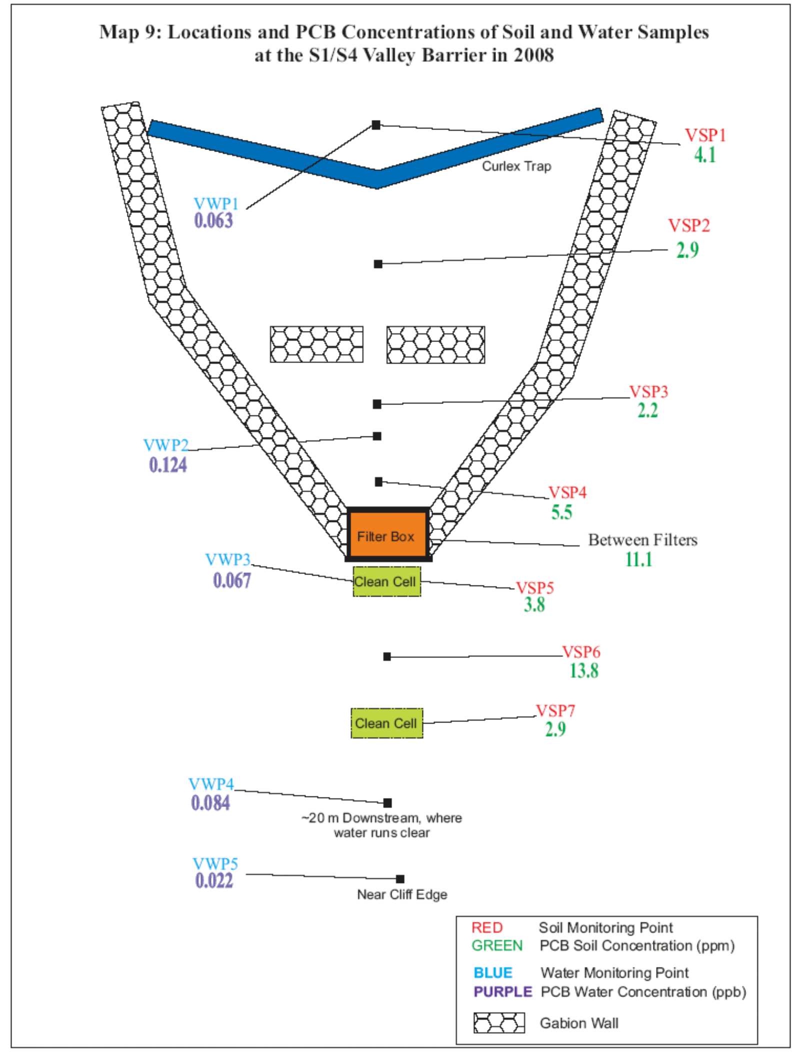

Figure 5 S1/S4 Valley Barrier Sampling Point Locations

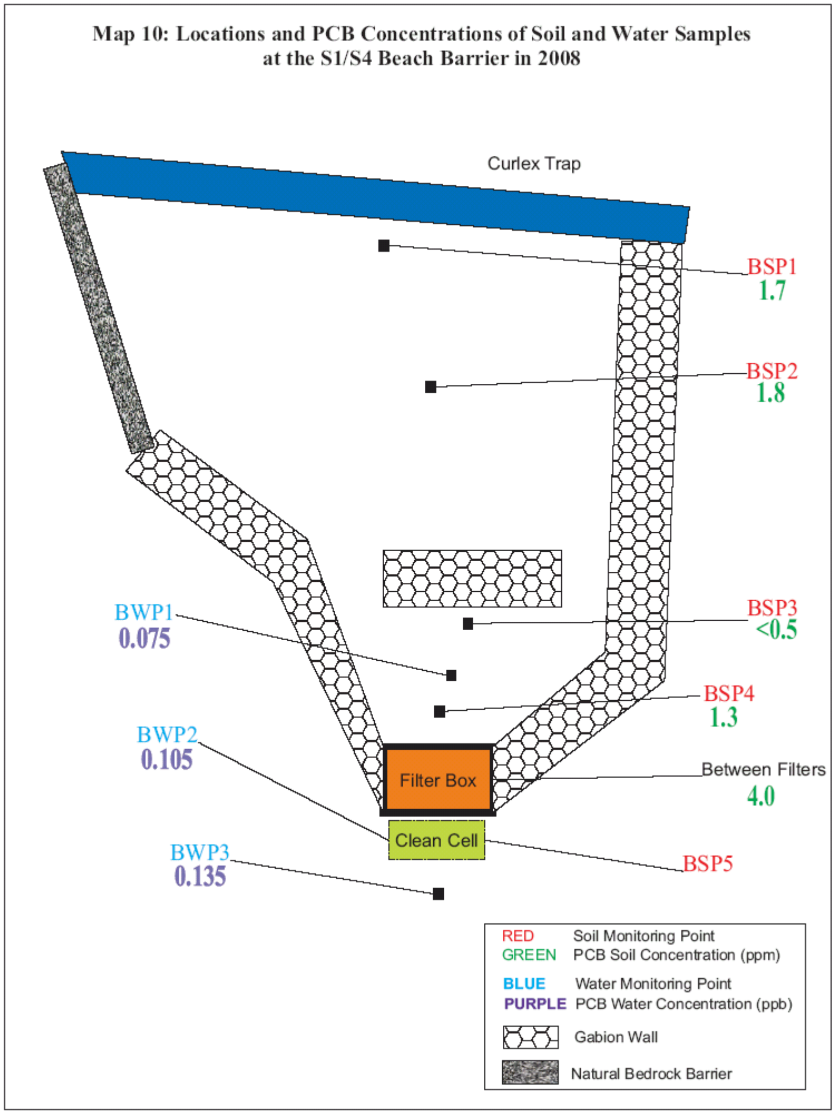

Figure 6 S1/S4 Beach Barrier Sampling Points

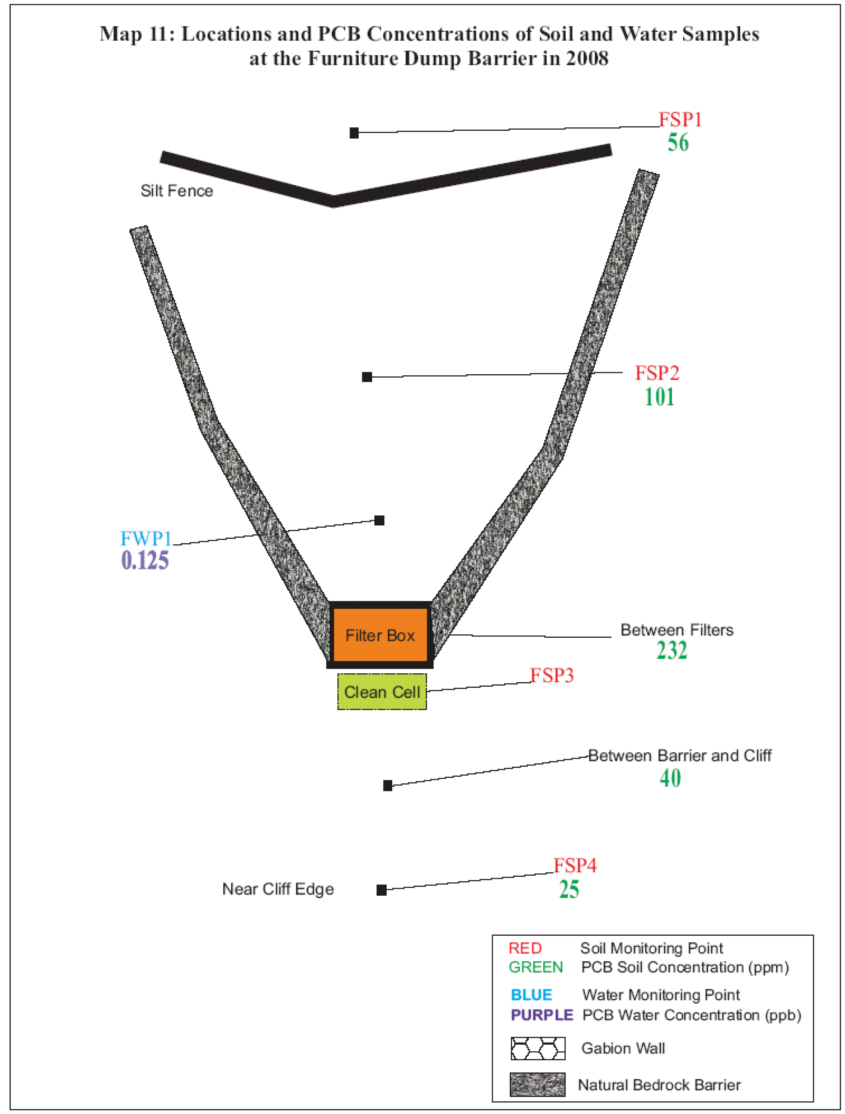

Figure 7 Furniture Dump Drainage Pathway Barrier Sampling Points

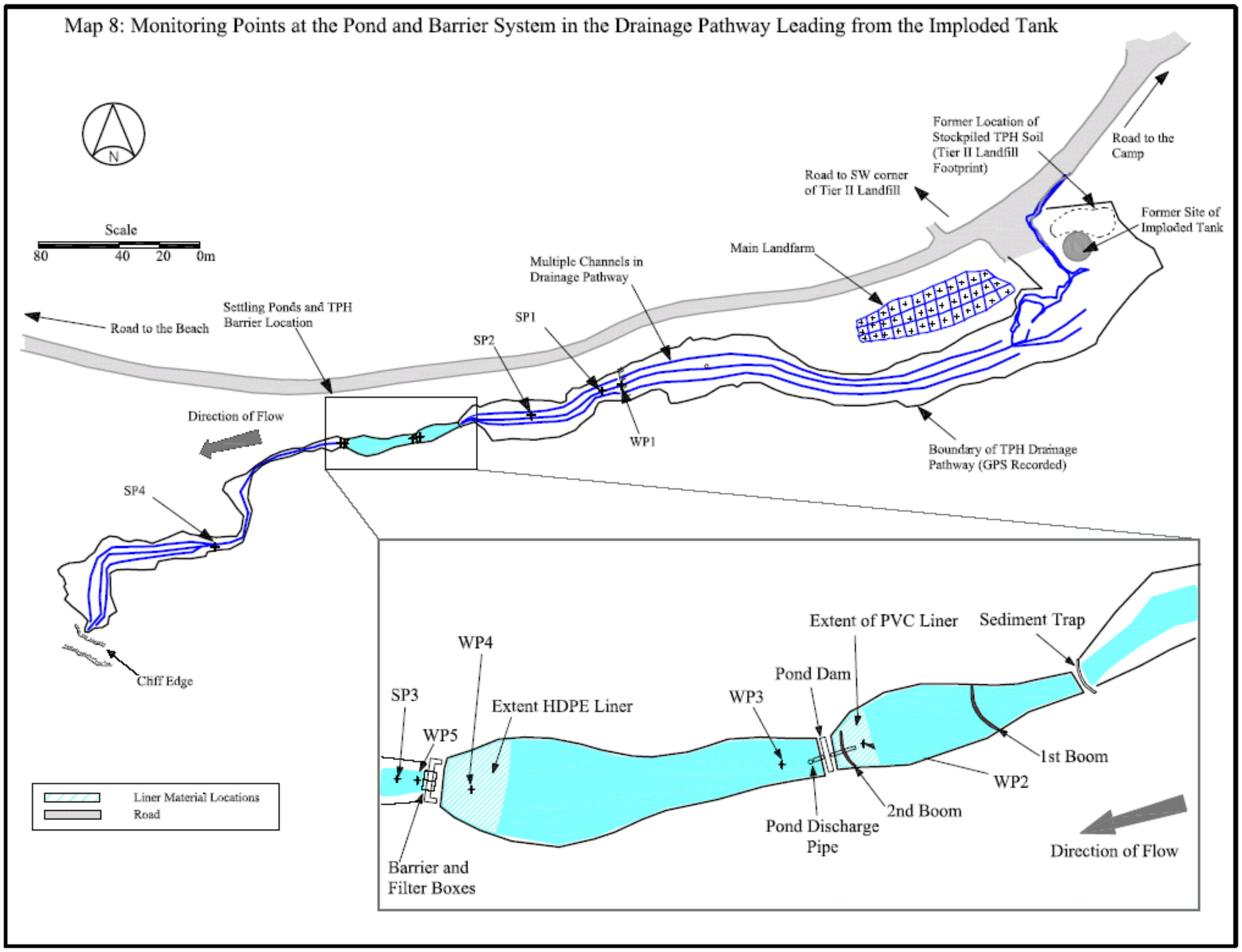

Figure 8. TPH Drainage Pathway Sampling Point Locations

Tables

Table 1 GPS Coordinates of Soil and Water Monitoring Points at Resolution Island Landfills

Source Description	Latitude			Longitude		
	° Deg	′ Min	″ Sec	° Deg	′ Min	″ Sec
Monitoring Well (MW) 1A	61	35	48.11	64	38	39.75
MW 1B	61	35	48.37	64	38	36.92
MW 2	61	35	45.66	64	38	42.96
MW 3A	61	35	43.93	64	38	48.18
MW 3B	61	35	44.01	64	38	48.06
MW 4	61	35	44.71	64	38	48.91
MW 5A	61	35	43.47	64	38	50.54
MW 5B	61	35	43.43	64	38	50.75
MW 6	61	35	42.65	64	38	53.88
MW 11	61	35	51.36	64	39	40.99
MW 12	61	35	54.67	64	39	45.85
MW 13	61	35	53.55	64	39	48.01
MW 14	61	35	54.5	64	39	48.27
MW 21	61	35	43.15	64	38	58.8
MW 22	61	35	43.1	64	38	59.06

Table 2 Various Matrices, Container Compatibility, Sampling, and Handling Conditions

Test	Matrix	Sampling Equipment	Container type	Shipping conditions	Storage conditions	Maximum holding time
PCB	Water	Directly into container, use of foot valve and Waterra tubing for wells	Teflon bottles	Refrigerated	Refrigerated	30 days
	Soil	New plastic scoops	Whirlpak and amber glass jars with Teflon lined lids for low levels	Refrigerated	Refrigerated	30 days
	Vegetation	Manual and shears	Whirlpak or Ziplock bag	Frozen	Frozen	30 days
Metals	Water	Directly into container, use of foot valve and Waterra tubing for wells	Plastic bottles	Refrigerated	Refrigerated	6 months
	Soil	New plastic scoops	Whirlpak	Refrigerated	Refrigerated	1 year
TPH	Water	Directly into container, use of foot valve and Waterra tubing for wells	Glass bottles	Refrigerated	Refrigerated	30 days
	Soil	New plastic scoops	Amber glass bottles with Teflon lined lids	Refrigerated	Refrigerated or Frozen	4 wks refrigerated 6 mo frozen
Nutrients	Soil	New plastic scoops	Whirlpak	Refrigerated	Frozen	6 months
Conductivity/pH	Water	No sampling – direct measurement with probes				

Table 3 Analytical Tests and Matrices, Method References, Descriptions, and Detection Limits

Test	Matrix	Description	Reference	Detection limit
PCB	Water	Solvent extraction; analysis by GC-ECD	USEPA Method 8082A-1 Polychlorinated Biphenyls (PCB's) by Gas Chromatography. USEPA, Washington D.C.	20 ppt
	Soil	Solvent extraction; analysis by GC-ECD	*Ibid.*	2 ppb
	Vegetation	Solvent extraction; analysis by GC-ECD	*Ibid.*	0.4 ppb
Metals	Water	Arctic Suite of metals tested (As, Co, Cd, Cr, Cu, Ni, Pb, Zn); acid digestion, neat, or filtered with stabilization: analysis by ICP-AES	USEPA Method 200.15: Determination of Metals and Trace Elements in Water by Ultrasonic Nebulization Inductively Coupled Plasma-Atomic Emission Spectroscopy, USEPA, Washington D.C.	As, Co – 0.003 ppm Cd – 0.001 ppm Cr, Cu, Ni – 0.005 ppm Pb, Zn – 0.010 ppm
	Soil	Arctic Suite of metals tested (As, Co, Cd, Cr, Ni, Pb, Zn); acid digestion with analysis by ICP-AES	USEPA Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectroscopy, USEPA, Washington D.C.	As – 50 ppm Co, Cu, Ni – 5 ppm Cd – 1 ppm Cr – 20 ppm Pb – 10 ppm Zn – 15 ppm
TPH	Water	Solvent extraction; analysis by GC-FID	USEPA Method 8015B: Non-halogenated Organics Using GC/FID. USEPA, Washington D.C.	1 ppm
	Soil	Solvent extraction; analysis by GC-FID	*Ibid.*	20 ppm
Nutrients Total P, Total N, extractable P and N	Soil	Kjeldhal (acid digest) for totals. KCl extractions. Analyzed using colorimetric methods with Autoanalyzer.	Methods of Soil Analysis Pt. 3. Chemical Methods, (1996 edition). Soil Science Society of America (SSSA) and American Agronomy Society (ASA), Madison, WI	Total N, Total P, Extractable P – 5 ppm NO_2-N – 1 ppm NO_3-N (+NO_2-N), NH_3-N – 2ppm
Conductivity and pH	Monitoring wells	In situ measurements using portable pre-calibrated meters		NA; Measured to 1 decimal place