QUALITY ASSURANCE (QA)
AND QUALITY CONTROL (QC) PLAN
FOR THE LANDFILL MONITORING PROGRAM
AT THE
DYE-M (CAPE DYER)
DEW LINE SITE

Revised September 2005

Prepared by:
ENVIRONMENTAL SCIENCES GROUP
for
DEFENCE CONSTRUCTION CANADA
&
UMA ENGINEERING LTD.

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APPENDIX A: PROOF OF LABORATORY ACCREDITATION

1. Introduction

A landfill monitoring plan was developed by the Department of National Defence (DND) in cooperation with Nunavut Tunngavik Incorporated (NTI) to address post-closure monitoring requirements for landfills at the DEW Line sites. This monitoring requirement was outlined in the Environmental Provisions of the DND/NTI Cooperation Agreement.

The objective of the landfill monitoring program is to collect sufficient information to assess the performance of the landfills from both an environmental and geotechnical perspective and consists of four main components:

1) visual monitoring;
2) soil monitoring;
3) active layer water monitoring; and
4) thermal monitoring.

Only the soil and active layer water monitoring programs are included in this QA/QC plan.

The soil and active layer water monitoring program is composed of background and baseline assessment as well as contaminant evaluation. The methodology used for the sampling and analysis of landfill monitoring program samples remains the same regardless of whether the samples are background samples, baseline samples or samples used for contaminant evaluation.

2. Sample Collection

2.1. Location

Sample locations were marked with a disk stamped with the sample number and a piece of flagging tape, attached with a 150-mm nail. Each sample location was assigned a distinct sample number. These sample numbers were recorded on a map as well as in a field notebook along with a description of the associated sample location. GPS coordinates of sample locations are collected and recorded. Photographs of the sample location are also taken.

2.2. Sampling Equipment

The following table summarizes the equipment and storage requirements for each soil sample type collected. New bottles were used in all cases for the collection of the soil samples.

Contaminant	**Container**	**Amount**	**Storage**
Polychlorinated Biphenyls (PCBs)	Amber glass jar with Teflon-lined lid	30 g	Cool or ambient temperature
Total Petroleum Hydrocarbons (TPH) as F1, F2 & F3	Amber glass jar with Teflon-lined lid – no headspace	30 g	< 4 ^{0}C
Inorganic Elements (See note 1)	Whirlpak	50 g	Cool or ambient temperature

1- arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc

The following table summarizes the equipment and storage requirements for each water sample type collected. New bottles were used in all cases for the collection of these samples.

Contaminant	**Container**	**Amount**	**Rinse**	**Storage**	**Special Treatment**
pH	1L Plastic Bottle	Full	No	Cool	Do not filter
Inorganic Elements (See note 1)	1L Plastic Bottle	Full	No	Cool	Do not filter
Polychlorinated Biphenyls (PCBs)	1L Amber glass *or Teflon*, with Teflon-lined lid	Full	Glass – no Teflon - yes	Cool	Do not filter
Total Petroleum Hydrocarbons (TPH)	Amber glass *or Teflon* with Teflon-lined lid	Full – no headspace	Glass – no Teflon - yes	Cool	Do not filter

1-total arsenic, total cadmium, total chromium, total cobalt, total copper, total lead, total mercury, total nickel, total zinc

2.3. Sampling Methods

2.3.1. Soil Sampling

Soil samples were collected in duplicate at predetermined upgradient and downgradient locations of the landfills created during the construction phase of the cleanup. Every sample location was marked with an implanted 150-mm stainless steel nail, to which was attached a plastic disk stamped with the sample number and a long strip of brightly coloured flagging tape (i.e. a "sample tag").

The soil samples were collected using one of two methods. Samples were obtained using a plastic scoop and stored in both Whirl Pak^{TM} bags and 125-mL amber glass jars fitted with Teflon-lined lids certified to be free of organic materials. All soil samples were kept at ambient temperature. Each sample was given a blind number that was the only number provided on the labels of samples submitted for analysis. This number matched that stamped on the sample tag left at the sample location. Sample locations and descriptions were recorded independently by at least two team members, in note pads and/or on field maps, and a photographic record was made of each general area that was to be delineated.

Soil was sampled from the upper 10 cm and was collected so as to obtain representative material. Shallow depth samples to 30 cm were also collected at each sample location. All samples were shipped by guaranteed air-freight to the Environmental Sciences Group (ESG) at the Royal Military College (RMC). Soil samples destined for total petroleum hydrocarbon (TPH) analysis in the south were kept below 4 ^{0}C where possible and samples to be analyzed for inorganic elements (As, Cd, Cr, Co, Cu, Pb, Zn, Hg) or PCBs were kept either cool or at ambient temperature prior to and during shipping. One sample from each duplicate pair was analyzed by the Analytical Services Unit (ASU) at Queen's University or by the Analytical Services Group (ASG) at RMC. An additional 10% of these analyses were repeated for quality control purposes.

2.3.2. Active Layer Water Sampling

Monitoring wells were installed around landfills during the cleanup of the site according to the cleanup's contract drawings and specifications to determine whether contaminants were migrating from the facility. The wells consisted of 5-cm diameter stainless steel pipe with 100-cm long screen surrounded by a filter sock. The wells were installed with the use of a drill rig. The hole was backfilled with grout at the base and filter sand around the screen, then capped with a bentonite seal. The wells were typically protected from damage by wildlife and the elements with a lockable external metal casing.

Monitoring wells were sampled so as to avoid alteration of groundwater chemistry through contact with drilling fluid, cross-contamination between wells, or by exposure to the atmosphere. Wells that had been installed in the current season were sampled after as much time as possible had elapsed following installation, to allow the groundwater to reach physical and chemical equilibrium. Each well was purged before it was sampled. Purge water was monitored for pH, temperature, and conductivity, using an Extech Oyster Model 34145A or equivalent, with the appropriate probes immersed directly into a flow-through cell. The pH probe was calibrated using the accompanying buffer solutions of pH 4 and pH 7. When conductivity calibration standards were available, the conductivity probe was also calibrated.

Sampling commenced once those parameters had stabilized. The sampling bottles were labeled with a unique sample number. Purging and sampling were done using a low flow rate to minimize turbulence in the well and aeration of the water sample. The pump and tubing were rinsed with groundwater from the sampling location before the sample was taken. For TPH analysis, water samples were collected in 250-mL amber glass bottles which were not pre-rinsed, and were completely filled to avoid any gas pockets in the sample. Teflon bottles were used for organic, non-TPH analysis, and were pre-rinsed with the sample water. For inorganic analysis, water samples were collected the same way, but in 1-L polyethylene bottles.

Ideally, samples collected for inorganic analyses should be acidified in the field, at the time of collection. However, regulations concerning the transportation of dangerous goods make supplying concentrated nitric acid in the field difficult. Where samples cannot be acidified in the field, it will be requested that the samples are acidified immediately upon receipt in the lab, *prior* to decanting or sample extraction. When acidifying in the lab, the container will be rinsed with 35% HNO_3 and included with the sample.

Samples are not to be filtered at any time. If samples contain excessive sediment, the samples will simply be decanted in the southern laboratory (*following* acidification, for metal analyses) prior to analysis.

The water samples will be kept cool (approximately 4^0 C) prior to and during shipping. In general, water samples will be collected when transportation from the site will be available almost immediately after, as many types of the required analyses should be performed as quickly as possible after collection.

2.4. Shipment of Samples

Samples are to be shipped by guaranteed airfreight in coolers from the site to their respective accredited laboratory for analysis. Chain-of-custody forms will be filled out and checked for each sample before shipment from the North, and the contents of shipments will be verified upon receipt in the laboratory.

3. Lab Analysis

3.1. Lab Accreditation

All laboratory analysis is carried out at accredited labs. The following laboratories are the ones primarily responsible for the analysis of water samples collected at DYE-M (Cape Dyer):

1) Analytical Services Unit, Queen’s University, Kingston ON; and
2) Analytical Sciences Group, Royal Military College of Canada, Kingston ON.

Proof of accreditation from these laboratories is located in Appendix A. The standard methods used by the laboratories for each of these analyses are listed in the laboratory’s scope of accreditation.

3.2. Detection Limits

The following table provides a summary of the detection limits for the analysis to be performed on water samples collected at DYE-M (Cape Dyer).

Parameter	**Detection Limit**
Soil	
Polychlorinated Biphenyls (PCBs)	3.0 ng/g
Total Petroleum Hydrocarbons (TPH) as F1, F2 & F3	40 µg/g
Inorganic Elements (See note 1)	Cu = 5.0 µg/g; Ni = 5.0 µg/g; Co = 5.0 µg/g; Cd = 1.0 µg/g; Pb = 10 µg/g, Zn = 15 µg/g; Cr = 20 µg/g; As = 1.0 µg/g; Hg = 0.1 µg/g

Parameter	Detection Limit
Water	
pH	-
Inorganic Elements (See note 2)	µg/L levels
Polychlorinated Biphenyls (PCBs)	0.020 µg/L
Total Petroleum Hydrocarbons (TPH)	1 mg/L

1- arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, zinc
2 -total arsenic, total cadmium, total chromium, total cobalt, total copper, total lead, total mercury, total nickel, total zinc

3.3. Methodology

The following is a summary of the methods to be used in the analysis of the water samples collected from DYE-M (Cape Dyer).

3.3.1. Digestion of Various Matrices for Inorganic Elements

Analyses were conducted by the Analytical Services Unit, Queen's University, Kingston, Ontario. Each sample was clearly labeled and stored in a secured area (before and after analysis) at a temperature appropriate for the analytical method.

3.3.1.1. 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 contaminants. Approximately 0.5 g of powdered sample was heated with 2 mL of nitric acid and 6 mL of hydrochloric acid overnight so that the volume was reduced to 1-2 mL. This solution was then made up to 25 mL with distilled deionized water. Although not all metals may be brought into solution by this procedure (some may be locked into silicate minerals), metals that are released are considered to be of greater environmental significance than are true total metals.

3.3.1.2. Water

For total metals, the sample was vigorously shaken. A 400-mL aliquot of sample was used, acidified with nitric acid, and concentrated by boiling to dryness. The sample was acidified, refluxed, transferred to a volumetric flask, and made up to 25 mL. The sample was then filtered and analyzed for the requested elements.

3.3.2. Inorganic Elements by Inductively Coupled Plasma Atomic Emission Spectroscopy

Analyses were conducted by the Analytical Services Unit, Queen's University, Kingston, Ontario. Each sample was clearly labeled and stored in a secured area (before and after analysis) at a temperature appropriate for the analytical method.

Concentrations of the following eight elements were measured: arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn). Samples were analyzed in batches of up to 36, which comprised up to 28 samples, 2 blanks, 4 duplicates and 2 samples of reference material (NRC MESS-3 or SS-2).

3.3.3. Mercury in Soil and Water

Analyses were conducted by the Analytical Services Group, Royal Military College, Kingston, Ontario. Each sample was clearly labeled and kept at a low temperature before and after analysis.

The samples were treated in one of two ways:

(i) Water samples reported as total mercury were similarly preserved. A 5-mL aliquot was digested with 5 mL of a 1:4 concentrated nitric acid: concentrated sulphuric acid mixture. Digestion conditions were 195 °C for 6 hours. The final digest was made up to a volume of 10 mL with distilled deionized water. A set of standards, duplicate samples, triplicate blanks, and a reference control solution were digested with each total mercury run.

(ii) Mercury in soil samples was similarly digested (0.25 g dry soil, 195 °C for 6 hours, 5 mL of 1:4 concentrated nitric acid: concentrated sulphuric acid). After the digestion, the samples were made up to 25 mL with distilled deionized water. A set of standards, a duplicate, a blank, and a soil reference were digested with each soil run.

The samples were analyzed using cold vapour generated mercury hydride atomic absorption spectrophotometry. Water samples and digests were analyzed using a Perkin-Elmer FIMS-100 Mercury System equipped with a 253.7 ηm source mercury lamp, quartz cell, Perkin-Elmer AS-90 autosampler, and the Perkin Elmer AA WinLab Analyst software. The carrier solution was 3% HCl and the reducing agent was 1.1% tin chloride ($SnCl_2$) in 3% HCl. Ultrahigh-purity argon was used as the carrier gas, with the flow rate set between 40 and 70 mL/min. Three 500-μL replicates for each sample were analyzed. A signal was generated in the quartz cell by measuring the amount of light (wavelength 253.7 ηm) absorbed. The mercury concentrations in the samples were determined by comparing sample absorbance responses to a calibration curve generated from standards of known concentration. Duplicates, blanks, and control samples were included in each run. Soil and dissolved mercury data are not background corrected. Total mercury data are corrected for mean background absorbance. The sample results were reported to detection limits of 0.1 μg/g (ppm) for mercury in soil and 0.0004 mg/L (ppm) for total mercury in water.

3.3.4. pH Measurement

Measurements on water and soil samples were conducted by the Analytical Services Group, Royal Military College, Kingston, Ontario.

Water samples were measured directly using a 50-mL sample; the pH of soil was determined by mixing 10 g of soil with 10 mL of distilled water, allowing the mixture to settle, and measuring the pH of the supernatant. The pH was measured with a Denver Instruments model 220/300729.1 pH meter and probe, relative to buffered reference standards and control.

3.3.5. Polychlorinated Biphenyls in Soil

Analyses were conducted by the Analytical Services Group, Royal Military College, Kingston, Ontario. Each sample was clearly labeled and stored at low temperatures in a secured area before and after analysis.

All samples were thoroughly homogenized before they were sampled for the analysis. Soil samples were subsampled for determination of wet/dry weight ratio. Accurately weighed samples of wet soil (10 g) to which the surrogate standard DCBP, sodium sulphate (40 g) and Ottawa sand (20 g) were added, were extracted three times for 20 minutes with 50 mL of dichloromethane on an orbital shaker. Accurately weighed samples of soil that could not be extracted by shaker were added, and were extracted by Soxhlet for 4 hours at 4 - 6 cycles per hour with 250 mL of dichloromethane. In both cases, the extract was then concentrated by rotoevaporation to approximately 1 mL, and 5 mL of hexane were added and again evaporated to 1 mL. This was repeated twice more, resulting in 1 mL of hexane solvent, which was then applied to a Cu-Florisil (Diagnostix) column for cleanup. The column was thoroughly rinsed with hexane and the eluate containing the PCBs diluted to 10.0 mL. A 2-mL GC vial was filled in preparation for analysis.

An alternative extraction method used for solid samples was pressurized solvent extraction (PSE). Extractions were performed according to ASG Procedure 02-38 'Extraction by PSE.' An Applied Separations PSE system capable of six simultaneous extractions was used in conjunction with 33-mL stainless steel extraction vessels, frits, and filters. Each vessel was filled to a depth of approximately 1 cm with Cu-Florisil (Diagnostix) cleanup reagent, to which a mixture of 5-10 g of sodium sulphate, 10 g soil, and appropriate surrogate spikes was added. The remaining void was filled with Ottawa sand and glass wool. Six extraction vessels containing samples, blanks, or controls were placed in the automated PSE system. Extraction proceeded according to the following parameters: solvent hexane, static temperature 100 ^{o}C, static time 5 minutes, 1 extraction cycle. The extracts were flushed to 45-mL collection vessels using a 3-minute solvent flush and 2-minute nitrogen gas flush.

The samples were analyzed by gas chromatography (GC) with electron capture detection (ECD), using an HP/Agilent 6890 Plus Gas Chromatograph equipped with a ^{63}Ni Electron Capture Detector (GC/ECD), a SGE HT-8 fused silica capillary column (10 m, 0.1 mm i.d. x 0.1 µm film thickness) and HP ChemStation software. The conditions were as follows: Sample volume 0.5 µL, splitless injection, temperature programmed ramp and constant helium carrier gas pressure. Nitrogen was used as a makeup gas for the ECD. All values were reported as µg/g dry weight (ppm).

Samples requiring ultra-low detection limit analysis were similarly treated, using Soxhlet or PSE extraction techniques. In each case, the samples were concentrated to a known volume of approximately. 0.5 mL. A 0.5-µL injection volume was used for GC analysis. All values were reported as ng/g dry weight (ppb).

3.3.6. Polychlorinated Biphenyls in Water

Analyses were conducted by the Analytical Services Group, Royal Military College, Kingston, Ontario. Each sample was clearly labeled and stored at low temperatures in a secured area before and after analysis.

A 500-mL sample was placed in a 1-L separatory funnel and spiked with decachlorobiphenyl (DCBP), an internal standard. Dichloromethane (25 mL) was added to the separatory funnel, which was then shaken with frequent venting. The bottom layer was decanted through a funnel containing anhydrous sodium sulphate and into a round-bottom flask. This extraction step was repeated twice more, giving a collected volume of 75 mL in the round-bottom flask. The solvent in the flask was then exchanged for hexane by rotary evaporation of the original 75 mL down to 1 mL, and 5 mL of hexane were added and again evaporated to 1 mL. The addition of 5 mL of hexane was repeated twice more to give a final volume of 1 mL after the last rotary evaporation. The 1-mL volume remaining in the flask was pipetted onto a Cu-Florisil (Diagonstix) solid phase extraction tube (Supelco) and eluted with hexane. The column was thoroughly rinsed with hexane and the eluate containing the PCBs was diluted to 10 mL. A GC vial (2 mL) was then filled in preparation for analysis.

All samples were analyzed by gas chromatography (GC) with electron capture detection (ECD), using an HP/Agilent 6890 Plus Gas Chromatograph equipped with a ^{63}Ni Electron Capture Detector (GC/ECD), an SGE HT-8 column (10 m, 0.1 mm i.d. x 0.1 µm film thickness) and HP ChemStation software. The conditions were as follows: Sample volume 0.5 µL, splitless injection, temperature programmed ramp, and constant helium carrier gas pressure. Nitrogen was used as a makeup gas for the ECD. All values were reported as µg/g dry weight (ppm). Analyses requiring ultra-low detection limits were similarly treated, but were extracted from 800 mL water and concentrated to a known volume of approximately 0.5 mL after Cu-Florisil (Diagnostix) elution.

3.3.7. CCME Method of Petroleum Hydrocarbons in Soil and Water

Analyses were conducted by the Analytical Services Group, Royal Military College, Kingston, Ontario. Each sample was stored in an appropriate, clearly labelled container and kept at low temperatures in a secured area before and after analysis. Soil analysis was performed as prescribed in the CCME Reference Method for Canada Wide Standard for Petroleum Hydrocarbons in Soil, 2001.

(a) Soil Fraction F1

Accurately weighted samples of wet soil (5 g) were extracted on a shaker for 1 hour with 10 mL of methanol. The methanol layer was then transferred into a vial and refrigerated until analysis. A 50-µL aliquot of the extract, made up to 5 mL with water, was directly syringed into a Tekmar autosampler/purge-and-trap apparatus. The sample was purged with high purity helium gas for 11 minutes. The trapped components were desorbed from the trap in the unit by heating to 225 °C and holding for 4 minutes. A Hewlett Packard 6890 GC-FID system was used for analysis in conjunction with an SPB-1 fused silica capillary column (30 m, 0.25 mm i.d. x 0.25 µm film thickness). The retention time was marked using nC6 and nC10 hydrocarbons, and calibration was performed with toluene. Blanks, control samples and duplicates were run at a frequency of approximately 20%. A wet/dry ratio for the sample was determined using a sub-sample. The final result was calculated using the dry weight of the sample (µg/g). When analyses for benzene, toluene, ethylbenzene and xylenes (BTEX) were requested, the BTEX results were subtracted from the F1 fraction results.

(b) Soil Fraction F2 to F4

Soil samples were homogenized and subsamples dried for moisture determination. Accurately weighed samples of wet soil (10 g) were extracted by Soxhlet for 6 hours at 4-6 cycles per hour with 250 mL of hexane/acetone (1:1). The extract was filtered through sodium sulphate and 3 mL of toluene were added. The extract was then concentrated by rotoevaporation. A column of 15 mm diameter containing 5.0 g activated silica below 1 cm of sodium sulphate was prepared and eluted with 10 mL 50:50 dichloromethane: hexane. The concentrated extracted was added to the head of the column and eluted with 20 mL 50:50 dichloromethane:hexane. Toluene (1 mL) was added and the collected eluent was concentrated to approximately 1 mL using rotary evaporation.

Analysis was performed by GC-FID using an Agilent 6890 instrument fitted with a cool on-column injection system. A DB-1 capillary column (15 m, 0.53 mm diameter, 0.15µm film) was used to achieve separation. Blanks, control samples, and duplicates were run at a frequency of approximately 20%. Calibrations were performed and the retention time was marked using nC10, nC16, and nC34 hydrocarbons. NC50 was analyzed as the performance standard, with a required response of less than 70% of that obtained using nC10, nC16, and nC34 response factors. The final result was reported as mg/kg for each fraction. In any samples that underwent analysis for polycyclic aromatic hydrocarbons (PAH), naphthalene was subtracted from fraction F2, and the other 15 priority pollutant PAHs were subtracted from fraction F3.

(c) Water Fraction F1

For water samples, 5 mL of sample were directly syringed into the water purge-and-trap apparatus. Chromatography and calibration were as described for soil samples.

(d) Water Fraction F2-F4

A 200-mL portion of the water sample was accurately measured and transferred to a clean 125-mL glass separatory funnel. Hexane (5 mL) was added and the mixture was shaken vigorously and allowed to separate. If emulsions formed, the funnel was briefly sonicated to ensure adequate phase separation. Some of the hexane phase was then transferred to a GC vial and the extract analyzed by GC under the same conditions as for soil samples, and using the same calibration and retention time markers. The final result was reported as mg/L for each fraction..

3.4. Reporting Requirements

The following types of QA/QC samples will also be collected as part of the landfill monitoring sampling program. Note that if more than one type of bottle is used for a sample, QA/QC samples will be submitted in each type of bottle used for the collection of the samples.

Field duplicates*:* Approximately 10% of the samples were collected as field duplicates. That is, two samples were collected from one sample location. These samples were handled in the same way and submitted blindly to the laboratories for analysis.

Field blanks: Field blanks consisted of distilled water and were collected to ensure that there is no corruption of samples from the sampling method. The distilled water was poured from its container into the sample container at the same time and using the same techniques as used to collect the regular water samples.

Travel blanks: The purpose of travel blanks is to ensure that there is no corruption of the sample or sample container during travel. Ideally, a full set of travel blanks should accompany each shipment of water samples. However, in cases where very few samples are shipped at a time, this guideline can be extended to a more reasonable number. Travel blanks were filled at ESG prior to leaving for the field. They were shipped with the sample bottles, stored with the sample bottles on site, brought out to the sampling location in the field, returned to the lab, and shipped to the labs with the water samples. They should not be opened unless the other bottles or water samples are opened for some reason during shipping.

Appendix A: Proof of Laboratory Accreditation

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CAEAL Directory of Laboratories

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Member: ☐

Password: ☐

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Membership Number: 2709

Laboratory Name: **Queen's Analytical Services Unit**

Parent Institution: Queen's University

Address: Environmental Studies Biosciences Complex Kingston, Ontario K7L 3N6

Contact: Dr. Allison Rutter

Phone: (613) 533-2642

Fax: (613) 533-2897

Email: ruttera@biology.queensu.ca

Standard: Conforms with requirements of CAN-P-4D (ISO/IEC 17025)

Clients Served:

Revised On: February 21, 2005

Valid To: February 16, 2008

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Scope of Accreditation

Search Criteria - results highlighted in yellow

Laboratory Name contains "analytical services unit"

Oil

PCB - Oil (004)

ASU 04; based on EPA 8081

GC/ECD - EXTRACTION

Total PCB

Soil/Sediment

Metals - Soil (007)

ASU007; based on EPA 200.7

ICP/OES - DIGESTION

Arsenic

Cadmium

Chromium

Cobalt

Copper

Lead

Nickel

Zinc

Water (Inorganic)

Ammonia - Water (009)

ASU09; based on TECHNICON METHOD

AUTO COLOR

Ammonia

Water (Inorganic)

Dissolved Metals - Water (008)

ASU08; based on EPA 200.7

ICP/AES

- Dissolved Arsenic
- Dissolved Cadmium
- Dissolved Chromium (High)
- Dissolved Cobalt (High)
- Dissolved Copper (High)
- Dissolved Lead (High)
- Dissolved Manganese (High)
- Dissolved Nickel (High)
- Dissolved Zinc (High)

Water (Inorganic)

Major Ions - Water (003)
ASU 03; based on DIONEX MANUAL

- ION CHROMATOGRAPHY
- Chloride
- Nitrate
- Nitrate plus Nitrite
- Sulfate

Water (Inorganic)

Oil and Grease - Water (010)
ASU10; based on SM 5520 (20TH EDITION)

- GRAVIMETRIC - EXTRACTION
- Oil and Grease

Water (Inorganic)

Total Metals - Water (012)
ASU08; based on EPA 200.7

- ICP/AES
- Total Arsenic
- Total Cadmium
- Total Chromium
- Total Cobalt
- Total Copper
- Total Lead
- Total Manganese
- Total Nickel
- Total Zinc

Water (Organic)

Biphenyl - Water (005)
ASU 05; IN HOUSE METHOD

- GC/FID - EXTRACTION
- Biphenyl
- Biphenyl Ether

Water (Organic)

Phenols - Water (001)
ASU 01; based on MOE METHOD 1983

- AUTOANALYZER/COLORIMETRY
- Phenols

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Membership Number: 2965

Laboratory Name: **RMC Analytical Services Group**

Parent Institution: The Royal Military College of Canada

Address: Dept. of Chemistry & Chemical Engineering RMC, PO Box 17000 Stn. Forces Kingston, Ontario K7K 7B4

Contact: Dr. David Kelly

Phone: (613) 541-6000 Ext. 6921

Fax: (613) 545-8341

Email: david.kelly@rmc.ca

Standard: Conforms with requirements of CAN-P-4D (ISO/IEC 17025)

Clients Served: Specified Clients

Revised On: January 03, 2005

Valid To: January 03, 2008

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Scope of Accreditation

Search Criteria - results highlighted in yellow

Laboratory Name contains "analytical services group"

Oil

Total Chlorine - Oil (003)

ASG 003; based on J. RADIONAL CHEM., 50, 229-234 (1979) AND based on ANAL. CHIM. ACTA., 108, 137-147 (1979).

NAA

Total Chlorine

Plant Tissue

Polychorinated Biphenyls (PCB) - Plants (020)

ASG026; based on EPA 8082, EPA 680, EPA 8082, EPA 3545, EPA 3640C, FRAME, ET. AL. J. HIGH RESOL. CHROMATOGR., 19:657-668, 1996.

Arochlors

PCB Conegeners

Radio Chemistry

Radionuclide Activity - Biota (008)

ASG 031; based on SM AMERICAN WATER ASSN. METHOD 7120, SM FOR EXAM. OF WATER/WASTEWATER, 20TH ED., & USEPA METHOD 901.1.

GAMMA SPECTROSCOPY

Barium-140

Cerium-144

Cesium-134

Cesium-136

Cesium-137

Cesium-138

Cobalt-60
Iodine-131
Iodine-132
Iodine-133
Iodine-134
Iodine-135
Lanthanum-140
Molybdenum-99
Niobium-95
Rubidium-86
Rubidium-88
Ruthenium-103
Ruthenium/Rhodium-106
Strontium-91
Tellurium-129m
Tellurium-131m
Tellurium-132
Yttrium-90m
Yttrium-91m
Zirconium-95

Soil

BTEX/Petroluem Hydrocarbons (PHC) - Soil (025)

ASG 053; based on CCME REFERENCE METHOD FOR THE CANADA-WIDE STANDARD FOR PETROLEUM HYDROCARBONS IN SOIL - TIER 1 METHOD 2001

GC/MS - EXTRACTION
Benzene
Ethylbenzene
F1: C6-C10
F2: C10-C16
F3: C16-C34
F4: C34-C50
m/p-xylene
o-xylene
Toluene

Soil/Sediment

Activity of Radionuclide - Soil (007)

ASG 030; based on SM AMERICAN WATER ASSN. METHOD 7120, SM FOR EXAM. OF WATER/WASTEWATER, 20TH ED., & USEPA METHOD 901.1.

GAMMA SPECTROSCOPY
Barium-140
Cerium-144
Cesium-134
Cesium-136
Cesium-137
Cesium-138
Iodine-131
Iodine-132
Iodine-133
Iodine-134
Iodine-135
Lanthanum-140
Molybdenum-99
Niobium-95
Rubidium-86
Rubidium-88
Ruthenium-103
Ruthenium/Rhodium-106
Strontium-91
Tellurium-129m
Tellurium-131m
Tellurium-132
Yttrium-90m
Yttrium-91m
Zirconium-95

Soil/Sediment

PCBs - Soil (005)

ASG 005; based on EPA 8081

GC/ECD - SOXHLET/PSE
PCBs

Soil/Sediment

Polycyclic Aromatic Hydrocarbons (PAH) - Soil (001)
ASG 002; based on EPA 8100
- GC/MS - EXTRACTION
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo (a) anthracene
- Benzo (a) pyrene
- Benzo (b) fluoranthene
- Benzo (g,h,i) perylene
- Benzo (k) fluoranthene
- Chrysene
- Dibenz (a,h) anthracene
- Fluoranthene
- Fluorene
- Indeno (1,2,3 - cd) pyrene
- Naphthalene
- Phenanthrene
- Pyrene

Soil/Sediment

Total Petroleum Hydrocarbons (TPH) - Soil (010)
ASG010; based on EPA 3550B, EPA 8015C
- GC/FID - EXTRACTION
- Total Petroleum Hydrocarbons

Water (Inorganic)

Alkalinity - Water (Drinking/Surface/Sewage/Ground) (013)
ASG035; based on NAQUADAT NO. 10101, EPA 310.1, SM 20TH ED. 2320
- POTENTIOMETRIC
- Alkalinity (pH 4.5)

Water (Inorganic)

Biochemical Oxygen Demand (BOD) - Water (Surface/Sewage/Ground) (019)
ASG042; based on NAQUADAT NO. 08201, EPA 405.1, SM 20TH ED. 5210
- D.O. METER
- BOD (5 day)

Water (Inorganic)

Conductivity - Water (Drinking/Surface/Sewage/Ground) (016)
ASG038; based on SM 20TH. ED. 2510, EPA 120.1
- CONDUCTIVITY METER
- Conductivity (25Ã?C)

Water (Inorganic)

Mercury - Water (Ground/Surface/Drinking) (011)
ASG021; based on EPA 7470A
- FLOW INJECTION MERCURY SPEC
- Mercury

Water (Inorganic)

Metals - Water (024)
ASG 049; based on EPA 200.8 AND SM 20TH ED. 3125
- ICP/MS
- Dissolved Aluminum
- Dissolved Beryllium
- Dissolved Boron
- Dissolved Cadmium
- Dissolved Chromium
- Dissolved Cobalt
- Dissolved Copper
- Dissolved Lead
- Dissolved Manganese
- Dissolved Molybdenum
- Dissolved Nickel
- Dissolved Silver
- Dissolved Strontium
- Dissolved Thallium
- Dissolved Tin
- Dissolved Uranium
- Dissolved Vanadium Parameter suspended on 5/18/2005
- Total Antimony
- Total Arsenic

Water (Inorganic)

pH - Water (Drinking/Surface/Sewage/Ground) (015)
ASG037; based on SM 20TH. ED. 4500-H+, EPA 150.1

- pH METER
- pH

Water (Inorganic)

Total Dissloved Solids (TDS) - Water (Drinking/Surface/Sewage/Ground) (018)
ASG040; based on EPA 160.1, SM 18TH ED. 2540C

- GRAVIMETRIC
- Total Dissolved Solids

Water (Inorganic)

Total Suspended Solids (TSS) - Water (Drinking/Surface/Sewage/Ground) (017)
ASG039; based on EPA 160.2, SM 18TH ED. 2540D

- GRAVIMETRIC
- Total Suspended Solids

Water (Microbiology)

Coliforms - Water (Drinking/Surface/Sewage/Ground) (014)
ASG036; based on MOE MICROMEFDC-E3407, SM 20TH ED. 9225

- MEMBRANE FILTRATION (DC)
- Escherichia coli (E. coli)
- Total Coliforms

Water (Microbiology)

Fecal Coliforms - Water (Drinking/Surface/Sewage/Ground) (022)
ASG044; based on MOE MICROMEFDC-E3407, SM 20TH ED. 9222 D

- MEMBRANE FILTRATION (m FC)
- Fecal Coliforms

Water (Microbiology)

Heterotrophic Plate Count (HPC) - Water (Drinking/Surface/Sewage/Ground) (023)
ASG041; SM 20TH ED. 9215 D

- MEMBRANE FILTRATION
- Heterotrophic Plate Count (HPC)

Water (Organic)

Total PCB - Water (Surface/Sewage/Ground) (009)
ASG015, ASG022; based on EPA 8082, EPA 617, FRAME, ET. AL. J. HIGH RESOL. CHROMATOGR., 19: 657-668, 1996

- GC/MS - EXTRACTION
- Total PCB

Water (Organic)

Total PCB - Water (021)
ASG006, ASG008; based on EPA 8082, EPA 617, FRAME, ET. AL. J. HIGH RESOL. CHROMATOGR., 19: 657-668, 1996.

- GC/ECD - EXTRACTION
- Total PCB

Water (Organic)

Volatile Organic Compounds (VOC) - Water (Drinking/Surface/Ground) (012)
ASG023; based on EPA 624, EPA 8260B

- GC/MS - PURGE AND TRAP
- 1,1-Dichloroethane
- 1,1-dichloroethylene
- 1,1-Dichloropropene
- 1,1,1-Trichloroethane
- 1,1,1,2,-Tetrachloroethane
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- 1,2-Dibromo-3-chloropropane
- 1,2-Dibromoethane
- 1,2-dichlorobenzene
- 1,2-dichloroethane
- 1,2-Dichloropropane
- 1,2,3-Trichlorobenzene
- 1,2,3-Trichloropropane
- 1,2,4-Trichlorobenzene
- 1,2,4-Trimethylbenzene
- 1,3-Dichlorobenzene
- 1,3-Dichloropropane
- 1,3,5-Trimethylbenzene
- 1,4-dichlorobenzene
- 2-Chlorotoluene
- 2,2-Dichloropropane
- 4-Chlorotoluene
- Benzene
- Bromobenzene
- Bromochloromethane
- Bromodichloromethane
- Bromoform

Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dibromomethane
Dichlorodifluoromethane
Dichloromethane Parameter suspended on 8/17/2005
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene
Isopropyltoluene
m/p-xylene
n-Butylbenzene
n-Propylbenzene
Naphthalene
o-xylene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

Water (Radiochemistry)

Alpha/Beta Radiation (Swab) (004)
ASG 004; RMC-CMR LSC PROCEDURES MANUAL VER. 1.0
LIQUID SCINTILLATION COUNTING
Alpha radiation
Beta radiation

Water (Radiochemistry)

Radionuclide (Activity) - Water (006)
ASG 024; based on SM AMERICAN WATER ASSN. METHOD 7120, SM FOR EXAM. OF WATER/WASTEWATER, 20TH ED., & USEPA METHOD 901.1.
GAMMA SPECTROSCOPY
Barium-140
Cerium-144
Cesium-134
Cesium-136
Cesium-137
Cesium-138
Cobalt-60
Iodine-131
Iodine-132
Iodine-133
Iodine-134
Iodine-135
Lanthanum-140
Molybdenum-99
Niobium-95
Rubidium-86
Rubidium-88
Ruthenium-103
Ruthenium/Rhodium-106
Strontium-91
Tellurium-129m
Tellurium-131m
Tellurium-132
Yttrium-90m
Yttrium-91m
Zirconium-95

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CLIENTS SERVED:	All interested parties
FIELDS OF TESTING:	Chemical/Physical
PROGRAM SPECIALTY AREA:	Environmental
ISSUED ON:	2005−06−22
VALID TO:	2006−11−02

ENVIRONMENTAL AND OCCUPATIONAL HEALTH AND SAFETY

Environmental

Water (Microbiology)

(Coliforms − Water [014]) (OSDWA)

ASG036; based on MOE
MICROMEFDC−E3407, SM 20TH ED. 9225

MEMBRANE FILTRATION (DC)
Escherichia coli (E. coli)
Total Coliforms

(Fecal Coliforms − Water [022]) (OSDWA)

ASG044; based on MOE
MICROMEFDC−E3407, SM 20TH ED. 9222
D

MEMBRANE FILTRATION (m FC)
Fecal Coliforms

(Heterotrophic Plate Count (HPC) − Water [023]) (OSDWA)

ASG041; SM 20TH ED. 9215 D

MEMBRANE FILTRATION
Heterotrophic Plate Count (HPC)

Notes:

CAN−P−4D (ISO/IEC 17025): General Requirements for the Competence of Testing and Calibration Laboratories ISO/IEC 17025−1999)

CAN−P−1598: Guidelines for Accreditation of Environmental Testing Laboratories

OSDWA: Indicates the appendix is used for the analysis of Ontario drinking water samples, which is subject to the rules and related regulations under the Ontario "Safe Drinking Water Act" (2002)

P. Paladino, P. Eng., Director, Conformity Assessment

Date: 2005−06−22

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