# Solid Waste Management Facility
# Abandonment and Restoration Plan

## Hamlet of Arviat

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# 1.0 Introduction

Community and Government Services (CGS) of the Government of Nunavut (GN), retained Nuna Burnside Engineering and Environmental Ltd. (Nuna Burnside), on behalf of the Hamlet of Arviat, to develop an Abandonment and Restoration Plan for the Solid Waste Management Facility. This report has been completed as a condition of Part G, Item 1 of the Nunavut Water Board licence 3AM-ARV1015 issued to the Hamlet on August 23, 2010. A copy of the licence is provided in Appendix A.

A Solid Waste Management Report dated December 2010, was prepared by Nuna Burnside to document conditions in 2010 and provide interim improvement recommendations until a new Solid Waste Management Facility can be construction and commissioned.

## 1.1 Site Location

The Hamlet of Arviat is located within the Kivalliq Region, Nunavut, at general latitude 61°6'N and general longitude 94°3'W (Figure 1). The Community is located approximately 225 km south of Rankin Inlet and 265 km north of Churchill Manitoba. The Hamlet of Arviat is predominately residential with a few small commercial and institutional establishments. Hunting and fishing in the traditional manner is still a prime occupation for many of the inhabitants.

## 1.2 Site Description

The Hamlet of Arviat provides regular solid waste pickup for the residents, businesses, and institutions. The Solid Waste Management Facility includes a landfill site for municipal solid waste and a long-term storage area for bulky metals. Currently waste oil, glycol, and other hazardous wastes are stored in a designated area next to the Public Works garage.

The current landfill is reaching capacity and the designated area for hazardous waste does not meet hazardous waste storage guidelines. A new Solid Waste Management Site has been identified, however is still in the planning process (Figure 2). The new site will also have a designed Hazardous Waste Storage Area and Bulky Metals Storage Area.

This Abandonment and Restoration Plan has been created for the current Solid Waste Disposal Facility which consists of the following components:

- Municipal Solid Waste Disposal Area (Landfill)
- Bulky Metals Waste Area (located north of the fill area)

- Hazardous Waste Storage Area (currently next to the Hamlet garage).

Figure 2 illustrates the locations of the solid waste disposal facilities in Arviat.

## 1.3 Objective

The objective of the Abandonment and Restoration Plan is to provide guidance to the Hamlet to minimize the long term effects on the health of the community and the environment caused by areas used for waste disposal once they are no longer in use.

The report includes the following aspects:

- Characterization of existing waste disposal areas and waste
- Environmental conditions of the waste disposal areas
- Plans for abandonment and restoration, and
- Post-closure environmental monitoring.

# 2.0 Physical Setting

## 2.1 Topography and Drainage

The topography surrounding the Hamlet of Arviat is relatively flat with a sight rise when moving inland away from Hudson Bay. Local bedrock is generally overlain by glacial fluvial sediments. Arviat is located in the physiographic region of the Hudson Bay lowlands, characterized by low topographic relief, occasional bedrock outcrops and glacial and glacio-fluvial overburden sediments. Boulder fields and eskers are common. Approximately 20 to 30 percent of the land is shallow ponds with depths of 1 m or less. Land between the ponds is marshy, vegetated by grasses and sedges.

## 2.2 Geology and Morphology

Arviat is located on the northern shore of a peninsula on the west coast of Hudson Bay. The Hamlet is located in a zone of continuous permafrost, extending from 30 m to over 100 m. The active layer varies between 0.5 and 0.3 m. The predominant local vegetation consists of mosses and lichens on rocky outcrops, with hardy grasses and sages in swampy and/or more sheltered areas.

## 2.3 Climate

The closest climate station to Arviat is the Rankin Inlet Airport Weather Station. The Rankin Inlet area receives an average of 18.1 cm of rainfall and 119.7 cm of snowfall per annum. Mean annual precipitation totals 29.7 cm per annum. July mean high and low temperatures are 14.9$^{o}$C and 5.9$^{o}$C, respectively. January mean high and low temperatures are -28.3$^{o}$C and -35.5$^{o}$C, respectively. Winds are generally north-west, and average 23 km/h (Rankin Inlet Weather Station, Climate Normals 1991-2000, Environment Canada, 2010).

# 3.0 Municipal Solid Waste Disposal Area (Landfill)

The municipal solid waste disposal area (landfill) is located 2.0 km southeast of Arviat (Figure 3). The landfill is located along an esker, less than 1 km north of the Hudson Bay. The landfill area consists of a non-lined area surrounded by a three meter containment berm. The landfill area footprint is approximately 160 x 200 m measured from the inside of the containment berms and 170 x 210 m when including the berms. Photographs of the landfill are included in Appendix B.

## 3.1 Adjacent Land Use

The Hamlet sewage lagoons are located immediately east of the municipal landfill area with one lagoon not in use sharing the landfill's eastern berm. The Arviat Airport is located 0.6 km west of the site. Hudson Bay is less than 1 km north of the site. A 450 metre setback surrounding the lagoons is designated in the Community Land Use Plan as restrictive to development. The landfill is within this 450 m setback.

Previous studies have determined that the landfill is too close to the airport and should close as soon as possible.

## 3.2 Assessment of Existing Conditions at Landfill

### 3.2.1 Site Security

The landfill has operated without any dedicated operator or manager. Fences are located around the landfill area but locals and animals are free to enter through the entrance of the landfill. There is no gate.

### 3.2.2 Solid Waste Sources and Composition

The waste in the landfill generally consists of domestic wastes, construction debris, scrap wood, and animal carcasses. Municipal waste in remote northern communities like Arviat is generally composed of 60% to 80% paper and food and 15% to 30% recyclable materials such as aluminum and glass containers (GLL, 2007).

Over the 30 years of use, waste disposal practices have changed with increasing government control and education. It can be assumed that small amounts of hazardous waste has been deposed of at the site. Historically waste included domestic sewage in the form of honey bags and unknown amounts of hazardous waste (EBA, 1995).

### 3.2.3 Waste Placement History and Filling Methods

The landfill site began receiving waste in 1977 (AESL, 1985) and has operated as an open dump for approximately 30 years. Waste initially was dumped at the edge of the esker. The eastern berm of the sewage lagoon was used as the eastern boundary. Over the years the landfill has expanded with the construction of the south and western berms.

There is no compaction of waste and the landfill is covered infrequently with fill. Burning is used to reduce volumes of waste and is uncontrolled with only rudimentary segregation of combustible material from non-combustible materials.

There were no recorded planning studies indicating how the facility was sited, or engineering plans to indicate how it was to operate, what its capacity was, or how it was to be closed.

### 3.2.4 Soil Cover and Surface Water Drainage

Covering of the waste with soil does not occur at the landfill on a regular basis. An area of waste was covered by sand and gravel on the west and central part of the site in early 2010.

A containment berm is built around the landfill area. It acts to control waste disposal and channel surface water runoff from the site. Water that enters the landfill drains to areas of lowest elevation on the south side of the landfill. Surface water ponding is present at the south-east corner of the site and the south-west corner of the site. Water eventual discharges through a culvert located at the south-west corner of the site. After discharging from the landfill, water flows west into a tundra wetland. This area is identified as a Contaminant Attenuation Zone (CAZ) in Figure 3.

### 3.2.5 Leachate Generation

All precipitation that falls on the site eventually drains from the site as leachate. The average total precipitation for Arviat is 297 mm per year. Based on an evapotranspiration rate of 200 mm per year (Appendix C), the total input of precipitation to the landfill is 3,288$m^3$/year. This would be expected to leave the site as leachate.

### 3.2.6 Landfill Gas

Landfill gas created by the decomposition of garbage consists of 50% methane and 5% carbon dioxide with some small amounts of the non-methane organic compounds. In order to create methane you need anaerobic conditions. Since the landfill waste has not

been compacted or covered, it is likely that most of the waste is in aerobic conditions and that any gases created in the landfill waste are released to the atmosphere. There are no buildings or places for the gas to build up in close proximity to the site. Landfill gas is not considered a significant issue at the site.

Landfill gas is also limited by climate conditions and the gradual invasion of permafrost into the waste.

## 3.3 Environmental Conditions of Site

### 3.3.1 Field Methods, Sampling and Observations

To assess the environmental conditions of the landfill, a field program was initiated in the Fall 2010. The field program included the documentation and surveying of the landfill area, water quality sampling and a test pit within the adjacent wetland area.

Water sampling of the leachate at the discharge point of the landfill and downstream of the landfill was conducted in September 2010. Water quality results were compared to the Canadian Water Quality Standards for the Protection of Aquatic Life (CCME, 2007). Leachate sampled just outside of the landfill discharge point exceeded CCME guidelines in iron, copper, lead, zinc and phenols. Samples taken within the contaminant attenuation zone (CAZ) did not have any exceedences. A summary of the sample results and Certificates of Analysis are provided in Appendix D. The sample locations are shown in Figure 3.

A test pit was dug within the landfill CAZ in November 2010. The test pit extended 1.2 metres below surface until reaching permafrost and encountered 20 cm of root mass and 1 meter of peat moss. Water was encountered only 10 cm below surface. The test pit results suggest that there is thick layer of active organic material within the CAZ that is capable receiving leachate discharge from the site for attenuation, however the majority of leachate flow would occur in the surface water regime.

## 3.4 Abandonment and Restoration Plan

The abandonment and restoration of the existing landfill will require the following activities:

- Removal and relocation of hazardous waste in landfill to hazardous waste storage area
- Consolidation, compaction and contouring of existing solid waste
- Construction of perimeter surface water drainage ditches and discharge pathways
- Implementation of a post-closure environmental monitoring and inspection program.

### 3.4.1 Estimated Quantity of Solid Waste

To determine landfill capacity, the annual amount of solid waste generated by the Hamlet was estimated. The estimate is based on population data provided by Census Canada and average annual waste generation rates for northern communities in Canada.

In this case, the site has been determined to require closure due to its proximity to the airport and its unsuitability for expansion. Although there are no engineering reports describing the limits to the sites capacity, Hamlet staff indicated that the capacity was assumed to be the top of the berms. Since it could be up to five years before another site is constructed, licensed, and commissioned, the existing landfill will need to remain in service. Therefore, its “capacity” is based on remaining in service for a maximum of five years.

Solid waste projections for the Hamlet are provided in Appendix C. The table is based on the Census 2006 population of 2,060 and a growth rate of 3.2 percent (Nunavut Bureau of Statistics, 2010). The table assumes that 20 percent of the waste is combustible and that there is no compaction. It also assumes that a volume of cover material is used annually equal to 20% of the volume of disposed waste.

A topographic survey of the waste area was completed in September 2010 to create a contour map of the current waste in the landfill. Contours of the waste are shown in Figure 4. Waste calculations show that in the next 5 years (2011 through 2015), the Hamlet will need 67,885 $m^3$ of space for their waste. A final closure shape has been produced that will fit the addition of 68,000 $m^3$ of waste (Figures 4 and 5).

The 5 year timeline has been selected as outlined in the Solid Waste Management Report 2010, by Nuna Burnside, to account for the likely timeline for a new facility to be constructed and commissioned.

### 3.4.2 Final Cover Construction

A final cover over the landfill waste will be applied to the landfill. Before covering, the waste should be spread evenly and compacted. A large heavy tracked excavator or bull dozer can be used to regrade the site and compact the waste. When regrading, waste should be moved and crushed to fill voids and obtain an even solid mass. The centre of the landfill should be higher than the sides creating a dome like shape with slopes no greater than 3:1. Using available soil fill, a 0.5 m layer of sand and gravel should be applied to cover the waste.

Permafrost will eventually migrate into the waste. A cross-section of the final closure shape is provided in Figure 5.

### 3.4.3 Drainage Patterns

The final cover slopes will be at least 2% to encourage drainage. The contours of the cover will be graded to cause surface water runoff to drain to the southwest corner of the site, which is the current discharge location. The water will discharge into a tundra pond located outside of the landfill. The water in the pond will discharge through a culvert into the landfill contaminant attenuation zone (CAZ) wetlands. A drawing showing the final topography of the site is included in Figure 4.

### 3.4.4 Proposed End Use

After the landfill is closed, the land will likely not be used for any other purpose. Signs should be posted to deter community residents from traveling in the area.

The area will remain within the 450 m planning setback for the sewage lagoons. The 450 m setback around the landfill will remain until post closure monitoring and inspections indicate it can be reduced.

## 3.5 Environmental Monitoring Program

Monitoring of the site should be continued after abandonment and restoration. Water samples should be taken from the discharge location (ARV-2) monthly from May to September, as per the water license. A sample taken at the end of the Contaminant Attenuation Zone should also be collected. These monitoring locations should be included as monitoring stations in the Hamlet's NWB licence. The berm around the landfill should be inspected annually to identify any areas of erosion or failure. Monitoring results should be reported annually in the Hamlet's Annual Report submitted to the Nunavut Water Board.

# 4.0 Bulky Metals Waste Area

The Bulky Metals Waste Area is located 250 m north of the landfill along an esker, 0.5 km south of the town. Vehicles, heavy equipment, empty 45 gallon drums, and other metal wastes are disposed and stored at this site (Figure 6). Photographs of the area are included in Appendix B.

## 4.1 Assessment of Existing Conditions

### 4.1.1 Waste Placement History and Filling Methods

The Bulky Metals Waste area was historically used as domestic waste disposal area. Records indicate disposal of domestic waste occurred during the mid-1970's until 1977. The area also received hazardous waste such as transformers in the 1970's (EBA, 1995). The filled area has been closed with a layer of fill. Soil impacted with petroleum hydrocarbons was transferred to the site in the early 1990s from the NWTPC tank farm.

Since the opening of the current landfill the Bulky Metals Waste Area has been used for the disposal of dry scrap metal waste and machinery. Metal wastes have been disposed of at the site manually by residents. Some segregation has occurred as vehicles tend to be stored along the south side of the site and "white waste" (appliances and water heating tanks) are stored at the back of the site (Figure 6).

## 4.2 Site Security

The bulky metals waste dump area has operated without any dedicated operator or manager. It is common for community residents to be scavenging the dump for metal and spare parts. There is no fence around the site.

## 4.3 Estimated Quantity of Waste

As part of the field program, a topographic survey was completed to outline the waste footprint and to determine the direction of drainage on the site. Contours and drainage off site are provided in Figure 6. The topographic survey was also used to estimate the volume of the contaminated soil piles. Based on the survey, the volume of soil is estimated to be approximately 218 $m^3$.

## 4.4 Environmental Conditions of Site

Soil and water sampling was completed at the Bulky Metals Waste site in September and November 2010.

In September 2010, soil samples were taken from the contaminated soil piles. There are two main piles of soil at the site. Two samples were taken from each pile at approximately 20 to 30 cm below surface (HW-P1-A, HW-P1-B, HW-P2-A and HW-P2-B). A surface water sample (BW-1) was also taken from ponded water just south of the Bulky Waste Area (Figure 6).

In November 2010, two test pits were excavated down gradient of site to identify and sample the active zone. The test pits were dug to a depth of 1.1 metres. 0 to 20 cm below ground surface (bgs) was vegetation. From 0.2 metres to 0.8 metres was silty fine sand with roots and organics. From 0.8 to 1.1 m bgs was grey silty sand. A soil sample from each test pit (ARV-5-1 and ARV-5-2) was collected and submitted for grain size analysis. Samples from the groundwater seepage in the test pits were also collected.

### 4.4.1 Sampling Results

Soil samples taken from the suspected contaminated soil piles were analyzed for metals, petroleum hydrocarbons, BTEX, PAHs, phenols and PCBs. The results were compared to the Canadian Soil Quality Guidelines for the Protection of Environment and Health Guidelines for industrial land use and coarse grained soil (Appendix E). Exceedences in petroleum hydrocarbons F2 (C>10-C16) and F3 (C>16-C34) were identified.

Surface water sampled in September 2010 was analysed for petroleum hydrocarbons, PAHs and VOCs. The results were compared to the Canadian Water Quality Guidelines for the Protection of Aquatic Life – Fresh Water (Appendix E). No exceedences were identified. Groundwater samples taken from seepage within the test pits were analysed for petroleum hydrocarbons, metals and inorganics, VOCs and BTEX. Exceedences of metals including aluminum, arsenic, barium, boron, iron, lead and zinc were identified. The concentration of metals in the groundwater seepage may be related to background conditions rather then impacts from the bulky metals, but this has not been confirmed by a background baseline study.

Grain size analysis results identified soil sample ARV-5-1 to be sandy loam and ARV-5-2 to be silt loam. A grain size distribution plot is provided in Appendix C. The active layer acts as a migratory pathway for contamination when thawed.

Sampling locations are shown in Figure 5. A summary of the sampling results and certificates of analysis are provided in Appendix D.

### 4.4.2 Contaminated Soil Excavation and Relocation

Seven hundred and fifty cubic meters of contaminated soil were reportedly removed from the N.W.T. Power Corporation tank farm and brought to the Bulky Waste site for landfarming (EBA, 1995). Some of the soil has been spread over the former landfill with approximately 300 $m^3$ stockpiled. The soil is believed to be contaminated with diesel. A topographic survey of the piles was completed in September 2010 which estimated the volume of soil to be approximately 217.6 $m^3$. Soil samples taken from the piles of soil exceeded CCME guidelines for industrial land uses for petroleum hydrocarbons F2 (C>10-C16) and F3 (C>16-C34). The piles should be moved from the site to the landfill or to a constructed landfarm.

## 4.5 Abandonment and Restoration

The abandonment and restoration of the bulky metals waste area should be done in consultation with the community. The abandonment and restoration would include the following components:

- Inventory of waste and removal of hazardous waste such as car batteries
- Drain fluids from all vehicles to ensure that hazardous liquids are not present
- Remove and bury waste at location acceptable to community
- Remove any contaminated soil to landfarm for treatment
- Initiate confirmatory sampling program.

Waste will need to be buried in a location that is acceptable to the community. Because permafrost reaches up to 1 meter in depth, the burial location would need to be at an elevated location where the land drains and there is a deeper active layer. A cell at the proposed new landfill is a possible location.

Once all waste is removed from the site, a confirmatory sampling program would be required. The program would include surface and groundwater quality and soil sampling. Before abandonment of the current site, a new site needs to be identified and approved by the Hamlet and NWB.

### 4.5.1 Proposed End Use

In the Hamlet's Community Plan, a 450 m buffer surrounds the waste disposal area and is designated as restrictive development. Upon closure of the site, the Hamlet can apply to have this buffer removed or reduced based on risk to human health. Confirmatory sampling should be used to determine what land uses would be permitted based on

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (Appendix E).

# 5.0 Hazardous Waste Storage Area

The Hamlet of Arviat currently stores some of its hazardous waste beside the public works garage (Figure 7). Metal drums of waste oils and fuels are stored outside behind the garage in rows. Some of the drums are stacked on skids while others are on the ground. Photos of the area are included in Appendix B.

Based on information from the Hamlet and field observations there is approximately 100 drums of waste stored at the Hazardous Waste Storage Area. Contents in the drums included aviation fuel, waste oil and diesel fuel.

## 5.1 Environmental Conditions of Site

### 5.1.1 Assessment of Contaminated Soil and Water

A site visit of the area identified stained soil beside the waste oil drums. Samples of the stained area were collected in September 2010 and analyzed for hydrocarbons, PAHs and VOCs. All three samples exceeded the CCME soil quality standards for petroleum hydrocarbons F3 and F4 (CCME, 2007b). The results are provided in Appendix D. Exceedances are listed in Table 1 below:

**Table 1 Soil Samples at Hazardous Waste Storage Area**

| Parameter | CCME Guideline | HW-1 | HW-2 | HW-3 |
|---|---|---|---|---|
| PH C6-C10 (F1) | 320 | <5 | <5 | <5 |
| PH C>10-C16 (F2) | 260 | <10 | <10 | <10 |
| PH C>13-C34 (F3) | 1700 | **26000** | **32000** | **24000** |
| PH C>34-C50 (F4) | 3300 | **4800** | **6000** | **4400** |

PH = petroleum hydrocarbons

## 5.2 Abandonment and Restoration

For abandonment of the site all accumulated drums should be labelled clearly with contents and stacked and strapped for transport. All wastes including oils, fuels, batteries, antifreeze, solvents that cannot be rendered safe for landfilling or cannot be reused should be removed from the community and shipped to a proper disposal facility. Materials must be contained, manifested, and arrangements must be made with a shipper to back haul the materials to a licensed waste disposal site.

The proposed new Solid Waste Management Facility includes a Hazardous Waste Storage area that meets the regulatory requirements. Once constructed the materials could be placed at the new facility.

The DOE monitors the movement of hazardous wastes from generators, carriers to receivers of the wastes, through the use of a tracking document known as a Waste Manifest. A Waste Manifest must accompany all movements, and all parties must register with DOE by contacting:

Robert Eno, Director, Environmental Protection Division (867) 975-7729
reno@gov.nu.ca

Ian Rumbolt, Manager of Pollution, Department of Environment (867) 975-7748
irumbolt@gov.nu.ca

Alain, Chouinard. Environmental Protection Officer – Arviat (867) 857-2828
AChouinard@gov.nu.ca

### 5.2.1 Confirmatory Sampling

Once all waste is removed from the Public Works Yard, confirmatory sampling should be completed. Contaminated soil will need to be moved to a landfarm or to be used as cover at the landfill. Samples should be compared to the CCME Guidelines for industrial land use (Appendix E).

## 6.0 Implementation Schedule and Cost Estimate

As outlined in the Solid Waste Management Report 2010, by Nuna Burnside, and the Plan for Compliance, the existing Solid Waste Management Facility is out of compliance with regulations and needs to be closed. Nuna Burnside was retained by CGS-GN, on behalf of the Hamlet, to locate, design and oversee the construction of a new Solid Waste Management Facility. The Hamlet is currently in the process of deciding on the nature and location of a new facility.

Until new facilities can be constructed and commissioned, it is recommended that the existing facilities be operated in the most environmentally sound manner possible.

Given the logistics of funding and construction in Nunavut, a practical schedule has been developed based on commissioning new facilities by 2015. The abandonment and restoration of the existing facilities is based upon the assumption that they will continue to operate until 2015. As outlined in the Plan of Compliance, although there is funding committed towards constructing new facilities, no funding commitment have been made to conduct the abandonment and restoration of the existing facilities. A rough estimate of potential costs based on estimates for similar recent projects are as follows:

- Clean up of the Hazardous Waste Storage Area adjacent to the Public Works Garage – $50,000.
  Costs assume:
  - Materials are manifested, placed on skids, and stored at the new facility
  - Does not include shipping out of the community
  - Contaminated soil is excavated and shipped to the landfill as cover material
  - Confirmatory sampling and report.

- Clean up of the Bulky Metals Area – $300,000.
  Costs assume:
  - Hazardous materials removal (batteries, fluids, etc.)
  - Removal of all materials to the new Solid Waste Disposal Facility and segregated disposal (waste, hazardous waste, and bulky metal)
  - Does not include future processing (cell constriction, shipping out of the community, etc.) at the new Hazardous Waste Management Facility
  - All contaminated soils shipped to the existing landfill as cover or to the new Solid Waste Management Facility as cover

- Confirmatory sampling and report.

- Abandonment and Restoration of Landfill Site – $350,000.
  Cost Assume:
  - Compaction and contouring waste
  - Excavation from adjacent borrow area of 0.5 m of cover material for finial cover
  - Berms to remain in place with coarse boulder and cobbles placed in southwest corner to allow leachate drainage until permafrost migrates into the waste
  - Installation of monitoring wells in the waste to track internal conditions
  - Confirmatory sampling and reporting
  - Does not include post closure annual monitoring requirements.

More detailed planning will be required, based on actual site conditions at the time of abandonment and restoration, the location of the new Solid Waste Disposal Facility, and Hamlet planning.

## 7.0 Summary

The existing Solid Waste Management Facilities are out of compliance with the NWB license and regulatory requirements.

A new Solid Waste Management Facility has been located and designed, however the exact nature and location is contingent upon Hamlet approval and the completion of their Community Plan. The existing facilities will continue to operate on a best practices basis until a new facility is constructed and commissioned.

The Abandonment and Restoration of the existing facilities is based on their condition not deteriorating significantly in the next five years. The landfill site closure is based on less than five additional years of filling.

Detailed planning will be required to coordinate the closure of the existing facilities in coordination with the commissioning of a new facility.

The Abandonment and Restoration planning will require coordination with Hamlet and their input, to ensure it is consistent with their Community Plan.

Respectfully Submitted:

Stephanie Charity, P.Geo.

December 24, 2010
Date

Jim Walls, P.Geo.

December 24, 2010
Date

REGISTERED PROFESSIONAL GEOLOGIST
J.R. WALLS
LICENSEE
NWT/NU

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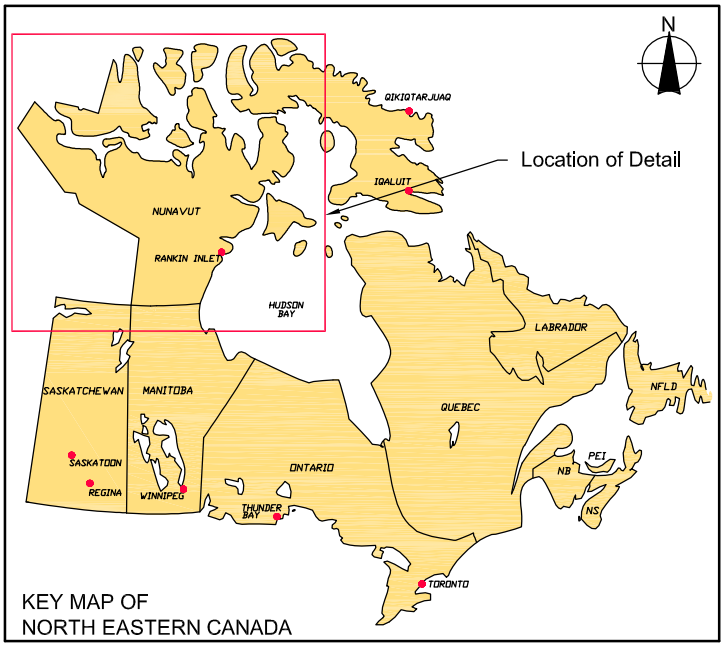
# Figures


Map Reference:
Map Art Publishing




# FIGURE 1 - SITE LOCATION MAP

## HAMLET OF ARVIAT

*HAMLET OF ARVIAT, NUNAVUT*

## SOLID WASTE MANAGEMENT FACILITY ABANDONMENT AND RESTORATION PLAN

December, 2010
Project Number: N-O15746

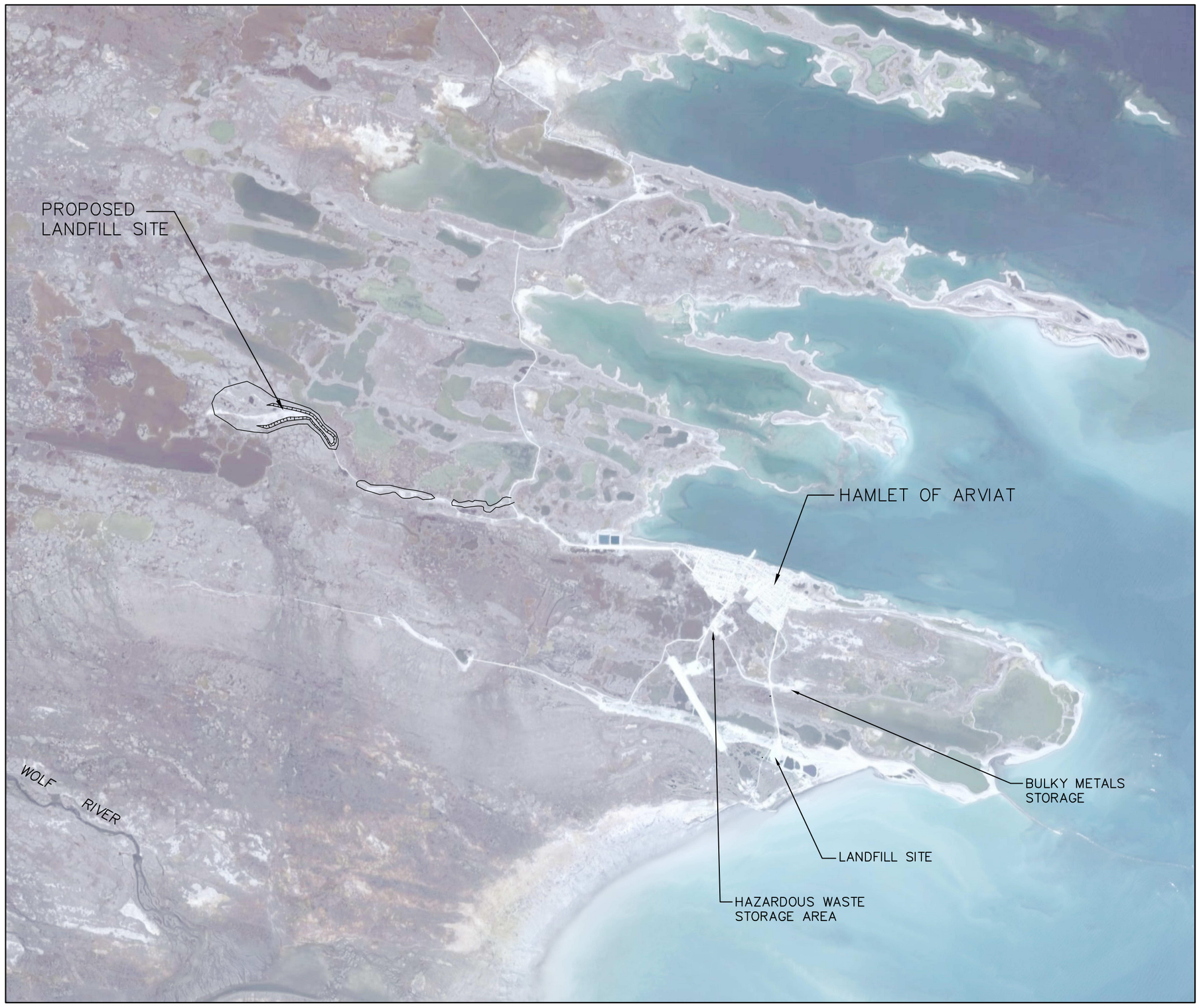
Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AR PLAN 2010 SL.dwg

Plot Time: Dec 17, 2010–11:34am




# FIGURE 2

## HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

*SOLID WASTE MANAGEMENT A&R PLAN*

## SOLID WASTE MANAGEMENT FACILITY LOCATION

Satellite Image Source:
Background colour satellite image obtained from Google Earth Pro.

Map Source:
Background physical features obtained from the National Topographic Database Website.

N

0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Kilometres

1:50,000
December, 2010
Project Number: N-O15746

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AR PLAN 2010 CP.dwg

Plot Time: Dec 22, 2010 - 11:35am


# FIGURE 3

## HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

*SOLID WASTE MANAGEMENT A&R PLAN*

## SOLID WASTE DISPOSAL AREA

LEGEND

- WATER SAMPLE LOCATION
- TEST PIT LOCATION
- CONTAMINANT ATTENUATION ZONE

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

N

0 20 40 60 80 100 120 140 160
Metres

1:2,000
December, 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AR PLAN SOLID WASTE DISPOSAL AREA.dwg

Plot Time: Jan 17, 2011 - 11:05am


# FIGURE 4-A

## HAMLET OF ARVIAT
## HAMLET OF ARVIAT, NUNAVUT
*SOLID WASTE MANAGEMENT A&R PLAN*

# CLOSED LANDFILL DESIGN SITE PLAN

LEGEND

- A A — CROSS-SECTION ORIENTATION
- 11 — EXISTING GROUND SURFACE / WASTE SURFACE CONTOUR (Surveyed by Nuna Burnside, September 2010)
- 14 — PROPOSED SURFACE OF CLOSED LANDFILL
- EXISTING LANDFILL FENCE
- EXISTING OUTSIDE LIMIT OF LANDFILL BERM

Site Features:
Site features shown on this plan represent site conditions surveyed in September 2010 by Nuna Burnside.
Background 2008 satellite image obtained from Quickbird Satellite Image ©Digital Globe Inc.

N

0 10 20 30 40 50 60 70 80
Metres

1:1,000
December 2010
Project Number: N-0157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Sheppard

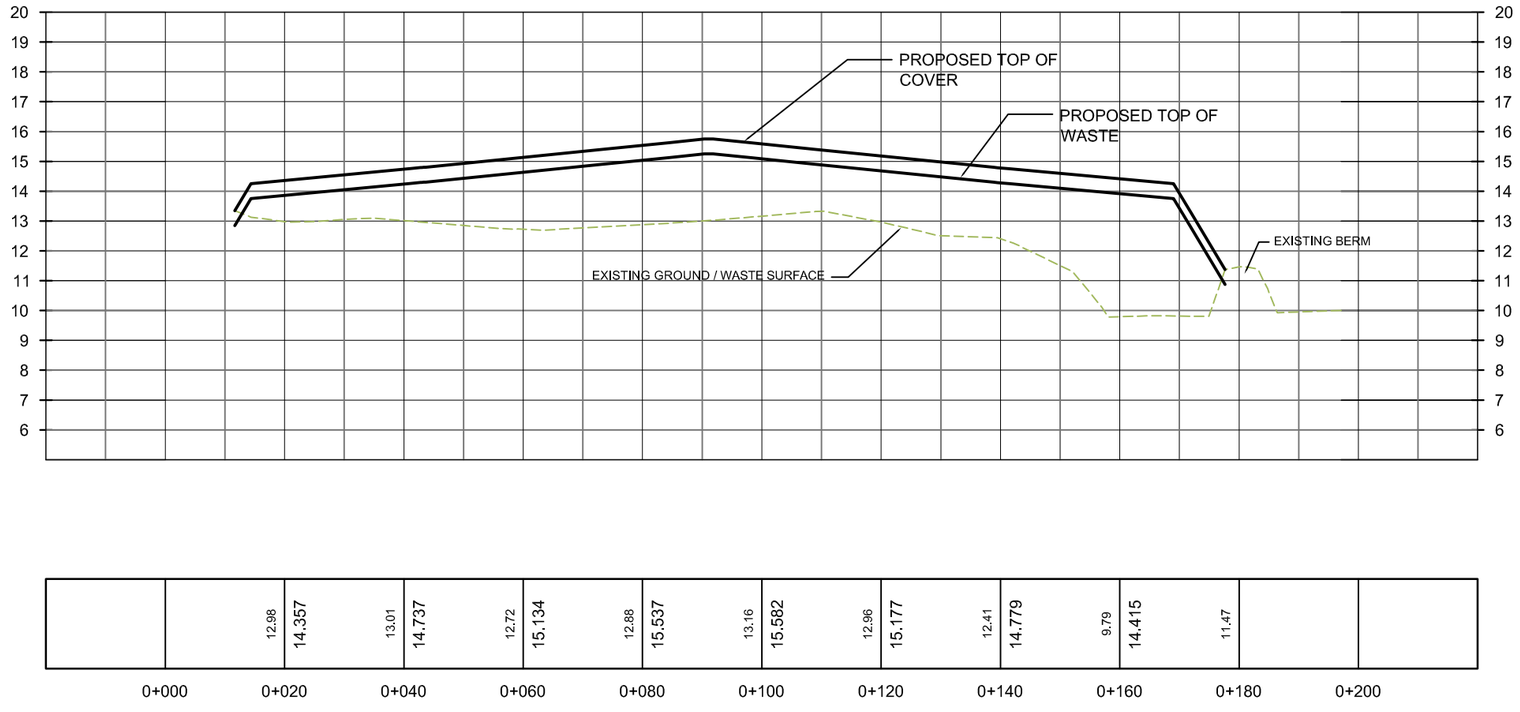
Verified by: S. Charity

NUNA BURNSIDE

N-O15746 SWMF AR PLAN CLOSED LANDFILL DESIGN.dwg

Plot Time: Jan 17, 2011 - 9:38am

Drawing




CROSS SECTION A-A

# FIGURE 4-B

## HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT
*SOLID WASTE MANAGEMENT A&R PLAN*

## CLOSED LANDFILL DESIGN CROSS - SECTION A-A

1:1,000
December 2010
Project Number: N-O157460

Prepared by: C. Sheppard Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AR PLAN CLOSED LANDFILL XSA.dwg

Plot Time: Jan 17, 2011-9:42am

Drawing


# FIGURE 5

## HAMLET OF ARVIAT
## HAMLET OF ARVIAT, NUNAVUT
*SOLID WASTE MANAGEMENT A&R PLAN*

## BULKY METALS WASTE AREA

LEGEND

- WATER QUALITY SAMPLE LOCATION
- TEST PIT LOCATION WITH WATER QUALITY SAMPLE
- SOIL SAMPLE LOCATION
- SURFACE WATER FLOW DIRECTION
- 10m — GROUND SURFACE CONTOUR *(Survey by Burnside, September 2010)*

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

N

0 20 40 60 80 100 120 140 160
Metres

1:2,000
December, 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AR PLAN BULKY METALS WASTE AREA.dwg

Plot Time: Jan 17, 2011-10:40am

Drawing


# FIGURE 6

## HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

*SOLID WASTE MANAGEMENT A&R PLAN*

## HAZARDOUS WASTE STORAGE AREA

LEGEND

- SOIL SAMPLE LOCATION
- SURFACE WATER DRAINAGE FLOW DIRECTION

Satellite Image Source:
Quickbird Satellite Image ©Digital Globe Inc., Date 2008

N

0 10 20 30 40 50 60
Metres

1:750
December, 2010
Project Number: N-O157460

Projection: UTM Zone 15
Datum: NAD83

Prepared by: C. Dickie

Verified by: S. Charity

BURNSIDE

N-O15746 SWMF AP PLAN HAZARDOUS WASTE AREA.dwg

Plot Time: Jan 17, 2011-11:10am

Drawing

BURNSIDE
An Aboriginal Owned Company

# Appendix A
# Nunavut Water Board Licence

# NUNAVUT WATER BOARD

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## WATER LICENCE NO: 3AM-ARV1015

## Hamlet of Arviat, Nunavut

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# NUNAVUT WATER BOARD

**LICENCE NO: 3AM-ARV1015**

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# NUNAVUT WATER BOARD

**WATER LICENCE No. 3AM-ARV1015**

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

HAMLET OF ARVIAT
(Licensee or Applicant)

ARVIAT, NUNAVUT X0C 0E0
(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water or dispose of waste for a period subject to restrictions and conditions contained within this Licence:

| | |
|---|---|
| Licence Number/Type: | 3AM-ARV1015 TYPE "A" |
| Water Management Area: | NUNAVUT 06 |
| Location: | ARVIAT, KIVALLIQ REGION, NUNAVUT<br>LATITUDE: 61° 06' 30" N, LONGITUDE: 94° 03' 31" W |
| Classification: | MUNICIPAL UNDERTAKING |
| Purpose: | DIRECT USE OF WATER AND DEPOSIT OF WASTE |
| Quantity of Water use not to Exceed: | EIGHTY-SIX THOUSAND (86,000)<br>CUBIC METRES PER ANNUM |
| Date of Licence Issuance: | AUGUST 23, 2010 |
| Expiry of Licence: | AUGUST 31, 2015 |

This Licence, issued and recorded at Gjoa Haven, Nunavut, includes and is subject to the annexed conditions.

**Thomas Kabloona,**
**Nunavut Water Board**
**Chair**

**APPROVED BY:**

**Minister of Indian and Northern Affairs Canada**

**DATE LICENCE APPROVED:** _____

## PART A: SCOPE, DEFINITIONS AND ENFORCEMENT

### 1. SCOPE

a. This Licence allows for the use of Water and disposal of Waste including operation of a Water Supply Facility, Solid Waste Disposal Facility, Hazardous Waste Storage Area, Bulky Metals Area, and Sewage Disposal Facility; as well as construction and operation of a New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, upon approval by the Board, by the Hamlet of Arviat, Nunavut for a municipal undertaking (Latitude 61° 06' 30" N and Longitude 94° 03' 31" W);

b. This Licence is issued subject to conditions contained herein with respect to the taking of Water and the depositing of Waste of any type in any Waters or in any place under any conditions where such Waste or any other Waste that results from the deposits of such Waste may enter any Waters. Whenever new regulations are made or existing regulations are amended by the Governor in Council under the Act, or other statutes imposing more stringent conditions relating to the quantity, type or manner under which any such Waste may be so deposited, this Licence shall be deemed to be subject to such requirements; and

c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with all applicable legislation, guidelines and directives.

### 2. DEFINITIONS

In this Licence, these definitions apply and changes may be made at the discretion of the Board.

**"Act"** means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act;*

**"Amendment"** means a change to original terms and conditions of this Licence requiring correction, addition or deletion of specific terms and conditions of the Licence and/or modifications inconsistent with the terms of the set terms and conditions of the Licence;

**"Analyst"** means an Analyst designated by the Minister under Section 85 (1) of the Act;

**"Applicant"** means the Licensee;

**"Appurtenant undertaking"** means an undertaking in relation to which a use of Waters or a deposit of Waste is permitted by a licence issued by the Board;

**"Board"** means the Nunavut Water Board established under the *Nunavut Land Claims Agreement*;

**"Bulky Metals Area"** comprises the area and associated structures designed to contain bulky metal waste as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

**"Effluent"** means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant;

**"Engineer"** means a professional engineer registered to practice in Nunavut in accordance with the *Consolidation of Engineers and Geoscientists Act S. Nu 2008, c.2* and the *Engineering and Geoscience Professions Act S.N.W.T. 2006, c.16 Amended by S.N.W.T. 2009, c.12*;

**"Final Discharge Point"** in respect of an Effluent, means an identifiable discharge point of a facility beyond which the operator of the facility no longer exercises control over the quality of the Effluent;

**"Freeboard"** means the vertical distance between water line and the designed maximum operating height on the crest of a dam or dyke's upstream slope;

**"Geotechnical Engineer"** means a professional engineer registered with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists and whose principal field of specialization is with the engineering properties of earth materials in dealing with man-made structures and earthworks that will be built on a site. These can include shallow and deep foundations, retaining walls, dams, and embankments;

**"Grab Sample"** means a single Water or wastewater sample taken at a time and place representative of the total discharge;

**"Greywater"** means all liquid wastes from showers, baths, sinks, kitchens and domestic washing facilities, but does not include toilet wastes;

**"Hazardous Waste"** means waste classified as "hazardous" by Nunavut Territorial or Federal legislation, or as "dangerous goods" under the *Transportation of Dangerous Goods Act*;

**"Hazardous Waste Storage Area"** comprises the area and associated structures designed to contain Hazardous Waste as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

**"Hydrocarbon Impacted Soil Storage and Treatment Facility"** means an area designed to treat Petroleum Hydrocarbon-Impacted Soil, as referred to in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

**"Inspector"** means an Inspector designated by the Minister under Section 85 (1) of the Act;

**"Licensee"** means the holder of this Licence;

**"Modification"** means an alteration to a physical work that introduces a new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion, and changes to the operating system that are consistent with the terms of this Licence and do not require amendment;

**"Monitoring Program"** means a monitoring program established to collect data on surface Water and groundwater quality, Waste and Waste deposition, to assess impacts to the freshwater aquatic environment of an appurtenant undertaking;

**"New Solid Waste Disposal Facility"** comprises the area and associated structures designed to contain solid waste as referred to in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

**"Nunavut Land Claims Agreement" (NLCA)** means the *"Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada*", including its preamble and schedules, and any amendments to that agreement made pursuant to it;

**"Petroleum Hydrocarbon Impacted Soil"** means soil in which the primary petroleum product present, as determined by laboratory analysis consistent with that described in the *Canada-Wide Standards for Petroleum Hydrocarbons in Soil*, generally consists of fuel oil, diesel fuel, gasoline and/or jet fuel;

**"Sewage"** means all Toilet Wastes and Greywater;

**"Sewage Disposal Facilities"** comprises the area, including wetland and engineered lagoon designed to contain Sewage as described in the Application for Water Licence filed by the Applicant on September 2, 2003, and illustrated in Arviat Sewage Lagoon drawings prepared by FSC Architects and Engineers for Government of Nunavut, Job No. 507-340, FSC Project No. 2003-0440-003, Submission for Tender July 11$^{th}$, 2003;

**"Sewage Sludge"** means the semi-solid Sewage material which settles at the bottom of the Sewage lagoon;

**"Solid Waste Disposal Facilities"** comprises the area and associated structures designed to contain solid waste as described in the Application for Water Licence filed by the Applicant on September 2, 2003;

**"Toilet Wastes"** means all human excreta and associated products, but does not include Greywater;

**"Waste"** means, as defined in section 4 of the Act, any substance that, by itself or in combination with other substances found in Water, would have the effect of altering the quality of any Water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any Water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

"**Waste Disposal Facilities**" means all facilities designated for the disposal of Waste including the Sewage Disposal Facilities, Solid Waste Disposal Facilities, Hazardous Waste Storage Area, Bulky Metals Area, and upon approval by the Board, New Solid Waste Disposal Facility, and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009;

**"Water"** means water as defined in section 4 of the Act;

**"Water Supply Facilities"** comprises the area and associated intake infrastructure at the Wolf River Water Supply, as described in the Application for Water Licence Renewal filed by the Applicant on January 5, 2009 and illustrated in Arviat Water Supply Filtration Upgrade drawings prepared by Dillon Consulting for Government of Nunavut Public Works and Services, Issued for Tender, April 2008, Project No. 078254; Figure 4 – Hamlet of Arviat Water Licence Submission Wolf River Water Intake drawing prepared by Nuna Burnside, December 2008, Project Number N-O15746;

**"Work Plan"** refers to the electronic document (letter) from Jim Walls, P.Geo., Nuna Burnside Engineering and Environmental Ltd., to Bryan Purdy, Government of Nunavut Community Government Services, Re: Work Plan to Address INAC, DFO, and NWB Licence Compliance Issues GN File 08-3025 Hamlet of Arviat, Nunavut File No. N-0 15746.1, dated June 23, 2010.

## 3. ENFORCEMENT

a. Failure to comply with this Licence will be a violation of the Act, subjecting the Licensee to the enforcement measures and the penalties provided for in the Act.

b. All inspection and enforcement services regarding this Licence will be provided by Inspectors appointed under the Act.

c. For the purpose of enforcing this Licence and with respect to the use of Water and deposit or discharge of Waste by the Licensee, Inspectors appointed under the Act, hold all powers, privileges and protections that are conferred upon them by the Act or by other applicable law.

## PART B: GENERAL CONDITIONS

1. This Licence incorporates a previously issued Type B licence, NWB3ARV0308, to the Hamlet of Arviat, which allowed for the use of water and disposal of waste.

2. In the event of a conflict between the previously issued Type B licences and this Type A Licence, the condition of this Type A Licence prevails.

3. The Licensee shall file an annual report with the Board for review, no later than March 31st

of the year following the calendar year being reported, which shall contain the following information collected during that period:

a. Tabular summaries of all data generated under the Monitoring Program;
b. The monthly and annual quantities of freshwater obtained from all sources;
c. The monthly and annual quantities of Wastes removed for disposal from Water Supply Facilities and Waste Disposal Facilities;
d. A summary of modifications and/or major maintenance work carried out on Water Supply Facilities and Waste Disposal Facilities including all associated structures and facilities;
e. A list of unauthorized discharges and summary of follow-up actions taken;
f. Any revisions to approved plans and manuals as required by Part B, Item 12, submitted in the form of an addendum;
g. A summary of the status of implementation of the Work Plan, including an indication of the status of the funding required to carry out the Work Plan and an estimated timeframe for receipt of the necessary funding;
h. A fiscal update of the Licensee's funding commitments associated with all facilities governed by this Licence including all associated structures and facilities for the upcoming year and identifying shortfalls in such funding commitments for the previous year;
i. A summary of abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;
j. A summary of any studies, reports and plans requested by the Board that relate to Waste disposal, Water use or reclamation, and a brief description of any future studies planned; and
k. Any other details on water use or waste disposal requested by the Board by November 1st of the year being reported.

4. The Licensee shall comply with the Monitoring Program described in this Licence and any Amendments to the Monitoring Program as may be made from time to time, pursuant to the conditions of this Licence.

5. The Monitoring Program and compliance dates specified in the Licence may be modified at the discretion of the Board.

6. Metres, devices or other such methods used for measuring the volumes of Water used and Waste discharged, shall be installed, operated and maintained by the Licensee to the satisfaction of an Inspector.

7. The Licensee shall, within ninety (90) days after the first visit by the Inspector following approval of this Licence, post the necessary signs, to identify the stations of the Monitoring Program. All signage postings shall be in Inuktitut and English.

8. The Licensee shall, for all plans submitted under this Licence, include a proposed timetable for implementation. Plans submitted, cannot be undertaken without subsequent written Board approval and direction. The Board may alter or modify a plan if necessary to

achieve the legislative objectives and will notify the Licensee in writing of acceptance, rejection or alteration of the plan.

9. In the event that a plan is not found acceptable to the Board, the Licensee shall, within thirty (30) days of notification by the Board, provide a revised version to the Board, for approval in writing.

10. The Licensee shall, for all plans submitted under this Licence, implement the plan as approved by the Board in writing.

11. Every plan to be carried out pursuant to the terms and conditions of this Licence shall become a part of this Licence, and any additional terms and conditions imposed upon approval of a plan by the Board become part of this Licence. All terms and conditions of the Licence should be contemplated in the development of a plan where appropriate.

12. The Licensee shall review the plans and manuals referred to in this Licence as required by changes in operation and/or technology and revise accordingly. Revisions to the plans or manuals are to be submitted in the form of an addendum to be included with the annual report required by Part B, Item 3, complete with a revisions list detailing where significant content changes are made.

13. The Licensee shall ensure a copy of this Licence is maintained at the municipal office and at the site of operation at all times.

14. Any communication with respect to this Licence shall be made in writing to the attention of:

Manager of Licensing
Nunavut Water Board
P. O. Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369
Email: licensing@nunavutwaterboard.org

15. Any notice made to an Inspector shall be made in writing to the attention of:

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4295
Fax: (867) 979-6445

16. The Licensee shall submit one (1) paper copy and one (1) electronic copy of all reports, studies, and plans to the Board or as otherwise requested by the Board. Reports or studies submitted to the Board by the Licensee shall include an executive summary in English and

Inuktitut.

17. The Licensee shall ensure that any document(s) or correspondence submitted by the Licensee to the Board, is received by the Board and maintain on file a copy of the acknowledgment of receipt issued by the Manager of Licensing.

18. This Licence is assignable as provided for in Section 44 of the Act.

19. The expiry or cancellation of this Licence does not relieve the Licensee from any obligation imposed by the Licence, or any other regulatory requirement.

20. The Licensee shall file a Water Licence Renewal Application with the Board no later than September 1, 2014.

## PART C: CONDITIONS APPLYING TO WATER USE AND MANAGEMENT

1. The Licensee shall obtain all freshwater from Wolf River at Monitoring Program Station ARV-1 as otherwise approved by the Board in writing.

2. The annual quantity of water used for all purposes shall not exceed eighty-six thousand (86, 000) cubic metres per annum, or as otherwise approved by the Board in writing.

3. The Licensee shall equip all water intake hoses with a screen of an appropriate mesh size to ensure that fish are not entrained and shall withdraw Water at a rate such that fish do not become impinged on the screen.

4. The Licensee shall submit to the Board for approval in writing by December 31, 2010, as-built drawings stamped and signed by an Engineer confirming compliance with the DFO guideline "Freshwater Intake End of Pipe Fish Screen Guideline". The drawings shall include information regarding the operating capacity of the pump used and the intake screen size.

5. The Licensee shall not remove any material from below the ordinary high water mark of any Water body.

6. The Licensee shall not cause erosion to the banks of any body of Water and shall provide necessary controls to prevent such erosion.

7. Sediment and erosion control measures shall be implemented prior to and maintained during construction and operation to prevent entry of sediment into Water.

8. The Licensee shall submit to the Board for review by December 31, 2010, the Water balance assessment for Wolf River and an assessment of the potential effects of drawdown of Wolf River on the aquatic environment. The assessment shall include recommended mitigation measures and an implementation schedule.

9. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.

## PART D: CONDITIONS APPLYING TO WASTE DISPOSAL AND MANAGEMENT

1. The Licensee shall direct all Sewage to the Sewage Disposal Facility.

2. All Effluent discharged from the Sewage Disposal Facilities at Monitoring Program Station ARV-4 shall not exceed the following Effluent quality limits, or as otherwise approved by the Board in writing:

| Parameter | Maximum Concentration of any Grab Sample |
|---|---|
| Fecal Coliform | $1 \times 10^4$ CFU/dl |
| $BOD_5$ | 80 mg/l |
| Total Suspended Solids | 100 mg/l |
| Oil and Grease | No visible sheen |
| pH | Between 6 and 9 |

3. A Freeboard limit of 1.0 metre, or as recommended by a qualified Geotechnical Engineer and as approved by the Board in writing, shall be maintained at all dams, dyke or structures intended to contain, withhold, divert or retain Water or Wastes.

4. The Licensee shall provide at least ten (10) days notification to an Inspector, prior to initiating any planned discharges from any Waste Disposal Facility.

5. The Licensee shall submit to the Board for approval in writing by December 31, 2010, a Sewage Disposal Facility Report. The Report shall include:

   a. As-built drawings and design plans of the Sewage Disposal Facility (including the lagoon and wetland) signed and stamped by an Engineer;
   b. A preliminary discharge and wetland hydrology assessment;
   c. The results of an inspection by a Geotechnical Engineer of the Sewage Disposal Facility lagoon including its berms and an evaluation of the impact of sewage seepage through the lagoon berms on the environment;
   d. An evaluation of the long term impacts of the Sewage Disposal Facility on the environment;
   e. A Sludge Management Plan that addresses sludge assessment and disposal methods. The Plan shall be incorporated in to the Sewage Disposal Facility Operations and Maintenance Manual referred to in Part F Item 1b;
   f. Recommended measures to optimize the Sewage Disposal Facility; and
   g. A schedule for implementing recommended measures.

6. The Licensee shall, prior to commissioning of the New Solid Waste Disposal Facility, or as otherwise approved by the Board in writing:

a. Dispose of and contain all non-Hazardous, non-bulky metal, solid Waste at the Solid Waste Disposal Facility;
b. Dispose of and contain all bulky metal Waste at the Bulky Metals Area; and
c. Segregate and securely store all hazardous materials and Hazardous Waste within the Hazardous Waste Storage Area in a manner as to prevent the deposit of deleterious substances into any Water, until such a time that the materials have been removed for proper disposal at a licensed facility.

7. The Licensee shall not open burn plastics, wood treated with preservatives, electric wire, styrofoam, asbestos or painted wood to prevent the deposition of Waste materials of incomplete combustion and/or leachate from contaminated ash residual, from impacting any surrounding Waters, or as otherwise approved by the Board in writing.

8. The Licensee shall maintain records of all Waste removed from site and records of confirmation of proper disposal of removed Waste. These records shall be made available to an Inspector upon request.

9. The Licensee shall store and contain all Petroleum Hydrocarbon Impacted Soil in a manner as to prevent the deposit of deleterious substances into any Water.

10. The Licensee shall submit to the Board for approval in writing, at least sixty (60) days prior to the commissioning of a Hydrocarbon Impacted Soil Storage and Treatment Facility, a Hydrocarbon Impacted Soil Storage and Treatment Facility Management Plan including proposed Effluent quality limits for Monitoring Program Station ARV-10.

11. The Licensee shall dispose of all Effluent from contaminated soil areas and the Hydrocarbon Impacted Soil Storage and Treatment Facility, that exceed Effluent quality limits approved by the Board in Part D Item 14 (c) and Part D Item 10 respectively, off site at a licensed hazardous waste facility, or as otherwise approved by the Board in writing.

12. The discharge locations for all treated Effluents from the Hydrocarbon Impacted Soil Storage and Treatment Facility and contaminated soil areas shall be located at a minimum of thirty one (31) metres from the ordinary high water mark of any Water body and where direct or indirect flow into a Water body is not possible and no additional impacts are created.

13. The Licensee shall, prior to the removal of any treated soil from the Hydrocarbon Impacted Soil Storage and Treatment Facility, obtain written documentation from the Government of Nunavut Environmental Protection Service, confirming that the soils have been treated in accordance with the Government of Nunavut's "*Environmental Guideline for Contaminated Site Remediation, 2009"* for its intended use.

14. The Licensee shall submit to the Board for approval in writing by December 31, 2010, a Solid Waste Management Report. The Report shall include:

a. As-built drawings of the Solid Waste Disposal Facility, Hazardous Waste Storage Area, and Bulky Metals Area, signed and stamped by an Engineer;
b. Capacity assessment of the Solid Waste Disposal Facility;
c. An inventory and assessment of contaminated soil and water at the Solid Waste Disposal Facility, Bulky Metals Area, and Hazardous Waste Storage Area, and a plan for the treatment and disposal of contaminated soil and water including proposed Effluent quality limits for Monitoring Program Station ARV-11;
d. Recommendations for Water and wastewater containment, treatment, and drainage control. This Plan shall be incorporated into the Solid Waste Disposal Facility Operations and Maintenance Plan referred to in Part F Item 2d.
e. Recommended measures to optimize solid waste management; and
f. A schedule for implementing recommended measures.

15. Licensee shall implement measures to ensure hazardous materials and/or leachate from the Waste Disposal Facilities does not enter Water.

16. Licensee shall, annually between the months of June and September, undertake a geotechnical inspection to be carried out by a Geotechnical Engineer that takes into account all facilities intended to contain, withhold, divert or retain Water or Wastes. The inspection shall be conducted in accordance with the Canadian Dam Safety Guidelines, where applicable.

17. The Licensee shall, within sixty (60) days of completion of the geotechnical inspection referred to in Part D, Item 16, submit to the Board for review, the Geotechnical Engineer's inspection Report. The Licensee shall include a cover letter outlining an implementation plan to address the recommendations of the Geotechnical Engineer.

18. The Licensee shall maintain and operate all Water Supply Facilities and Waste Disposal Facilities in such a manner as to prevent structural failure.

## PART E: CONDITIONS APPLYING TO MODIFICATIONS AND CONSTRUCTION

1. The Licensee shall, at least sixty (60) days prior to construction of the New Solid Waste Disposal Facility and/or the Hydrocarbon Impacted Soil Storage and Treatment Facility, or any dams, dykes or structures intended to contain, withhold, divert or retain Water or Wastes, submit to the Board, for approval in writing, final design Plans and construction drawings signed and stamped by an Engineer.

2. The Licensee shall obtained approval from the Board in writing prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain Water or Wastes.

3. The Licensee may, without written approval from the Board, carry out Modifications provided that such Modifications are consistent with the terms of this Licence and the following requirements are met:

a. The Licensee has notified the Board in writing of such proposed Modifications at least sixty (60) days prior to beginning the Modifications to include:
   i. A description of the facilities and/or works to be constructed;
   ii. The proposed location of the structure(s);
   iii. Identification of any potential impacts to the receiving environment;
   iv. A description of any monitoring required, including sampling locations, parameters measured and frequencies of sampling;
   v. Schedule for construction;
   vi. Drawings of engineered structures signed and stamped by an Engineer; and
   vii. Proposed sediment and erosion control measures.
b. The proposed Modifications do not place the Licensee in contravention of the Licence or the Act;
c. The Board has not, within sixty (60) days following notification of the proposed Modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and
d. The Board has not rejected the proposed Modifications;

4. Modifications for which any of the conditions referred to above have not been met can be carried out only with approval from the Board in writing.

5. The Licensee shall provide as-built plans and drawings of the construction and/or Modifications referred to in Part E of this Licence within ninety (90) days of completion of the Construction or Modification. These plans and drawings shall be signed and stamped by an Engineer.

## PART F: CONDITIONS APPLYING TO OPERATIONS AND MAINTENACE

1. The Licensee shall, within sixty (60) days following Board approval of the Sewage Disposal Facility Report referred to in Part D, Item 5, submit to the Board, for approval in writing, a revision to the Plan entitled "Sewage Treatment Facility Operation and Maintenance (O&M) Plan, Hamlet of Arviat" May 2009, revised May 2010, to address the following:

   a. Requirements of the Licence;
   b. Sludge Management Plan referred to in Part D Item 5e; and
   c. Results of the Sewage Disposal Facility Report referred to in Part D Item 5.

2. The Licensee shall, within sixty (60) days following Board approval of the Solid Waste Disposal Facility Report referred to in Part D Item 14, submit to the Board, for approval in writing, a revision to the Plan entitled "Solid Waste Management Facility Operation and Maintenance (O&M) Plan, Hamlet of Arviat" January 2009, revised May 2010, to address the following:

   a. Requirements of the Licence;
   b. Bulky Waste Management Plan;

c. Hazardous Waste Management Plan including Hazardous Waste containment and segregation measures, and procedures for the movement of Hazardous Waste;
d. Recommendations for Water and wastewater containment, treatment, and drainage control as referred to in Part D Item 14(d); and
e. Results of the Solid Waste Disposal Facility Report referred to in Part D Item 14.

3. The Licensee shall, at least three (3) months prior to commissioning the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, submit to the Board, for approval in writing, a revised Solid Waste Management Facility Operations and Maintenance (O&M) Plan referred to in Part F Item 2 to address the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility.

4. The Licensee shall, in preparation of the revised plan referred to in Part F, Item 3, consult Environment Canada for guidance related to Petroleum Hydrocarbon Impacted Soils storage and treatment facility design, siting, operation, monitoring, sampling and analytical methods, decommissioning and closure, as well as record keeping and reporting.

5. The Licensee shall, by December 31, 2010, submit to the Board for review, an Addendum to the approved Plan entitled "Environmental Emergency Contingency Plan, Hamlet of Arviat" May 2009, revised May 2010, to address reviewers' comments including the following:

   a. Procedures for the movement of Hazardous Waste;
   b. Contact information for the Government of Nunavut Department of Environment Manager of Pollution; and
   c. Detailed information regarding clean-up methods/procedures for spills on Water or ice.

6. If, during the period of this Licence, an unauthorized discharge of Waste and or Effluent occurs, or if such discharge is foreseeable, the Licensee shall:

   a. Employ as required, the approved Environmental Emergency Contingency Plan referred to in Part F Item 5;
   b. Report the incident immediately via the 24-Hour Spill Reporting Line (867) 920-8130 and to the Inspector at (867) 975-4295; and
   c. For each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain, clean up and restore the spill site.

## PART G: CONDITIONS APPLYING TO ABANDONMENT, RESTORATION AND CLOSURE

1. The Licensee shall, by December 31, 2010, submit to the Board, for review, an interim Abandonment and Restoration Plan for the Solid Waste Disposal Facility, Bulky Metals Area, Hazardous Waste Storage Area and any contaminated sites identified in the Solid Waste Management Report referred to in Part D Item 14 (c). The Plan shall incorporate, where applicable, the appropriate sections described in Part G Item 3.

2. The Licensee shall, by December 31, 2010, submit to the Board, for approval in writing, a Final Abandonment and Restoration Plan for the two abandoned sewage lagoons. The Plan shall incorporate, where applicable, the appropriate sections described in Part G Item 3.

3. The Licensee shall, at least six (6) months prior to abandoning any facilities or upon submission of final design drawings for the construction of new facilities to replace existing ones, submit to the Board, for approval in writing, a Final Abandonment and Restoration Plan for the facilities being decommissioned. The Plan shall incorporate, where applicable, information on the following:

    a. Water intake facilities;
    b. The water treatment and waste disposal sites and facilities;
    c. Former dump sites;
    d. Petroleum and chemical storage areas;
    e. Any site affected by waste spills;
    f. Leachate prevention;
    g. An implementation and completion schedule;
    h. Maps delineating all disturbed areas, and site facilities;
    i. Consideration of altered drainage patterns;
    j. Type and source of cover materials;
    k. Future area use;
    l. Hazardous Wastes; and
    m. A proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

4. The Licensee shall carry out progressive reclamation of any Water Supply Facilities and Waste Disposal Facilities no longer required for the Licensee's operations.

5. In order to promote growth of vegetation and the needed microclimate for seed deposition, all disturbed surfaces shall be prepared by ripping, grading, or scarifying the surface to conform to the natural topography.

6. The Licensee shall, prior to the use of reclaimed soils that have been contaminated by hydrocarbons, or soils referred to in Part D, Item 14(c), consult with the Government of Nunavut, Department of Environment and obtain written confirmation that the soil meets

the objectives as outlined in the Government of Nunavut's *Environmental Guideline for Contaminated Site Remediation*, March 2009 (Revised).

7. The Licensee shall complete the restoration work within the time schedule specified in an approved Abandonment and Restoration Plan, or as subsequently revised and approved by the Board in writing.

8. The Licensee shall complete all restoration work prior to the expiry of this Licence.

## PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

1. The Licensee shall maintain Monitoring Program Stations at the following locations:

| Station Number | Description | Frequency | Status |
|---|---|---|---|
| ARV-1 | Raw water supply at Wolf River prior to treatment. | Monthly | Active (Volume) |
| ARV-2a | Effluent from the discharge point of the Solid Waste Disposal Facility. | Quality<br>Monthly during the months of May to August and prior to discharge of accumulated impacted water.<br><br>Acute Toxicity<br>Annually | Active (Quality and Acute Toxicity) |
| ARV-2b | Effluent from the discharge point of the New Solid Waste Disposal Facility. | Quality<br>Monthly during the months of May to August and prior to discharge of accumulated impacted water.<br><br>Acute Toxicity<br>Annually | Active (Quality and Acute Toxicity) |
| ARV-3 | Raw Sewage at truck offload point. | Monthly | Not active |

| | | | |
|---|---|---|---|
| ARV-4 | Effluent from the discharge point of the Sewage Disposal Facility (end of Wetland). | Quality<br>Monthly during the months of May to August.<br><br>Acute Toxicity<br>Annually | Active<br>(Quality and Acute Toxicity) |
| ARV-5 | Discharge from the Bulky Metal Waste Area. | Monthly during periods of observed flow. | New<br>(Quality) |
| ARV-6 | Discharge from the Hazardous Waste Storage Area. | Monthly during periods of observed flow. | New<br>(Quality) |
| ARV-7 | Water level in Wolf River. | Monthly during periods of open water. | New<br>(Water level) |
| ARV-8 | Water level in Sewage Disposal Facility lagoon. | Monthly during thawed conditions. | New<br>(Sewage level) |
| ARV-9 | Sewage Sludge removed from the Sewage Disposal Facility. | Monthly | New<br>(Volume) |
| ARV-10 | Effluent from the Final Discharge Point of the Hydrocarbon Impacted Soil Storage and Treatment Facility | To be determined in accordance with Part D Item 10 | New<br>(To be determined in accordance with Part D Item 10) |
| ARV-11 | Effluent discharge from dewatering contaminated soil areas. | To be determined in accordance with Part D Item 14 (c) | New<br>(To be determined in accordance with Part D Item 14 (c)) |

2. The Licensee shall, by December 31, 2010, maintain a water level Monitoring Program Station (ARV-7) at Wolf River.

3. The Licensee shall, by December 31, 2010, maintain a lagoon level Monitoring Program Station (ARV-8) at the Sewage Disposal Facility.

4. The Licensee shall provide the GPS co-ordinates (in degrees, minutes and seconds of latitude and longitude) of all locations where sources of Water are utilized for all purposes and at all Monitoring Program Stations.

5. The Licensee shall confirm the locations and GPS coordinates for all Monitoring Program Stations referred to in Part H Item 1 with an Inspector.

6. The Licensee shall determine the locations and GPS coordinates of any additional Monitoring Program Stations required for any new Waste Disposal Facilities with an Inspector.

7. The Licensee shall measure and record in cubic metres, the monthly and annual quantities of Water extracted for all purposes at Monitoring Program Station ARV-1.

8. The Licensee shall carry out, at a minimum, weekly inspections at Monitoring Program Stations ARV-2a, ARV-5, ARV-6, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, from May to August inclusive, to identify Effluent or Water flow in order to fulfill the monitoring requirements of Part H, Item 9. A record of inspections shall be retained and made available to an Inspector upon request.

9. The Licensee shall sample monthly at Monitoring Program Stations ARV-2a, ARV-4, ARV-5, ARV-6, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, during the months of May to August, inclusive. Samples shall be analyzed for the following parameters:

| | |
|---|---|
| $BOD_5$ | Faecal Coliforms |
| pH | Conductivity |
| Total Suspended Solids | Ammonia Nitrogen |
| Nitrate – Nitrite | Oil and Grease (visual) |
| Total Phenols | Sulphate |
| Sodium | Potassium |
| Magnesium | Calcium |
| Total Arsenic | Total Cadmium |
| Total Copper | Total Chromium |
| Total Iron | Total Lead |
| Total Mercury | Total Nickel |
| Total Zinc | Total Phosphorous |

10. The Licensee shall conduct the following acute toxicity tests at Monitoring Program Stations ARV-2a and ARV-4, and Station ARV-2b upon commissioning of the New Solid Waste Disposal Facility, once annually between June and September, approximately mid-way through the discharge period:

    a. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout (Reference Method EPS 1/RM/13), July 1990, published by the Department of the Environment, as amended in December 2000, and as may be further amended from time to time
    b. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia magna (Reference Method EPS 1/RM/14), July 1990, published by the Department of the Environment, as amended in December 2000, and as may be further amended from time to time.

11. The Licensee shall, when flow volumes at Monitoring Program Stations ARV- 2a, ARV-2b and ARV-4 are not sufficient to conduct the tests required by Part H Item 10, collect samples upstream where adequate flow volume exists.

12. The Licensee shall record water elevation monthly, during open water at Monitoring Program Station ARV-7.

13. The Licensee shall record water elevations monthly during thawed conditions at Monitoring Program Station ARV-8.

14. The Licensee shall measure and record in cubic metres the monthly and annual quantities of Sewage sludge removed from the Sewage Disposal Facility at Monitoring Program Station ARV-9.

15. The Licensee shall submit to the Board for review, by December 31, 2010 a revision to the approved Plan entitled "Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan, Hamlet of Arviat" May 2009, revised May 2010, to address the following:

    a. All monitoring requirements listed under Part H of the Licence;
    b. A covering letter from an accredited laboratory confirming acceptance of the Quality Assurance/ Quality Control (QA/QC) Plan for analyses to be performed under this Licence as required under Part H, Item 17.

16. The Licensee shall, at least six (60) days prior to commissioning the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility, submit to the Board, for approval in writing, a revision to the Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan, referred to in Part H Item 15, to address the New Solid Waste Disposal Facility and/or Hydrocarbon Impacted Soil Storage and Treatment Facility.

17. The Licensee shall annually review the QA/QC Plan referred to in Part H, Item 15 and modify it as necessary. The revised QA/QC Plan shall be submitted to the Board for review, accompanied by a current approval letter from an accredited lab and shall meet the standards as set out in Part H, Item 20 and Part H, Item 21 of the Licence.

18. The Licensee shall measure and record the volume of all contaminated soil, from all locations entering the Hydrocarbon Impacted Soil Storage and Treatment Facility.

19. The Licensee shall assess and record the concentration of Petroleum Hydrocarbon Impacted Soil entering any Hydrocarbon Impacted Soil Storage and Treatment Facility from all sources, as per the CCME *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil, User Guide, January 2008*.

20. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board.

21. All analyses shall be performed in a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.

22. The Licensee shall include all of the data and information required by the Monitoring Program in the Licensee's Annual Report, as required per Part B, Item 3(a) or as otherwise requested by an Inspector.

23. Modifications to the Monitoring Program may be made only upon written request and subsequent approval of the Board in writing.

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# Appendix B
# Photographs


Solid Waste Disposal Site Date: 9/11/2010
Landfill, looking south across fill area at front of landfill.

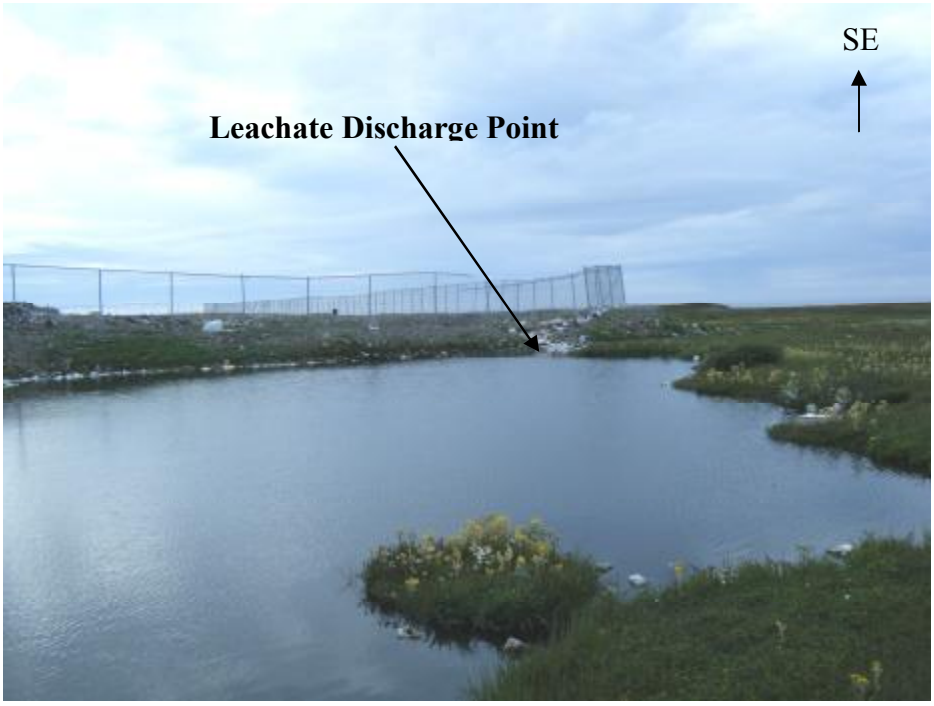

Solid Waste Disposal Site Date: 9/11/2010
North west side of landfill with waste covered.


Solid Waste Disposal Site Date: 9/11/2010
Looking southeast along north fence of landfill.


Solid Waste Disposal Site Date: 9/11/2010
Accumulated surface water at southeast corner of landfill.

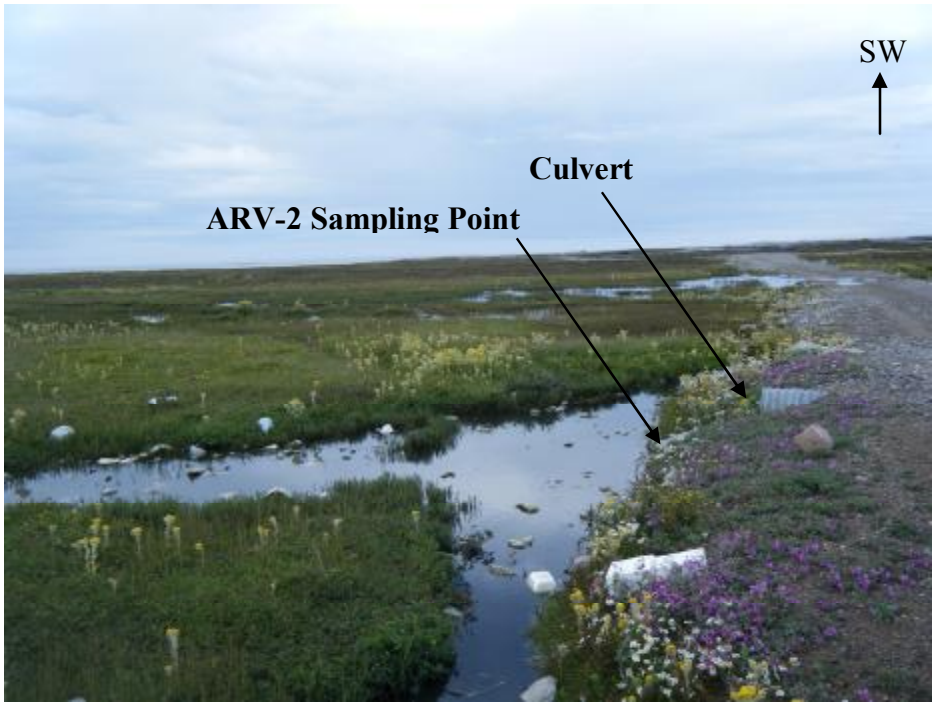

Solid Waste Disposal Site Date: 9/11/2010
Outside of south berm of landfill.


Solid Waste Disposal Site Date: 9/11/2010
Outside of west berm of landfill.




Solid Waste Disposal Site Date: 7/26/2010

Looking southeast across tundra pond which collects the leachate discharge from the landfill.




Solid Waste Disposal Site Date: 7/26/2010

ARV-2 monitoring station sample location adjacent to southwest corner of landfill.


Solid Waste Disposal Site Date: 9/9/2010
Wetlands down gradient of landfill, Contaminant Attenuation Zone.


Bulky Metals Waste Area Date: 9/8/2010
Contaminated soil piles and old fuel tanks and drums.


Bulky Metals Waste Area Date: 9/8/2010
Stock piles of contaminated soil.


Bulky Metals Waste Area Date: 9/8/2010
Looking towards waste area from wetlands south of site.


Bulky Metals Waste Area Date: 9/8/2010
Water ponding on south side of disposal area, sample location BW-1.


Hazardous Waste Storage Area Date: 9/9/2010
Waste oil drums stored next to Hamlet garage.


Hazardous Waste Storage Area Date: 9/9/2010
Stained soil beside waste oil drums.


Hazardous Waste Storage Area Date: 9/9/2010
Surface water on south side of Hazardous Waste Storage Area.

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# Appendix C
# Calculation Worksheets

# Waste Quantity Calculations - Hamlet of Arviat, Nunavut

| Calendar ear | Projected Population people | Annual olume of Solid Waste $m^3$ | Annual olume of Combustible Solid Waste $m^3$ | Annual olume of Combustible Solid Waste After Burning $m^3$ | Annual olume of Uncombustible Solid Waste $m^3$ | Total Annual olume of Uncombustible and Combusted (Burned) Solid Waste $m^3$ | Annual olume of Cover Material $m^3$ | Total Annual olume of Waste and Cover Material $m^3$ |
|---|---|---|---|---|---|---|---|---|
| 2006 | 2060 | 10527 | 2105 | 632 | 8421 | 9053 | 1811 | 10863 |
| 2007 | 2126 | 10864 | 2173 | 652 | 8691 | 9343 | 1869 | 11212 |
| 2008 | 2195 | 11216 | 2243 | 673 | 8973 | 9646 | 1929 | 11575 |
| 2009 | 2266 | 11579 | 2316 | 695 | 9263 | 9958 | 1992 | 11950 |
| 2010 | 2339 | 11952 | 2390 | 717 | 9562 | 10279 | 2056 | 12335 |
| 2011 | 2414 | 12336 | 2467 | 740 | 9868 | 10609 | 2122 | 12730 |
| 2012 | 2492 | 12734 | 2547 | 764 | 10187 | 10951 | 2190 | 13142 |
| 2013 | 2572 | 13143 | 2629 | 789 | 10514 | 11303 | 2261 | 13563 |
| 2014 | 2655 | 13567 | 2713 | 814 | 10854 | 11668 | 2334 | 14001 |
| 2015 | 2740 | 14001 | 2800 | 840 | 11201 | 12041 | 2408 | 14449 |
| 2016 | 2828 | 14451 | 2890 | 867 | 11561 | 12428 | 2486 | 14914 |
| 2017 | 2919 | 14916 | 2983 | 895 | 11933 | 12828 | 2566 | 15393 |
| 2018 | 3013 | 15396 | 3079 | 924 | 12317 | 13241 | 2648 | 15889 |
| 2019 | 3110 | 15892 | 3178 | 954 | 12714 | 13667 | 2733 | 16401 |
| 2020 | 3210 | 16403 | 3281 | 984 | 13122 | 14107 | 2821 | 16928 |
| 2021 | 3313 | 16929 | 3386 | 1016 | 13544 | 14559 | 2912 | 17471 |
| 2022 | 3420 | 17476 | 3495 | 1049 | 13981 | 15030 | 3006 | 18035 |
| 2023 | 3530 | 18038 | 3608 | 1082 | 14431 | 15513 | 3103 | 18616 |
| 2024 | 3643 | 18616 | 3723 | 1117 | 14893 | 16010 | 3202 | 19211 |
| 2025 | 3760 | 19214 | 3843 | 1153 | 15371 | 16524 | 3305 | 19828 |
| 2026 | 3881 | 19832 | 3966 | 1190 | 15866 | 17055 | 3411 | 20467 |
| 2027 | 4006 | 20471 | 4094 | 1228 | 16377 | 17605 | 3521 | 21126 |
| 2028 | 4135 | 21130 | 4226 | 1268 | 16903.9 | 18172 | 3634 | 21806 |
| 2029 | 4268 | 21809 | 4362 | 1309 | 17447.6 | 18756 | 3751 | 22507 |

**Calculation Assumptions**
20% of waste is combustible
30% of combustible waste is remaining after burning
There is no compaction.
20% cover material required per volume of garbage
Population growth rate is 3.2%

# Hydrology Calculations, Hamlet of Arviat

| | |
|---|---|
| Annual Rainfall (m/year) | 0.2972 |
| Evapotranspiration (m/year) | 0.200 |

Canadian Climate Normals 1971-2000, Environment Canada, Rankin Inlet Airport Weather Station

Specific values for Arviat were not available, estimated using several references, see below.

| | |
|---|---|
| Surface Area of Landfill ($m^2$) | 33825 |
| Rain ($m^3$/year) | 10,053 |
| Evapotranspiration ($m^3$/year) | 6,765 |
| Net Precipitation Input to Landfill ($m^3$/year) | 3,288 |

**Evapotranspiration Rates**

| Location | alue (mm) | Reference |
|---|---|---|
| Arviat, Nunavut | 203 | FSC Architects & Engineers, 2003 |
| Mackenzie Basin, Yukon | 241 | Serrereze et al, 2003 |
| Lena Basin, Russai | 182 | Serrereze et al, 2003 |
| Knob Lake, Quebec | 280 | Church, 1974 |
| Boot Creek, Inuvik, NWT | 75 | Church, 1974 |
| Mackenzie River Basin, Yukon | 216 | Yi Yip, 2008 |
| **Average** | **200** | |

**References**

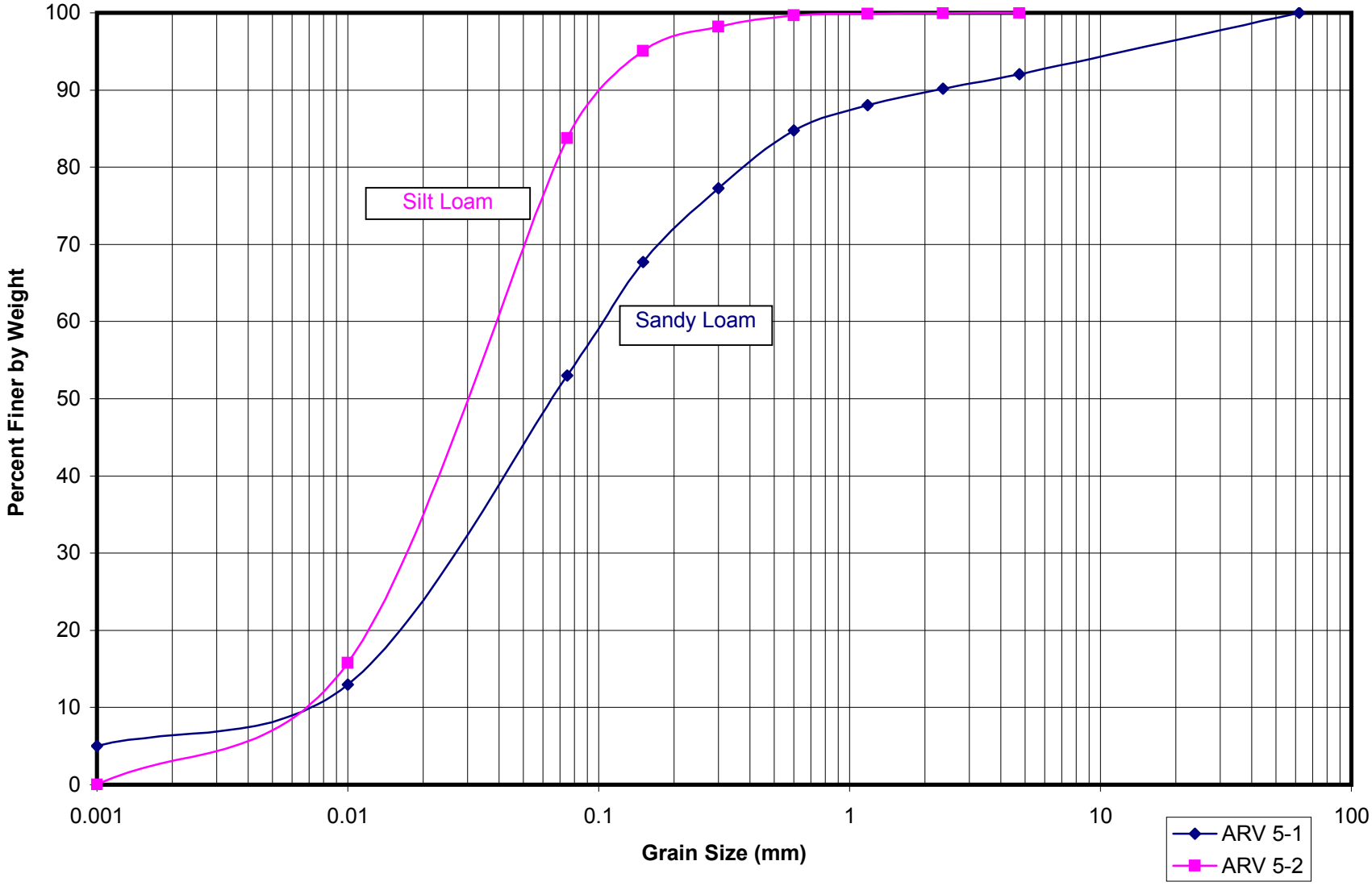

FSC Architects & Engineers, 2003. Design Concept for Arviat Sewage Lagoon prepared for Department of Community Government and Transportation, Government of Nunavut.

Church, M. 1974. Hydrology and Permafrost with Reference to Northern North America. In Proceedings: Workshop Seminar on Permafrost Hydrology, 7-20. Ottawa: Canadian National Committee, International Hydrological Decade (IHD).

Yi Yip, Q.M. 2008. Climate Impacts on Hydrometric Variables in Mackenzie River Basin. University of Waterloo, Waterloo, 2008.

Serreze, M.C., D.H. Bromwich, M.P. Clark, A.J. Etringer, T. Zhang and R. Lammers, 2003. Large-scale hydro-climatology of the terrestrial Arctic drainage system. Journal Geophysical Research, 108(D2). Doi:10. 1029/2002JD000919

# Grain Size Distribution Plot -
# Soil Samples from Bulky Waste Storage Area




Nuna Burnside Engineering and Environmental Ltd.
15746_SWM_Calculations.xls
Dec 2010

Hamlet of Arviat
N-O157460

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# Appendix D
# Sampling Results

## Table D-1 Summary of Water Quality Analysis - Landfill

| Parameter | Unit | Detection Limits | CCME Guidelines | AR -2 | AR -2 | AR -2 |
|---|---|---|---|---|---|---|
| | | | | 7 23 2010 | 9 1 2010 | 9 10 2010 |
| Colour | TCU | 5 | | 102 | - | - |
| Electrical Conductivity | S/cm | 2 | | 2010 | 2520 | 2630 |
| pH | N/A | - | | 8.07 | 8.11 | 8.21 |
| Turbidity | NTU | 0.5 | | 8.1 | - | - |
| Total Suspended Solids | mg/L | 10 | | 14 | <5.0 | 8 |
| Alkalinity (as CaCO3) | mg/L | 5 | | 440 | - | - |
| Bicarbonate (as CaCO3) | mg/L | 5 | | 440 | - | - |
| Total Hardness (as CaCO3) | mg/L | 10 | | 783 | - | - |
| Ammonia as N | mg/L | 0.02 | | 11 | 12.9 | 13.3 |
| Nitrate as N | mg/L | 0.05 | | <0.05 | <0.25 | <0.25 |
| Nitrite as N | mg/L | 0.05 | | <0.05 | <0.25 | <0.25 |
| Calcium | mg/L | 0.05 | | 248 | 244 | 230 |
| Chloride | mg/L | 0.1 | | 244 | - | - |
| Fluoride | mg/L | 0.05 | | <0.05 | - | - |
| Magnesium | mg/L | 0.05 | | 39.7 | 43 | 49 |
| Orthophosphate as P | mg/L | 0.1 | | 0.33 | - | - |
| Potassium | mg/L | 0.05 | | 44.7 | 43.9 | 44 |
| Reactive Silica | mg/L | 0.05 | | 9.17 | - | - |
| Sodium | mg/L | 0.05 | | 178 | 228 | 243 |
| Sulphate | mg/L | 0.1 | | 539 | 461 | 475 |
| Total Dissolved Solids | mg/L | 20 | | 1570 | - | - |
| Total Organic Carbon | mg/L | 0.5 | | 52 | - | - |
| Total Phosphorus | mg/L | 0.05 | | 0.64 | 0.62 | 0.56 |
| $BOD_{(5)}$ | mg/L | 1 | | 13 | 6.4 | <6.0 |
| Fecal Coliform | MPN/100ml | 3 | | - | 430 | 38 |
| Escherichia coli | MPN/100ml | 3 | | - | - | - |
| Aluminum | mg/L | 0.004 | 0.1 | 0.02 | 0.0219 | 0.0095 |
| Arsenic | mg/L | 0.003 | 0.005 | 0.005 | 0.00468 | 0.00482 |
| Barium | mg/L | 0.002 | | 0.05 | 0.0471 | 0.0458 |
| Boron | mg/L | 0.01 | | 1.22 | 1.49 | 1.34 |
| Cadmium | mg/L | 0.002 | 0.00054-0.00004[1] | <0.002 | <0.00001 | <0.00010 |
| Chromium Total | mg/L | 0.003 | | 0.013 | <0.001 | <0.0010 |
| Chromium VI | mg/L | 0.005 | 0.001 | <0.005 | - | - |
| Cobalt | mg/L | - | | - | 0.00051 | 0.00051 |
| Copper | mg/L | 0.003 | 0.002-0.004[1] | **0.007** | 0.00129 | 0.00149 |
| Iron | mg/L | 0.01 | 0.30 | **0.936** | **0.516** | **0.529** |
| Lead | mg/L | 0.002 | 0.001-0.007[1] | **0.028** | 0.000153 | 0.000145 |
| Manganese | mg/L | 0.002 | | 0.983 | 0.663 | 0.599 |
| Mercury | mg/L | 0.0001 | 0.000026 | <0.0001 | <0.00005 | <0.000050 |
| Molybdenum | mg/L | 0.002 | 0.073 | <0.002 | 0.00039 | 0.00036 |
| Nickel | mg/L | 0.003 | 0.025-0.15[1] | 0.004 | 0.0024 | <0.0020 |
| Selenium | mg/L | 0.004 | 0.001 | <0.004 | <0.001 | <0.0010 |
| Silver | mg/L | 0.002 | 0.0001 | <0.002 | <0.0001 | <0.00010 |
| Strontium | mg/L | 0.005 | | 1.68 | 1.53 | 1.66 |
| Thallium | mg/L | 0.006 | 0.0008 | <0.006 | <0.0001 | <0.00010 |
| Titanium | mg/L | 0.002 | | 0.01 | 0.00166 | 0.00299 |
| Uranium | mg/L | 0.002 | | <0.002 | 0.00064 | 0.00063 |
| Vanadium | mg/L | 0.002 | | <0.002 | 0.00071 | 0.00061 |
| Zinc | mg/L | 0.005 | 0.03 | **0.077** | 0.0203 | 0.016 |
| Phenols | mg/L | 0.001 | 0.004 | **0.005** | <0.001 | 0.002 |
| Total Oil and Grease | mg/L | 0.5 | | 5.2 | 2.4 | <1.0 |

**BOLD** - indicates exceedence of CCME standards

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Updated 2007

[1] Value depends on water hardness, see CCME Guidelines

TNTC - indicates Too Numerous To Count

## Table D-1 Summary of Water Quality Analysis - Landfill

| Parameter | Unit | Detection Limits | CCME Guidelines | LF-1 | LF-2 | LF-3 | AR -2 |
|---|---|---|---|---|---|---|---|
| | | | | 9 9 2010 | 9 9 2010 | 9 9 2010 | 11 1 2010 |
| Colour | TCU | 5 | | 30 | 55 | 49 | - |
| Electrical Conductivity | S/cm | 2 | | 1750 | 2040 | 2070 | - |
| pH | N/A | - | | 7.9 | 8.03 | 8.27 | - |
| Turbidity | NTU | 0.5 | | 0.9 | 3.3 | 1.6 | - |
| Total Suspended Solids | mg/L | 10 | | 288 | 21 | <10 | - |
| Alkalinity (as CaCO3) | mg/L | 5 | | 252 | 322 | 263 | - |
| Bicarbonate (as CaCO3) | mg/L | 5 | | 252 | 322 | 263 | - |
| Total Hardness (as CaCO3) | mg/L | 10 | | 808 | 735 | 599 | - |
| Ammonia as N | mg/L | 0.02 | | <0.02 | 1.23 | 0.26 | - |
| Nitrate as N | mg/L | 0.05 | | <0.05 | 0.81 | <0.05 | - |
| Nitrite as N | mg/L | 0.05 | | - | - | - | - |
| Calcium | mg/L | 0.05 | | 283 | 225 | 169 | - |
| Chloride | mg/L | 0.1 | | 114 | 267 | 334 | - |
| Fluoride | mg/L | 0.05 | | <0.05 | <0.05 | <0.05 | - |
| Magnesium | mg/L | 0.05 | | 24.5 | 42.1 | 43.1 | - |
| Orthophosphate as P | mg/L | 0.1 | | <0.1 | <0.1 | <0.1 | - |
| Potassium | mg/L | 0.05 | | 20.8 | 30.6 | 37.5 | - |
| Reactive Silica | mg/L | 0.05 | | 15.9 | 8.84 | 9.34 | - |
| Sodium | mg/L | 0.05 | | 82.5 | 171 | 204 | - |
| Sulphate | mg/L | 0.1 | | 650 | 518 | 469 | - |
| Total Dissolved Solids | mg/L | 20 | | 1440 | 1520 | 1450 | - |
| Total Organic Carbon | mg/L | 0.5 | | 36.5 | 25.8 | 26.5 | - |
| Total Phosphorus | mg/L | 0.05 | | 1.57 | 0.34 | 0.2 | - |
| BOD $_{(5)}$ | mg/L | 1 | | 27.4 | 6.0 | 2.6 | 34 |
| Fecal Coliform | MPN/100ml | 3 | | 23 | 9 | 4 | TNTC |
| Escherichia coli | MPN/100ml | 3 | | - | - | - | TNTC |
| Aluminum | mg/L | 0.004 | 0.1 | <0.004 | 0.006 | 0.004 | - |
| Arsenic | mg/L | 0.003 | 0.005 | <0.003 | 0.003 | 0.003 | - |
| Barium | mg/L | 0.002 | | 0.045 | 0.041 | 0.035 | - |
| Boron | mg/L | 0.01 | | 0.736 | 0.805 | 0.773 | - |
| Cadmium | mg/L | 0.002 | 0.00054-0.00004[1] | <0.002 | <0.002 | <0.002 | - |
| Chromium Total | mg/L | 0.003 | | <0.003 | 0.006 | 0.006 | - |
| Chromium VI | mg/L | 0.005 | 0.001 | <0.005 | <0.005 | <0.005 | - |
| Cobalt | mg/L | - | | - | - | - | - |
| Copper | mg/L | 0.003 | 0.002-0.004[1] | <0.003 | <0.003 | <0.003 | - |
| Iron | mg/L | 0.01 | 0.30 | <0.01 | 0.074 | 0.02 | - |
| Lead | mg/L | 0.002 | 0.001-0.007[1] | <0.002 | <0.002 | <0.002 | - |
| Manganese | mg/L | 0.002 | | 0.045 | 0.216 | 0.226 | - |
| Mercury | mg/L | 0.0001 | 0.000026 | <0.0001 | <0.0001 | <0.0001 | - |
| Molybdenum | mg/L | 0.002 | 0.073 | <0.002 | <0.002 | <0.002 | - |
| Nickel | mg/L | 0.003 | 0.025-0.15[1] | <0.003 | 0.003 | <0.003 | - |
| Selenium | mg/L | 0.004 | 0.001 | <0.004 | <0.004 | <0.004 | - |
| Silver | mg/L | 0.002 | 0.0001 | <0.002 | <0.002 | <0.002 | - |
| Strontium | mg/L | 0.005 | | 2.54 | 1.71 | 1.31 | - |
| Thallium | mg/L | 0.006 | 0.0008 | <0.006 | <0.006 | <0.006 | - |
| Titanium | mg/L | 0.002 | | 0.008 | 0.007 | 0.006 | - |
| Uranium | mg/L | 0.002 | | <0.002 | <0.002 | <0.002 | - |
| Vanadium | mg/L | 0.002 | | <0.002 | <0.002 | <0.002 | - |
| Zinc | mg/L | 0.005 | 0.03 | 0.007 | 0.013 | 0.009 | - |
| Phenols | mg/L | 0.001 | 0.004 | - | 0.002 | 0.001 | - |
| Total Oil and Grease | mg/L | 0.5 | | - | - | - | - |

**BOLD** - indicates exceedence of CCME standards

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for th

[1] Value depends on water hardness, see CCME Guidelines

TNTC - indicates Too Numerous To Count

## Table D-1 Summary of Water Quality Analysis - Landfill

| Parameter | Unit | Reported Detection Limits | CCME Guidelines - Fresh Water | AR -2 |
|---|---|---|---|---|
| | | | | 9 10 2010 |
| **Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)** | | | | |
| C6 - C10 (F1) | g/L | 25 | | <25 |
| C6 - C10 (F1 minus BTEX) | g/L | 25 | | <25 |
| C>10 - C16 (F2) | g/L | 100 | | <100 |
| C>10 - C16 (F2 minus Naphthalene) | g/L | 100 | | <100 |
| C6 - C16 (F1 F2) | g/L | 100 | | <100 |
| C>16 - C34 (F3) | g/L | 100 | | <100 |
| C>16 - C34 (F3 minus PAHs) | g/L | 100 | | <100 |
| C>34 - C50 (F4) | g/L | 100 | | <100 |
| C>16 - C50 (F3 F4) | g/L | 100 | | <100 |
| Gravimetric Heavy Hydrocarbons | g/L | 500 | | NA |
| | | | | |
| **PAHs in Water** | | | | |
| Naphthalene | g/L | 0.12 | | <0.12 |
| Acenaphthylene | g/L | 0.11 | | <0.11 |
| Acenaphthene | g/L | 0.10 | 5.8 | <0.10 |
| Fluorene | g/L | 0.09 | 3 | <0.09 |
| Phenanthrene | g/L | 0.10 | 0.4 | <0.10 |
| Anthracene | g/L | 0.07 | | <0.07 |
| Fluoranthene | g/L | 0.12 | 0.04 | <0.12 |
| Pyrene | g/L | 0.12 | 0.025 | <0.12 |
| Benzo(a)anthracene | g/L | 0.08 | 0.018 | <0.08 |
| Chrysene | g/L | 0.05 | | <0.05 |
| Benzo(b)fluoranthene | g/L | 0.05 | | <0.05 |
| Benzo(k)fluoranthene | g/L | 0.06 | | <0.06 |
| Benzo(a)pyrene | g/L | 0.01 | 0.015 | <0.01 |
| Indeno(1,2,3-cd)pyrene | g/L | 0.03 | | <0.03 |
| Dibenzo(a,h)anthracene | g/L | 0.09 | | <0.09 |
| Benzo(g,h,i)perylene | g/L | 0.06 | | <0.06 |
| 2-and 1-methyl Napthalene | g/L | 0.20 | 1.1 | <0.20 |
| Chrysene-d12 | % | | | 98 |
| | | | | |
| **olatile Organic Compounds in Water ( OC s)** | | | | |
| Dichlorodifluoromethane | g/L | 0.80 | | <0.80 |
| Chloromethane | g/L | 1.60 | | <1.60 |
| Vinyl Chloride | g/L | 0.68 | | <0.68 |
| Bromomethane | g/L | 0.80 | | <0.80 |
| Chloroethane | g/L | 0.80 | | <0.80 |
| Trichlorofluoromethane | g/L | 1.60 | | <1.60 |
| Acetone | g/L | 4.0 | | <4.0 |
| 1,1 Dichloroethylene | g/L | 1.20 | | <1.20 |
| Methylene Chloride | g/L | 1.20 | | <1.20 |
| trans- 1,2-dichloroethylene | g/L | 0.80 | | <0.80 |
| Methyl tert-butyl ether | g/L | 0.80 | | <0.80 |
| 1,1-Dichloroethane | g/L | 1.20 | | <1.20 |
| Methyl Ethyl Ketone | g/L | 4.0 | | <4.0 |
| cis- 1,2-Dichloroethylene | g/L | 0.80 | | <0.80 |
| Chloroform | g/L | 0.80 | 1.8 | <0.80 |
| 1,2 - Dichloroethane | g/L | 0.80 | 100 | <0.80 |
| 1,1,1-Trichloroethane | g/L | 1.20 | | <1.20 |
| Carbon Tetrachloride | g/L | 0.80 | | <0.80 |
| Benzene | g/L | 0.80 | | <0.80 |
| 1,2-Dichloropropane | g/L | 0.80 | | <0.80 |
| Trichloroethylene | g/L | 0.80 | | <0.80 |
| Bromodichloromethane | g/L | 0.80 | | <0.80 |
| cis-1,3-Dichloropropene | ug/L | 0.80 | | <0.80 |
| Methyl Isobutyl Ketone | g/L | 4.0 | | <4.0 |
| trans-1,3-Dichloropropene | g/L | 1.20 | | <1.20 |
| 1,1,2-Trichloroethane | g/L | 0.80 | | <0.80 |
| Toluene | g/L | 0.80 | | <0.80 |
| 2-Hexanone | g/L | 1.20 | | <1.20 |
| Dibromochloromethane | g/L | 0.40 | | <0.40 |
| Ethylene Dibromide | g/L | 0.80 | | <0.80 |
| Tetrachloroethylene | g/L | 0.80 | | <0.80 |
| 1,1,1,2-Tetrachloroethane | g/L | 0.40 | | <0.40 |
| Chlorobenzene | g/L | 0.40 | | <0.40 |
| Ethylbenzene | g/L | 0.40 | | <0.40 |
| m & p-Xylene | g/L | 0.80 | | <0.80 |
| Bromoform | g/L | 0.40 | | <0.40 |
| Styrene | g/L | 0.40 | | <0.40 |
| 1,1,2,2-Tetrachloroethane | g/L | 0.40 | | <0.40 |
| o-Xylene | g/L | 0.40 | | <0.40 |
| 1,3-Dichlorobenzene | g/L | 0.40 | 150 | <0.40 |
| 1,4-Dichlorobenzene | g/L | 0.40 | 26 | <0.40 |
| 1,2-Dichlorobenzene | g/L | 0.40 | 0.7 | <0.40 |
| 1,2,4-Trichlorobenzene | g/L | 1.20 | 24 | <1.20 |
| 1,3-Dichloropropene (Cis Trans) | g/L | 1.20 | | <1.20 |
| Xylene Mixture (Total) | g/L | 0.80 | | <0.80 |
| n-Hexane | g/L | 0.80 | | <0.80 |
| Toluene-d8 | % Recovery | | | 99 |
| 4-Bromofluorobenzene | % Recovery | | | 92 |

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Updated 2007

## Table D-2 Summary of Water Quality Analysis
## Bulky Metals Area

| Parameter | Unit | Reported Detection Limits (Sept) | Reported Detection Limits (Nov) | CCME Guidelines | BW-1 | AR -5 | AR -5-2 |
|---|---|---|---|---|---|---|---|
| | | | | | 9 9 2010 | 11 2 2010 | 11 2 2010 |
| **Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)** | | | | | | | |
| C6 - C10 (F1) | g/L | 25 | 25 | | <25 | <25 | <25 |
| C6 - C10 (F1 minus BTEX) | g/L | 25 | 25 | | <25 | <25 | <25 |
| C>10 - C16 (F2) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C>10 - C16 (F2 minus Naphthalene) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C6 - C16 (F1 F2) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C>16 - C34 (F3) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C>16 - C34 (F3 minus PAHs) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C>34 - C50 (F4) | g/L | 100 | 100 | | <100 | <100 | <100 |
| C>16 - C50 (F3 F4) | g/L | 100 | 100 | | <100 | <100 | <100 |
| Gravimetric Heavy Hydrocarbons | g/L | 500 | 500 | | NA | NA | NA |
| | | | | | | | |
| **PAHs in Water** | | | | | | | |
| Naphthalene | g/L | 0.12 | 0.12 | | <0.12 | - | - |
| Acenaphthylene | g/L | 0.11 | 0.11 | | <0.11 | - | - |
| Acenaphthene | g/L | 0.10 | 0.10 | 5.8 | <0.10 | - | - |
| Fluorene | g/L | 0.09 | 0.09 | 3 | <0.09 | - | - |
| Phenanthrene | g/L | 0.10 | 0.10 | 0.4 | <0.10 | - | - |
| Anthracene | g/L | 0.07 | 0.07 | | <0.07 | - | - |
| Fluoranthene | g/L | 0.12 | 0.12 | 0.04 | <0.12 | - | - |
| Pyrene | g/L | 0.12 | 0.12 | 0.025 | <0.12 | - | - |
| Benzo(a)anthracene | g/L | 0.08 | 0.08 | 0.018 | <0.08 | - | - |
| Chrysene | g/L | 0.05 | 0.05 | | <0.05 | - | - |
| Benzo(b)fluoranthene | g/L | 0.05 | 0.05 | | <0.05 | - | - |
| Benzo(k)fluoranthene | g/L | 0.06 | 0.06 | | <0.06 | - | - |
| Benzo(a)pyrene | g/L | 0.01 | 0.01 | 0.015 | <0.01 | - | - |
| Indeno(1,2,3-cd)pyrene | g/L | 0.03 | 0.03 | | <0.03 | - | - |
| Dibenzo(a,h)anthracene | g/L | 0.09 | 0.09 | | <0.09 | - | - |
| Benzo(g,h,i)perylene | g/L | 0.06 | 0.06 | | <0.06 | - | - |
| 2-and 1-methyl Napthalene | g/L | 0.20 | 0.20 | 1.1 | <0.20 | - | - |
| Chrysene-d12 | % | | | | 97 | - | - |
| | | | | | | | |
| **olatile Organic Compounds in Water ( OC s)** | | | | | | | |
| 1,1 Dichloroethylene | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| 1,1,1,2-Tetrachloroethane | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| 1,1,1-Trichloroethane | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| 1,1,2,2-Tetrachloroethane | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| 1,1,2-Trichloroethane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| 1,1-Dichloroethane | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| 1,2 - Dichloroethane | g/L | 0.20 | 0.40 | 100 | <0.20 | <0.40 | <2.00 |
| 1,2,4-Trichlorobenzene | g/L | 0.30 | 0.60 | 24 | <0.30 | <0.60 | <3.00 |
| 1,2-Dichlorobenzene | g/L | 0.10 | 0.20 | 0.7 | <0.10 | <0.20 | <1.00 |
| 1,2-Dichloropropane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| 1,3-Dichlorobenzene | g/L | 0.10 | 0.20 | 150 | <0.10 | <0.20 | <1.00 |
| 1,3-Dichloropropene (Cis Trans) | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| 1,4-Dichlorobenzene | g/L | 0.10 | 0.20 | 26 | <0.10 | <0.20 | <1.00 |
| 2-Hexanone | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| 4-Bromofluorobenzene | % Recovery | | | | 92 | 89 | 85 |
| Acetone | g/L | 1.0 | 10.0 | | <1.0 | <2.0 | <10.0 |
| Benzene | g/L | 0.20 | 0.40 | 370 | <0.20 | <0.40 | <2.00 |
| Bromodichloromethane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Bromoform | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Bromomethane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Carbon Tetrachloride | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Chlorobenzene | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Chloroethane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Chloroform | g/L | 0.20 | 0.40 | 1.8 | <0.20 | <0.40 | <2.00 |
| Chloromethane | g/L | 0.40 | 0.80 | | <0.40 | <0.80 | <4.00 |
| cis- 1,2-Dichloroethylene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| cis-1,3-Dichloropropene | ug/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Dibromochloromethane | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Dichlorodifluoromethane | g/L | 0.20 | 0.40 | | 20 | <0.40 | <2.00 |
| Ethylbenzene | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Ethylene Dibromide | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| m & p-Xylene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Methyl Ethyl Ketone | g/L | 1.0 | 10.0 | | <1.0 | <2.0 | <10.0 |
| Methyl Isobutyl Ketone | g/L | 1.0 | 10.0 | | <1.0 | <2.0 | <10.0 |
| Methyl tert-butyl ether | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Methylene Chloride | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| n-Hexane | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| o-Xylene | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Styrene | g/L | 0.10 | 0.20 | | <0.10 | <0.20 | <1.00 |
| Tetrachloroethylene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Toluene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Toluene-d8 | % Recovery | | | | 100 | 76 | 74 |
| trans- 1,2-dichloroethylene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| trans-1,3-Dichloropropene | g/L | 0.30 | 0.60 | | <0.30 | <0.60 | <3.00 |
| Trichloroethylene | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |
| Trichlorofluoromethane | g/L | 0.40 | 0.80 | | 17 | <0.80 | <4.00 |
| Vinyl Chloride | g/L | 0.17 | 0.34 | | <0.17 | <0.34 | <1.70 |
| Xylene Mixture (Total) | g/L | 0.20 | 0.40 | | <0.20 | <0.40 | <2.00 |

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Updated 2007

**BOLD** - indicates exceedence of CCME standards

## Table D-2 Summary of Water Quality Analysis
## Bulky Metals Area

| Parameter | Unit | Reported Detection Limits | CCME Guidelines | AR -5 | AR -5-2 |
|---|---|---|---|---|---|
| | | | | 11 2 2010 | 11 2 2010 |
| Colour | TCU | 5 | | 113 | 1050 |
| Electrical Conductivity | S/cm | 2 | | 1200 | 9230 |
| pH | N/A | - | | 6.61 | 6.31 |
| Turbidity | NTU | 0.5 | | 369 | 239 |
| Alkalinity (as CaCO3) | mg/L | 5 | | 47 | 118 |
| Bicarbonate (as CaCO3) | mg/L | 5 | | 47 | 118 |
| Total Hardness (as CaCO3) | mg/L | 10 | | 248 | 1460 |
| Ammonia as N | mg/L | 0.02 | | <0.02 | 20.8 |
| Nitrate as N | mg/L | 0.05 | | <0.05 | <0.05 |
| Nitrite as N | mg/L | 0.05 | | <0.05 | <0.05 |
| Calcium | mg/L | 0.05 | | 45.5 | 106 |
| Chloride | mg/L | 0.1 | | 340 | 3110 |
| Fluoride | mg/L | 0.05 | | <0.05 | <0.05 |
| Magnesium | mg/L | 0.05 | | 32.7 | 290 |
| Orthophosphate as P | mg/L | 0.1 | | <0.1 | <1.00 |
| Potassium | mg/L | 0.05 | | 7.66 | 57.1 |
| Reactive Silica | mg/L | 0.05 | | 13.8 | 31.8 |
| Sodium | mg/L | 0.05 | | 160 | 1640 |
| Sulphate | mg/L | 0.1 | | 55.9 | 636 |
| Total Dissolved Solids | mg/L | 20 | | 816 | 5930 |
| Total Organic Carbon | mg/L | 0.5 | | 53.6 | 240 |
| Total Phosphorus | mg/L | 0.05 | | 0.87 | 2.42 |
| Aluminum | mg/L | 0.004 | 0.1 | **3.92** | **6.13** |
| Arsenic | mg/L | 0.003 | 0.005 | **0.008** | **0.012** |
| Barium | mg/L | 0.002 | | **0.073** | **0.074** |
| Boron | mg/L | 0.01 | | **0.045** | **0.769** |
| Cadmium | mg/L | 0.002 | 0.00054-0.00004[1] | <0.002 | **0.003** |
| Chromium Total | mg/L | 0.003 | | 0.01 | 0.111 |
| Copper | mg/L | 0.003 | 0.002-0.004[1] | 0.01 | 0.039 |
| Iron | mg/L | 0.01 | 0.3 | **5.85** | **131.0** |
| Lead | mg/L | 0.002 | 0.001-0.007[1] | **0.008** | **0.01** |
| Manganese | mg/L | 0.002 | | 0.49 | 0.831 |
| Mercury | mg/L | 0.0001 | 0.000026 | <0.0001 | <0.0001 |
| Molybdenum | mg/L | 0.002 | 0.073 | <0.002 | 0.003 |
| Nickel | mg/L | 0.003 | 0.025-0.15[1] | 0.012 | 0.049 |
| Selenium | mg/L | 0.004 | 0.001 | <0.004 | <0.004 |
| Silver | mg/L | 0.002 | 0.0001 | <0.002 | <0.002 |
| Strontium | mg/L | 0.005 | | 0.408 | 1.5 |
| Thallium | mg/L | 0.006 | 0.0008 | <0.006 | <0.006 |
| Titanium | mg/L | 0.002 | | 0.114 | 0.132 |
| Uranium | mg/L | 0.002 | | <0.002 | 0.004 |
| Vanadium | mg/L | 0.002 | | 0.022 | 0.056 |
| Zinc | mg/L | 0.005 | 0.03 | **0.068** | **0.079** |

CCME - Canadian Council of Ministers of the Environment, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Updated 2007
**BOLD** - indicates exceedence of CCME standards

# Table D-3 Summary of Analysis - Soil Samples at Bulky Waste Area

| Parameter | Unit | Reported Detection Limit | CCME Guidelines | BW-P1-A | BW-P1-B | BW-P2-A | BW-P2-B |
|---|---|---|---|---|---|---|---|
| | | | | 9 9 2010 | 9 9 2010 | 9 9 2010 | 9 9 2010 |
| **Metals** | | | | | | | |
| Antimony | g/g | 0.8 | | <0.8 | <0.8 | <0.8 | <0.8 |
| Arsenic | g/g | 1 | 12 | 3 | 1 | 2 | 1 |
| Barium | g/g | 2 | 2000 | 26 | 35 | 31 | 31 |
| Beryllium | g/g | 0.5 | | <0.5 | <0.5 | <0.5 | <0.5 |
| Boron | g/g | 5 | | <5 | <5 | <5 | <5 |
| Cadmium | g/g | 0.5 | 22 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chromium | g/g | 2 | 87 | 11 | 15 | 13 | 12 |
| Cobalt | g/g | 0.5 | | 2.7 | 3.9 | 3.2 | 3.2 |
| Copper | g/g | 1 | 91 | 11 | 10 | 18 | 9 |
| Lead | g/g | 1 | 600 | 4 | 4 | 9 | 5 |
| Molybdenum | g/g | 0.5 | | 0.7 | <0.5 | 0.6 | <0.5 |
| Nickel | g/g | 1 | 50 | 6 | 9 | 8 | 7 |
| Selenium | g/g | 0.4 | 2.9 | <0.4 | <0.4 | <0.4 | <0.4 |
| Silver | g/g | 0.2 | | <0.2 | <0.2 | <0.2 | <0.2 |
| Thallium | g/g | 0.4 | 1 | <0.4 | <0.4 | <0.4 | <0.4 |
| Uranium | ug/g | 0.5 | 300 | 1.2 | 1.4 | 1 | 1.3 |
| Vanadium | g/g | 1 | 130 | 14 | 18 | 14 | 16 |
| Zinc | g/g | 5 | 360 | 25 | 34 | 54 | 20 |
| | | | | | | | |
| **Petroleum Hydrocarbons and BTE** | | | | | | | |
| Benzene | g/g | 0.002 | 0.03 | <0.002 | <0.002 | <0.002 | <0.002 |
| Toluene | g/g | 0.002 | 0.37 | <0.002 | <0.002 | <0.002 | <0.002 |
| Ethylbenzene | g/g | 0.002 | 0.082 | <0.002 | <0.002 | <0.002 | <0.002 |
| m & p-Xylene | g/g | 0.002 | | <0.002 | <0.002 | <0.002 | <0.002 |
| o-Xylene | g/g | 0.002 | | <0.002 | <0.002 | <0.002 | <0.002 |
| Xylene Mixture (Total) | g/g | 0.002 | 11 | <0.002 | <0.002 | <0.002 | <0.002 |
| Toluene-d8 | % Recovery | | | 113 | 106 | 112 | 94 |
| 4-Bromofluorobenzene | % Recovery | | | 115 | 103 | 109 | 122 |
| C6 - C10 (F1) | g/g | 5 | 320 | <5 | 11 | <5 | <5 |
| C6 - C10 (F1 minus BTEX) | g/g | 5 | | <5 | 11 | <5 | <5 |
| C>10 - C16 (F2) | g/g | 10 | 260 | **1200** | **3400** | 240 | 130 |
| C>10 - C16 (F2 minus Naphthalene) | g/g | 10 | | 1200 | 3400 | 240 | 130 |
| C>16 - C34 (F3) | g/g | 50 | 1700 | 430 | **1800** | **9100** | 130 |
| C>16 - C34 (F3 minus PAHs) | g/g | 50 | | 430 | 1800 | 9100 | 130 |
| C>34 - C50 (F4) | g/g | 50 | 3300 | <50 | <50 | 730 | 79 |
| Moisture Content | % | 0.1 | | 7.2 | 8.4 | 4.2 | 3 |
| | | | | | | | |
| **PAHs** | | | | | | | |
| Naphthalene | g/g | 0.03 | 22 | <0.03 | 0.04 | 0.04 | <0.03 |
| Acenaphthylene | g/g | 0.02 | | <0.02 | 0.04 | <0.02 | <0.02 |
| Acenaphthene | g/g | 0.03 | | <0.03 | 0.03 | <0.03 | <0.03 |
| Fluorene | g/g | 0.02 | | 0.02 | 0.15 | <0.02 | <0.02 |
| Phenanthrene | g/g | 0.02 | | <0.02 | 0.03 | <0.02 | <0.02 |
| Anthracene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Fluoranthene | g/g | 0.02 | | <0.02 | 0.03 | <0.02 | <0.02 |
| Pyrene | g/g | 0.02 | | 0.02 | 0.06 | 0.03 | <0.02 |
| Benzo(a)anthracene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Chrysene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(b)fluoranthene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(k)fluoranthene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(a)pyrene | g/g | 0.02 | 0.7 | <0.02 | <0.02 | <0.02 | <0.02 |
| Indeno(1,2,3-cd)pyrene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Dibenz(a,h)anthracene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(g,h,i)perylene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 | <0.02 |
| 2-and 1-methyl Naphthalene | g/g | 0.05 | | <0.05 | <0.05 | <0.05 | <0.05 |
| Chrysene-d12 | % | | | 79 | 89 | 100 | 93 |
| | | | | | | | |
| **Other Parameters** | | | | | | | |
| Phenols, Total | mg/kg | 1 | 3.8 | <1 | <1 | <1 | <1 |
| PCBs | g/g | 0.1 | 33 | <0.1 | <0.1 | <0.1 | <0.1 |
| Decachlorobiphenyl | % | | | 97 | 120 | 80 | 90 |

**Guidelines Used**

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Industrial Land Use, Coarse Grained

Canada-Wide Standard for Petroleum Hydrocarbonds in Soil, CCME 2008-2009

# Table D-4 Summary of Soil Analysis - Hazardous Waste Storage Area

| Parameter | Unit | Reported Detection Limit | CCME Guidelines | HW-1 | HW-2 | HW-3 |
|---|---|---|---|---|---|---|
| | | | | 9 10 2010 | 9 10 2010 | 9 10 2010 |
| **Metals** | | | | | | |
| Antimony | g/g | 0.8 | | <0.8 | <0.8 | <0.8 |
| Arsenic | g/g | 1 | 12 | 2 | 4 | 2 |
| Barium | g/g | 2 | 2000 | 22 | 23 | 21 |
| Beryllium | g/g | 0.5 | | <0.5 | <0.5 | <0.5 |
| Boron | g/g | 5 | | <5 | <5 | <5 |
| Cadmium | g/g | 0.5 | 22 | <0.5 | <0.5 | <0.5 |
| Chromium | g/g | 2 | 87 | 8 | 15 | 9 |
| Cobalt | g/g | 0.5 | | 2.4 | 2.7 | 2.4 |
| Copper | g/g | 1 | 91 | 7 | 6 | 9 |
| Lead | g/g | 1 | 600 | 4 | 3 | 3 |
| Molybdenum | g/g | 0.5 | | <0.5 | 1 | 0.5 |
| Nickel | g/g | 1 | 50 | 5 | 7 | 5 |
| Selenium | g/g | 0.4 | 2.9 | <0.4 | <0.4 | <0.4 |
| Silver | g/g | 0.2 | | <0.2 | <0.2 | <0.2 |
| Thallium | g/g | 0.4 | 1 | <0.4 | <0.4 | <0.4 |
| Uranium | ug/g | 0.5 | 300 | 0.9 | 0.9 | 1.2 |
| Vanadium | g/g | 1 | 130 | 12 | 13 | 14 |
| Zinc | g/g | 5 | 360 | 159 | 125 | 31 |
| | | | | | | |
| **Petroleum Hydrocarbons and BTE** | | | | | | |
| Benzene | g/g | 0.002 | 0.03 | <0.002 | <0.002 | <0.002 |
| Toluene | g/g | 0.002 | 0.37 | <0.002 | <0.002 | <0.002 |
| Ethylbenzene | g/g | 0.002 | 0.082 | <0.002 | <0.002 | <0.002 |
| m & p-Xylene | g/g | 0.002 | | <0.002 | <0.002 | <0.002 |
| o-Xylene | g/g | 0.002 | | <0.002 | <0.002 | <0.002 |
| Xylene Mixture (Total) | g/g | 0.002 | 11 | <0.002 | <0.002 | <0.002 |
| Toluene-d8 | % Recovery | | | 100 | 113 | 99 |
| 4-Bromofluorobenzene | % Recovery | | | 120 | 104 | 113 |
| C6 - C10 (F1) | g/g | 5 | 320 | <5 | <5 | <5 |
| C6 - C10 (F1 minus BTEX) | g/g | 5 | | <5 | <5 | <5 |
| C>10 - C16 (F2) | g/g | 10 | 260 | <10 | <10 | <10 |
| C>10 - C16 (F2 minus Naphthalene) | g/g | 10 | | <10 | <10 | <10 |
| C>16 - C34 (F3) | g/g | 50 | 1700 | **26000** | **32000** | **24000** |
| C>16 - C34 (F3 minus PAHs) | g/g | 50 | | 26000 | 32000 | 24000 |
| C>34 - C50 (F4) | g/g | 50 | 3300 | **4800** | **6000** | **4400** |
| Moisture Content | % | 0.1 | | 7.5 | 2.2 | 6.3 |
| | | | | | | |
| **PAHs** | | | | | | |
| Naphthalene | g/g | 0.03 | 22 | 0.03 | <0.03 | 0.05 |
| Acenaphthylene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 |
| Acenaphthene | g/g | 0.03 | | <0.03 | <0.03 | <0.03 |
| Fluorene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 |
| Phenanthrene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 |
| Anthracene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 |
| Fluoranthene | g/g | 0.02 | | 0.02 | <0.02 | <0.02 |
| Pyrene | g/g | 0.02 | | 0.04 | 0.02 | 0.03 |
| Benzo(a)anthracene | g/g | 0.02 | | 0.21 | 0.11 | 0.14 |
| Chrysene | g/g | 0.02 | | 0.11 | 0.07 | 0.1 |
| Benzo(b)fluoranthene | g/g | 0.02 | | 0.07 | 0.05 | 0.04 |
| Benzo(k)fluoranthene | g/g | 0.02 | | 0.02 | <0.02 | 0.02 |
| Benzo(a)pyrene | g/g | 0.02 | 0.7 | 0.13 | 0.09 | 0.07 |
| Indeno(1,2,3-cd)pyrene | g/g | 0.02 | | 0.05 | 0.03 | 0.03 |
| Dibenz(a,h)anthracene | g/g | 0.02 | | <0.02 | <0.02 | <0.02 |
| Benzo(g,h,i)perylene | g/g | 0.02 | | 0.08 | 0.05 | 0.04 |
| 2-and 1-methyl Naphthalene | g/g | 0.05 | | 0.05 | <0.05 | <0.05 |
| Chrysene-d12 | % | | | 89 | 95 | 89 |
| | | | | | | |
| **Other Parameters** | | | | | | |
| Phenols, Total | mg/kg | 1 | 3.8 | <1 | <1 | <1 |
| PCBs | g/g | 0.1 | 33 | <0.1 | <0.1 | <0.1 |
| Decachlorobiphenyl | % | | | 63 | 82 | 89 |

**Guidelines Used**

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Industrial Land Use, Coarse Grained

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# Certificate of Analysis

AGAT WORK ORDER: 10T421969
PROJECT NO: Arviat

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Jim Walls

## Microbiological Analysis (water)

DATE SAMPLED: Jul 23, 2010 | DATE RECEIVED: Jul 24, 2010 | DATE REPORTED: Aug 04, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-4 1889491 |
|---|---|---|---|---|
| Escherichia coli | CFU/1mL | 1 | 1 | 17700 |
| Total Coliforms | CFU/1mL | 1 | 1 | TNTC |
| Fecal Coliform | CFU/1mL | 1 | 1 | 13100 |
| Heterotrophic Plate Count | CFU/mL | | 10 | TNTC |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to SDWA -Schedule 23

1889491 The bacteria counts refer to a 1 mL sample aliquot diluted to 100 mL prior to filtration and incubation. A larger aliquot resulted in an overgrown plates.

Certified By: Elizabeth Rolokowska

AGAT Laboratories

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# Certificate of Analysis

AGAT WORK ORDER: 10T421969
PROJECT NO: Arviat

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Jim Walls

## Oil and Grease water

DATE SAMPLED: Jul 23, 2010 | DATE RECEIVED: Jul 24, 2010 | DATE REPORTED: Aug 04, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1889489 | ARV-4 1889491 |
|---|---|---|---|---|---|
| Oil and Grease (animal/vegetable) | mg/L | | 0.5 | 5.2 | 19 |
| Oil and Grease (mineral) in water | mg/L | | 0.5 | <0.5 | 1.5 |
| Oil and Grease (Total) in water | mg/L | | 0.5 | 5.2 | 21 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

AGAT Laboratories

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# Certificate of Analysis

AGAT WORK ORDER: 10T421969
PROJECT NO: Arviat

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Jim Walls

## BURNSIDE - Water Quality Assessment BOD, TSS, Phenols & Cr VI

DATE SAMPLED: Jul 23, 2010 | DATE RECEIVED: Jul 24, 2010 | DATE REPORTED: Aug 04, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1889489 | ARV-4 1889491 |
|---|---|---|---|---|---|
| Aluminum | mg/L | | 0.004 | 0.020 | 1.90 |
| Arsenic | mg/L | | 0.003 | 0.005 | 0.020 |
| Barium | mg/L | | 0.002 | 0.050 | 0.723 |
| Boron | mg/L | | 0.010 | 1.22 | 0.223 |
| Cadmium | mg/L | | 0.002 | <0.002 | <0.002 |
| Calcium | mg/L | | 0.05 | 248 | 8.57 |
| Chromium | mg/L | | 0.003 | 0.013 | 0.015 |
| Copper | mg/L | | 0.003 | 0.007 | 0.246 |
| Iron | mg/L | | 0.010 | 0.936 | 56.4 |
| Potassium | mg/L | | 0.05 | 44.7 | 19.7 |
| Magnesium | mg/L | | 0.05 | 39.7 | 4.83 |
| Mercury | mg/L | | 0.0001 | <0.0001 | <0.0001 |
| Manganese | mg/L | | 0.002 | 0.983 | 1.65 |
| Molybdenum | mg/L | | 0.002 | <0.002 | <0.002 |
| Sodium | mg/L | | 0.05 | 178 | 61.3 |
| Nickel | mg/L | | 0.003 | 0.004 | 0.018 |
| Total Phosphorus | mg/L | | 0.05 | 0.64 | 6.63 |
| Lead | mg/L | | 0.002 | 0.028 | 0.057 |
| Selenium | mg/L | | 0.004 | <0.004 | <0.004 |
| Silver | mg/L | | 0.002 | <0.002 | <0.002 |
| Strontium | mg/L | | 0.005 | 1.68 | 0.561 |
| Thallium | mg/L | | 0.006 | <0.006 | <0.006 |
| Titanium | mg/L | | 0.002 | 0.010 | 0.016 |
| Uranium | mg/L | | 0.002 | <0.002 | <0.002 |
| Vanadium | mg/L | | 0.002 | <0.002 | 0.020 |
| Zinc | mg/L | | 0.005 | 0.077 | 0.226 |
| Fluoride | mg/L | | 0.05 | <0.05 | <0.05 |
| Chloride | mg/L | | 0.10 | 244 | 71.2 |
| Nitrite as N | mg/L | | 0.05 | <0.05 | <0.05 |
| Ortho phosphate as P | mg/L | | 0.10 | 0.33 | 6.89 |
| Bromide | mg/L | | 0.05 | 1.87 | <0.05 |
| Nitrate as N | mg/L | | 0.05 | <0.05 | <0.05 |
| Sulphate | mg/L | | 0.10 | 539 | 0.98 |

Certified By:

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# Certificate of Analysis

AGAT WORK ORDER: 10T421969
PROJECT NO: Arviat

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Jim Walls

## BURNSIDE - Water Quality Assessment BOD, TSS, Phenols & Cr VI

DATE SAMPLED: Jul 23, 2010 | DATE RECEIVED: Jul 24, 2010 | DATE REPORTED: Aug 04, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1889489 | ARV-4 1889491 |
|---|---|---|---|---|---|
| pH | pH Units | | NA | 8.07 | 7.68 |
| Ammonia as N | mg/L | | 0.02 | 11.0 | 72.1 |
| Total Organic Carbon | mg/L | | 0.5 | 52.0 | 157 |
| Electrical Conductivity | uS/cm | | 2 | 2010 | 827 |
| Total Dissolved Solids | mg/L | | 20 | 1570 | 322 |
| Saturation pH | | | | 6.36 | 7.76 |
| % Difference/ Ion Balance | | | 0.1 | 3.0 | 5.9 |
| Total Hardness (as CaCO3) | mg/L | | 10 | 783 | 41 |
| Langlier Index | | | | 1.71 | -0.08 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 | <5 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 440 | 305 |
| Turbidity | NTU | | 0.5 | 8.1 | 38 |
| Alkalinity (as CaCO3) | mg/L | | 5 | 440 | 305 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 | <5 |
| Reactive Silica | mg/L | | 0.05 | 9.17 | 11.2 |
| Colour | TCU | | 5 | 102 | 266 |
| BOD (5) | mg/L | | 5 | 13 | 98 |
| Total Suspended Solids | mg/L | | 10 | 14 | 104 |
| Phenols | mg/L | | 0.001 | 0.005 | 0.187 |
| Chromium VI | mg/L | | 0.005 | <0.005 | <0.005 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

# Guideline Violation

AGAT WORK ORDER: 10T421969

PROJECT NO: Arviat

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http://www.agatlabs.com

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Jim Walls

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|
| 1889491 | ARV-4 | SDWA -Schedule 23 | Microbiological Analysis (water) | Escherichia coli | 1 | 17700 |
| 1889491 | ARV-4 | SDWA -Schedule 23 | Microbiological Analysis (water) | Fecal Coliform | 1 | 13100 |

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

# Certificate of Analysis

R.J. BURNSIDE

**ATTN:** STEPHANIE CHARITY / JIM WALLS

292 SPEEDVALE AVE., WEST
UNIT #7
GUELPH ON N1H 1C4

**Report Date:** 14-SEP-10 13:45 (MT)
**Version:** FINAL

**Lab Work Order #:** L927467 **Date Received:** 02-SEP-10

**Project P.O. #:** NOT SUBMITTED
**Job Reference:** N-015746
**Legal Site Desc:**
**CofC Numbers:**

**Other Information:**

**Comments:**

Paul Nicolas
Account Manager



**Manitoba Technology Centre Ltd.**
Part of the **ALS Laboratory Group**
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# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L927467-1 ARV-2<br>Sampled By: CLIENT on 01-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Physical Tests** | | | | | | | |
| Conductivity | 2520 | | 0.40 | umhos/cm | | 03-SEP-10 | R1459503 |
| pH | 8.11 | | 0.10 | pH units | | 03-SEP-10 | R1459503 |
| Total Suspended Solids | <5.0 | | 5.0 | mg/L | | 08-SEP-10 | R1461947 |
| **Anions and Nutrients** | | | | | | | |
| Ammonia as N | 12.9 | | 0.050 | mg/L | | 14-SEP-10 | R1465344 |
| Nitrate and Nitrite as N | <0.35 | | 0.35 | mg/L | | 07-SEP-10 | |
| Nitrate-N | <0.25 | | 0.25 | mg/L | | 03-SEP-10 | R1459992 |
| Nitrite-N | <0.25 | | 0.25 | mg/L | | 03-SEP-10 | R1459992 |
| Sulfate | 461 | | 2.5 | mg/L | | 03-SEP-10 | R1459992 |
| **Bacteriological Tests** | | | | | | | |
| Fecal Coliforms | 430 | | 3 | MPN/100mL | | 06-SEP-10 | R1459728 |
| **Total Metals** | | | | | | | |
| Aluminum (Al)-Total | 0.0219 | | 0.0050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Antimony (Sb)-Total | 0.00405 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Arsenic (As)-Total | 0.00468 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Barium (Ba)-Total | 0.0471 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Beryllium (Be)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Bismuth (Bi)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Boron (B)-Total | 1.49 | | 0.010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cadmium (Cd)-Total | <0.000010 | | 0.000010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Calcium (Ca)-Total | 244 | | 0.10 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cesium (Cs)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Chromium (Cr)-Total | <0.0010 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cobalt (Co)-Total | 0.00051 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Copper (Cu)-Total | 0.00129 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Iron (Fe)-Total | 0.516 | | 0.020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Lead (Pb)-Total | 0.000153 | | 0.000090 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Lithium (Li)-Total | 0.0363 | | 0.0020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Magnesium (Mg)-Total | 43.0 | | 0.010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Manganese (Mn)-Total | 0.663 | | 0.00030 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Mercury (Hg)-Total | <0.000050 | | 0.000050 | mg/L | 03-SEP-10 | 03-SEP-10 | R1459886 |
| Molybdenum (Mo)-Total | 0.00039 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Nickel (Ni)-Total | 0.0024 | | 0.0020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Phosphorus (P)-Total | 0.62 | | 0.20 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Potassium (K)-Total | 43.9 | | 0.020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Rubidium (Rb)-Total | 0.0411 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Selenium (Se)-Total | <0.0010 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Silicon (Si)-Total | 5.34 | | 0.050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Silver (Ag)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Sodium (Na)-Total | 228 | | 0.030 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Strontium (Sr)-Total | 1.53 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tellurium (Te)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L927467-1 ARV-2<br>Sampled By: CLIENT on 01-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Total Metals** | | | | | | | |
| Thallium (Tl)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Thorium (Th)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tin (Sn)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Titanium (Ti)-Total | 0.00166 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tungsten (W)-Total | <0.0010 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Uranium (U)-Total | 0.00064 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Vanadium (V)-Total | 0.00071 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Zinc (Zn)-Total | 0.0203 | | 0.0050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Zirconium (Zr)-Total | 0.00047 | | 0.00040 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 6.4 | | 1.0 | mg/L | 03-SEP-10 | 08-SEP-10 | R1460687 |
| Total Oil and Grease | 2.4 | DLM | 2.0 | mg/L | 10-SEP-10 | 10-SEP-10 | R1459975 |
| Phenols (4AAP) | <0.0010 | | 0.0010 | mg/L | 08-SEP-10 | 08-SEP-10 | R1461126 |
| L927467-2 ARV-4<br>Sampled By: CLIENT on 01-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Physical Tests** | | | | | | | |
| Conductivity | 1130 | | 0.40 | umhos/cm | | 03-SEP-10 | R1459503 |
| pH | 7.43 | | 0.10 | pH units | | 03-SEP-10 | R1459503 |
| Total Suspended Solids | 91.1 | | 5.0 | mg/L | | 08-SEP-10 | R1461947 |
| **Anions and Nutrients** | | | | | | | |
| Ammonia as N | 47.9 | | 0.050 | mg/L | | 14-SEP-10 | R1465344 |
| Nitrate and Nitrite as N | <0.35 | | 0.35 | mg/L | | 07-SEP-10 | |
| Nitrate-N | <0.25 | | 0.25 | mg/L | | 03-SEP-10 | R1459992 |
| Nitrite-N | <0.25 | | 0.25 | mg/L | | 03-SEP-10 | R1459992 |
| Sulfate | 9.3 | | 2.5 | mg/L | | 03-SEP-10 | R1459992 |
| **Bacteriological Tests** | | | | | | | |
| Fecal Coliforms | 110000 | | 3 | MPN/100mL | | 06-SEP-10 | R1459728 |
| **Total Metals** | | | | | | | |
| Aluminum (Al)-Total | 0.366 | | 0.0050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Antimony (Sb)-Total | 0.00038 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Arsenic (As)-Total | 0.0128 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Barium (Ba)-Total | 0.0424 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Beryllium (Be)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Bismuth (Bi)-Total | 0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Boron (B)-Total | 0.220 | | 0.010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cadmium (Cd)-Total | 0.000138 | | 0.000010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Calcium (Ca)-Total | 14.3 | | 0.10 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cesium (Cs)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Chromium (Cr)-Total | 0.0012 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Cobalt (Co)-Total | 0.00250 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Copper (Cu)-Total | 0.0547 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L927467-2 ARV-4<br>Sampled By: CLIENT on 01-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Total Metals** | | | | | | | |
| Iron (Fe)-Total | 8.09 | | 0.020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Lead (Pb)-Total | 0.00202 | | 0.000090 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Lithium (Li)-Total | 0.0108 | | 0.0020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Magnesium (Mg)-Total | 9.17 | | 0.010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Manganese (Mn)-Total | 0.428 | | 0.00030 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Mercury (Hg)-Total | <0.000050 | | 0.000050 | mg/L | 03-SEP-10 | 03-SEP-10 | R1459886 |
| Molybdenum (Mo)-Total | 0.00210 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Nickel (Ni)-Total | 0.0078 | | 0.0020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Phosphorus (P)-Total | 6.53 | | 0.20 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Potassium (K)-Total | 23.3 | | 0.020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Rubidium (Rb)-Total | 0.0255 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Selenium (Se)-Total | <0.0010 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Silicon (Si)-Total | 6.52 | | 0.050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Silver (Ag)-Total | 0.00035 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Sodium (Na)-Total | 98.4 | | 0.030 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Strontium (Sr)-Total | 0.128 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tellurium (Te)-Total | <0.00020 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Thallium (Tl)-Total | <0.00010 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Thorium (Th)-Total | 0.00024 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tin (Sn)-Total | 0.00083 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Titanium (Ti)-Total | 0.0205 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Tungsten (W)-Total | <0.0010 | | 0.0010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Uranium (U)-Total | 0.00041 | | 0.00010 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Vanadium (V)-Total | 0.00707 | | 0.00020 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Zinc (Zn)-Total | 0.0462 | | 0.0050 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| Zirconium (Zr)-Total | 0.00122 | | 0.00040 | mg/L | 07-SEP-10 | 07-SEP-10 | R1460846 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 40.0 | | 6.0 | mg/L | 03-SEP-10 | 08-SEP-10 | R1460687 |
| Total Oil and Grease | 6.7 | DLM | 2.0 | mg/L | 10-SEP-10 | 10-SEP-10 | R1459975 |
| Phenols (4AAP) | 0.0750 | | 0.0010 | mg/L | 08-SEP-10 | 08-SEP-10 | R1461126 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# Reference Information

**Sample Parameter Qualifier key listed:**

| Qualifier | Description |
|---|---|
| DLM | Detection Limit Adjusted For Sample Matrix Effects |

**Test Method References:**

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| ANIONS5-IC-WP | Water | Anions scan (IC) | EPA 300.1 IC |
| This analysis is carried out using procedures adapted from EPA Method 300.1 "Determination of Inorganic Anions in Drinking Water by Ion Chromatography". | | | |
| BOD-WP | Water | Biochemical Oxygen Demand (BOD) | APHA 5210 B |
| The sample is incubated for 5 days at 20 degrees Celcius. Comparison of dissolved oxygen content at the beginning and end of incubation provides a measure of biochemical oxygen demand. If carbonaceous BOD is requested, TCMP is added to the sample to chemically inhibit nitrogenous oxygen demand. If soluble BOD is requested, the sample is filtered prior to analysis. Surface waters have a DL of 1 mg/L. Effluents are diluted according to their history and will have a sample DL of 6 mg/L or greater, depending on the dilutions used. | | | |
| EC-WP | Water | Conductivity | APHA 2510B |
| Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes. | | | |
| FC-MPN-WP | Water | Fecal Coliform | APHA 9221A-C |
| The Most Probable Number (MPN) method is based on the Multiple Tube Fermentation technique. The results of examination of replicate tubes and dilutions of a sample are reported after confirmations specific to total coliform, fecal coliform and E. coli are performed. Results are reported in MPN/100 mL for water and MPN/gram for food and solid samples. | | | |
| HG-T-CVAF-WP | Water | Mercury Total | EPA245.7 V2.0 |
| Mercury in filtered and unfiltered waters is oxidized with Bromine monochloride and analyzed by cold-vapour atomic fluorescence spectrometry. | | | |
| MET-T-L-MS-WP | Water | Total Metals by ICP-MS | U.S. EPA 200.8-TL |
| Total Metals by ICP-MS: This analysis is carried out using sample preparation procedures adapted from Standard Methods for the examination of Water and Wastewater Method 3030E and analytical procedures adapted from U.S EPA Method 200.8 for analyis of metals by inductively coupled-mass spectrometery. | | | |
| NH3-COL-WP | Water | Ammonia by colour | APHA 4500 NH3 F |
| Ammonia - Colourimeric using Salicylate-nitroprusside and hypochlorite, in an alkaline phosphate buffer. | | | |
| NO2+NO3-CALC-WP | Water | Nitrate+Nitrite | CALCULATION |
| OGG-IR-WP | Water | Total Oil and Grease | APHA METHOD 5520C |
| PH-WP | Water | pH | APHA 4500H |
| pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode. | | | |
| PHENOLS-4AAP-WT | Water | Phenols (4AAP) | EPA 9066 |
| An automated method is used to distill the sample. The distillate is then buffered to pH 9.4 which reacts with 4AAP and potassium ferricyanide to form a red complex which is measured colorimetrically. | | | |
| SOLIDS-TOTSUS-WP | Water | Total Suspended Solids | APHA 2540 |
| The residue retained by a prepared 1.5 um Whatman 934-AH glass microfibre filter dried at 105 degrees C. | | | |

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| WP | ALS LABORATORY GROUP - WINNIPEG, MANITOBA, CANADA |
| WT | ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

# Reference Information

**GLOSSARY OF REPORT TERMS**

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*
*mg/kg - milligrams per kilogram based on dry weight of sample*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample*
*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*
*mg/L - unit of concentration based on volume, parts per million.*
*< - Less than.*
*D.L. - The reporting limit.*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

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# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg 153 Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | BW-1 1988754 |
|---|---|---|---|---|
| C6 - C10 (F1) | g/L | | 25 | <25 |
| C6 - C10 (F1 minus BTEX) | g/L | | 25 | <25 |
| C>10 - C16 (F2) | g/L | | 100 | <100 |
| C>10 - C16 (F2 minus Naphthalene) | g/L | | 100 | <100 |
| C6 - C16 (F1 F2) | g/L | | 100 | <100 |
| C>16 - C34 (F3) | g/L | | 100 | <100 |
| C>16 - C34 (F3 minus PAHs) | g/L | | 100 | <100 |
| C>34 - C50 (F4) | g/L | | 100 | <100 |
| C>16 - C50 (F3 F4) | g/L | | 100 | <100 |
| Gravimetric Heavy Hydrocarbons | g/L | | 500 | NA |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988754
The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 PAHs in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | BW-1 1988754 |
|---|---|---|---|---|
| Naphthalene | g/L | | 0.12 | <0.12 |
| Acenaphthylene | g/L | | 0.11 | <0.11 |
| Acenaphthene | g/L | | 0.10 | <0.10 |
| Fluorene | g/L | | 0.09 | <0.09 |
| Phenanthrene | g/L | | 0.10 | <0.10 |
| Anthracene | g/L | | 0.07 | <0.07 |
| Fluoranthene | g/L | | 0.12 | <0.12 |
| Pyrene | g/L | | 0.12 | <0.12 |
| Benzo(a)anthracene | g/L | | 0.08 | <0.08 |
| Chrysene | g/L | | 0.05 | <0.05 |
| Benzo(b)fluoranthene | g/L | | 0.05 | <0.05 |
| Benzo(k)fluoranthene | g/L | | 0.06 | <0.06 |
| Benzo(a)pyrene | g/L | | 0.01 | <0.01 |
| Indeno(1,2,3-cd)pyrene | g/L | | 0.03 | <0.03 |
| Dibenzo(a,h)anthracene | g/L | | 0.09 | <0.09 |
| Benzo(g,h,i)perylene | g/L | | 0.06 | <0.06 |
| 2-and 1-methyl Napthalene | g/L | | 0.20 | <0.20 |
| **Surrogate** | **Unit** | **Acceptable Limits** | | |
| Chrysene-d12 | % | 60-130 | | 97 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | BW-1 1988754 |
|---|---|---|---|---|
| Dichlorodifluoromethane | g/L | | 0.20 | 20 |
| Chloromethane | g/L | | 0.40 | <0.40 |
| Vinyl Chloride | g/L | | 0.17 | <0.17 |
| Bromomethane | g/L | | 0.20 | <0.20 |
| Chloroethane | g/L | | 0.20 | <0.20 |
| Trichlorofluoromethane | g/L | | 0.40 | 17 |
| Acetone | g/L | | 1.0 | <1.0 |
| 1,1 Dichloroethylene | g/L | | 0.30 | <0.30 |
| Methylene Chloride | g/L | | 0.30 | <0.30 |
| trans- 1,2-dichloroethylene | g/L | | 0.20 | <0.20 |
| Methyl tert-butyl ether | g/L | | 0.20 | <0.20 |
| 1,1-Dichloroethane | g/L | | 0.30 | <0.30 |
| Methyl Ethyl Ketone | g/L | | 1.0 | <1.0 |
| cis- 1,2-Dichloroethylene | g/L | | 0.20 | <0.20 |
| Chloroform | g/L | | 0.20 | <0.20 |
| 1,2 - Dichloroethane | g/L | | 0.20 | <0.20 |
| 1,1,1-Trichloroethane | g/L | | 0.30 | <0.30 |
| Carbon Tetrachloride | g/L | | 0.20 | <0.20 |
| Benzene | g/L | | 0.20 | <0.20 |
| 1,2-Dichloropropane | g/L | | 0.20 | <0.20 |
| Trichloroethylene | g/L | | 0.20 | <0.20 |
| Bromodichloromethane | g/L | | 0.20 | <0.20 |
| cis-1,3-Dichloropropene | ug/L | | 0.20 | <0.20 |
| Methyl Isobutyl Ketone | g/L | | 1.0 | <1.0 |
| trans-1,3-Dichloropropene | g/L | | 0.30 | <0.30 |
| 1,1,2-Trichloroethane | g/L | | 0.20 | <0.20 |
| Toluene | g/L | | 0.20 | <0.20 |
| 2-Hexanone | g/L | | 0.30 | <0.30 |
| Dibromochloromethane | g/L | | 0.10 | <0.10 |
| Ethylene Dibromide | g/L | | 0.20 | <0.20 |
| Tetrachloroethylene | g/L | | 0.20 | <0.20 |
| 1,1,1,2-Tetrachloroethane | g/L | | 0.10 | <0.10 |
| Chlorobenzene | g/L | | 0.10 | <0.10 |

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | BW-1 1988754 |
|---|---|---|---|---|
| Ethylbenzene | g/L | | 0.10 | <0.10 |
| m & p-Xylene | g/L | | 0.20 | <0.20 |
| Bromoform | g/L | | 0.10 | <0.10 |
| Styrene | g/L | | 0.10 | <0.10 |
| 1,1,2,2-Tetrachloroethane | g/L | | 0.10 | <0.10 |
| o-Xylene | g/L | | 0.10 | <0.10 |
| 1,3-Dichlorobenzene | g/L | | 0.10 | <0.10 |
| 1,4-Dichlorobenzene | g/L | | 0.10 | <0.10 |
| 1,2-Dichlorobenzene | g/L | | 0.10 | <0.10 |
| 1,2,4-Trichlorobenzene | g/L | | 0.30 | <0.30 |
| 1,3-Dichloropropene (Cis Trans) | g/L | | 0.30 | <0.30 |
| Xylene Mixture (Total) | g/L | | 0.20 | <0.20 |
| n-Hexane | g/L | | 0.20 | <0.20 |
| **Surrogate** | **Unit** | **Acceptable Limits** | | |
| Toluene-d8 | % Recovery | 60-130 | | 100 |
| 4-Bromofluorobenzene | % Recovery | 70-130 | | 92 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | LF-1 1988705 | LF-2 1988707 | LF-3 1988716 | SL-Wet1 1988725 | SL-Wet2 1988736 | SL-Wet3 1988742 | SL-Wet4 1988748 |
|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | mg/L | | 0.004 | <0.004 | 0.006 | 0.004 | 0.059 | 0.033 | 0.054 | 0.143 |
| Arsenic | mg/L | | 0.003 | <0.003 | 0.003 | 0.003 | 0.007 | 0.005 | 0.006 | 0.011 |
| Barium | mg/L | | 0.002 | 0.045 | 0.041 | 0.035 | 0.006 | 0.007 | 0.009 | 0.015 |
| Boron | mg/L | | 0.010 | 0.736 | 0.805 | 0.773 | 0.179 | 0.176 | 0.162 | 0.230 |
| Cadmium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Calcium | mg/L | | 0.05 | 283 | 225 | 169 | 15.9 | 20.9 | 24.4 | 12.0 |
| Chromium | mg/L | | 0.003 | <0.003 | 0.006 | 0.006 | 0.008 | 0.006 | 0.005 | 0.007 |
| Copper | mg/L | | 0.003 | <0.003 | <0.003 | <0.003 | 0.012 | 0.006 | 0.011 | 0.027 |
| Iron | mg/L | | 0.010 | <0.010 | 0.074 | 0.020 | 0.503 | 1.41 | 1.28 | 2.55 |
| Potassium | mg/L | | 0.05 | 20.8 | 30.6 | 37.5 | 15.6 | 14.8 | 14.7 | 21.7 |
| Magnesium | mg/L | | 0.05 | 24.5 | 42.1 | 43.1 | 8.66 | 15.9 | 17.7 | 9.76 |
| Mercury | mg/L | | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Manganese | mg/L | | 0.002 | 0.045 | 0.216 | 0.226 | 0.226 | 0.412 | 0.461 | 0.274 |
| Molybdenum | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Sodium | mg/L | | 0.05 | 82.5 | 171 | 204 | 75.5 | 111 | 110 | 94.2 |
| Nickel | mg/L | | 0.003 | <0.003 | 0.003 | <0.003 | 0.004 | 0.003 | 0.005 | 0.006 |
| Total Phosphorus | mg/L | | 0.05 | 1.57 | 0.34 | 0.20 | 0.98 | 1.56 | 1.45 | 4.54 |
| Lead | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Selenium | mg/L | | 0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 |
| Silver | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Strontium | mg/L | | 0.005 | 2.54 | 1.71 | 1.31 | 0.142 | 0.237 | 0.214 | 0.111 |
| Thallium | mg/L | | 0.006 | <0.006 | <0.006 | <0.006 | <0.006 | <0.006 | <0.006 | <0.006 |
| Titanium | mg/L | | 0.002 | 0.008 | 0.007 | 0.006 | 0.003 | 0.002 | 0.003 | 0.005 |
| Uranium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Vanadium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 | 0.004 | 0.003 | 0.003 | 0.006 |
| Zinc | mg/L | | 0.005 | 0.007 | 0.013 | 0.009 | 0.007 | <0.005 | <0.005 | 0.022 |
| Fluoride | mg/L | | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.50 |
| Chloride | mg/L | | 0.10 | 114 | 267 | 334 | 120 | 204 | 186 | 140 |
| Nitrite as N | mg/L | | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Ortho phosphate as P | mg/L | | 0.10 | <0.10 | <0.10 | <0.10 | 1.53 | 1.71 | 0.55 | 2.33 |
| Bromide | mg/L | | 0.05 | 1.42 | 2.63 | 2.58 | <0.05 | 1.16 | <0.05 | <0.05 |
| Nitrate as N | mg/L | | 0.05 | <0.05 | 0.81 | <0.05 | 1.00 | 0.30 | 0.39 | 0.40 |
| Sulphate | mg/L | | 0.10 | 650 | 518 | 469 | 18.4 | 37.3 | 26.6 | 11.5 |

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | LF-1 1988705 | LF-2 1988707 | LF-3 1988716 | SL-Wet1 1988725 | SL-Wet2 1988736 | SL-Wet3 1988742 | SL-Wet4 1988748 |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | pH Units | | NA | 7.90 | 8.03 | 8.27 | 7.89 | 7.82 | 7.84 | 8.18 |
| Ammonia as N | mg/L | | 0.02 | <0.02 | 1.23 | 0.26 | 36.5 | 25.7 | 18.3 | 71.9 |
| Total Organic Carbon | mg/L | | 0.5 | 36.5 | 25.8 | 26.5 | 28.3 | 21.0 | 22.7 | 61.4 |
| Electrical Conductivity | uS/cm | | 2 | 1750 | 2040 | 2070 | 793 | 1020 | 957 | 1030 |
| Total Dissolved Solids | mg/L | | 20 | 1440 | 1520 | 1450 | 368 | 496 | 484 | 436 |
| Saturation pH | | | | 6.59 | 6.53 | 6.70 | 7.70 | 7.52 | 7.43 | 7.53 |
| % Difference/ Ion Balance | | | 0.1 | 3.6 | 3.8 | 5.6 | 0.6 | 4.5 | 3.6 | 3.8 |
| Total Hardness (as CaCO3) | mg/L | | 10 | 808 | 735 | 599 | 75 | 118 | 134 | 70 |
| Langlier Index | | | | 1.31 | 1.50 | 1.57 | 0.19 | 0.30 | 0.41 | 0.65 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 252 | 322 | 263 | 193 | 186 | 200 | 306 |
| Turbidity | NTU | | 0.5 | 0.9 | 3.3 | 1.6 | 3.1 | 4.1 | 5.2 | 20.0 |
| Alkalinity (as CaCO3) | mg/L | | 5 | 252 | 322 | 263 | 193 | 186 | 200 | 306 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Reactive Silica | mg/L | | 0.05 | 15.9 | 8.84 | 9.34 | 12.3 | 11.4 | 8.67 | 14.2 |
| Colour | TCU | | 5 | 30 | 55 | 49 | 107 | 100 | 131 | 209 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## Chromium VI & TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | LF-1<br>1988705 |
|---|---|---|---|---|
| Chromium VI | mg/L | | 0.005 | <0.005 |
| Total Suspended Solids | mg/L | | 10 | 288 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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TEL (905)712-5100
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# Certificate of Analysis

AGAT WORK ORDER: 10T434899

PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## Chromium VI, Phenols & TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | LF-2 1988707 | LF-3 1988716 |
|---|---|---|---|---|---|
| Chromium VI | mg/L | | 0.005 | <0.005 | <0.005 |
| Phenols | mg/L | | 0.001 | 0.002 | 0.001 |
| Total Suspended Solids | mg/L | | 10 | 21 | <10 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

AGAT WORK ORDER: 10T434899
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## TSS (Water)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 22, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | SL-Wet1 1988725 | SL-Wet2 1988736 | SL-Wet3 1988742 | SL-Wet4 1988748 |
|---|---|---|---|---|---|---|---|
| Total Suspended Solids | mg/L | | 10 | 44 | <10 | <10 | 78 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

R.J. BURNSIDE
ATTN: Stephanie Charity
292 SPEEDVALE AVE., WEST
UNIT #7
GUELPH ON N1H 1C4
Phone: 519-823-4995

Date Received: 14-SEP-10
Report Date: 21-SEP-10 09:07 (MT)
Version: FINAL

# Certificate of Analysis

Lab Work Order #: L930982
Project P.O. #: NOT SUBMITTED
Job Reference: N-0157460
Legal Site Desc:
C of C Numbers:

Paul Nicolas
Account Manager

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L930982-1 LF-1<br>Sampled By: SC on 09-SEP-10 @ 11:50<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Fecal Coliforms | 23 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 27.4 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-2 LF-2<br>Sampled By: SC on 09-SEP-10 @ 12:05<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Fecal Coliforms | 9 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 6.0 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-3 LF-3<br>Sampled By: SC on 09-SEP-10 @ 13:43<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Fecal Coliforms | 4 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 2.6 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-4 SL-WET-1<br>Sampled By: SC on 09-SEP-10 @ 14:45<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Escherichia Coli | 15 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| Fecal Coliforms | 15 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 9.0 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-5 SL-WET-2<br>Sampled By: SC on 09-SEP-10 @ 14:25<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Escherichia Coli | 4 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| Fecal Coliforms | 4 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 21.2 | | 6.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-6 SL-WET-3<br>Sampled By: SC on 09-SEP-10 @ 15:10<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Escherichia Coli | 9 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| Fecal Coliforms | 9 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 5.6 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |
| L930982-7 SL-WET-4<br>Sampled By: SC on 09-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L930982-7 SL-WET-4<br>Sampled By: SC on 09-SEP-10 @ 15:45<br>Matrix: WATER | | | | | | | |
| **Bacteriological Tests** | | | | | | | |
| Escherichia Coli | 4300 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| Fecal Coliforms | 9300 | | 3 | MPN/100mL | | 17-SEP-10 | R1470963 |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand | 20.0 | | 1.0 | mg/L | 15-SEP-10 | 20-SEP-10 | R1471932 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# Reference Information

**Qualifiers for Sample Submission Listed:**

| Qualifier | Description |
|---|---|
| EHR | Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested |

**Test Method References:**

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| BOD-WP | Water | Biochemical Oxygen Demand (BOD) | APHA 5210 B |

The sample is incubated for 5 days at 20 degrees Celcius. Comparison of dissolved oxygen content at the beginning and end of incubation provides a measure of biochemical oxygen demand. If carbonaceous BOD is requested, TCMP is added to the sample to chemically inhibit nitrogenous oxygen demand. If soluble BOD is requested, the sample is filtered prior to analysis. Surface waters have a DL of 1 mg/L. Effluents are diluted according to their history and will have a sample DL of 6 mg/L or greater, depending on the dilutions used.

| | | | |
|---|---|---|---|
| EC-MPN-WP | Water | Escherichia Coli | APHA 9221A-C |

The Most Probable Number (MPN) method is based on the Multiple Tube Fermentation technique. The results of examination of replicate tubes and dilutions of a sample are reported after confirmations specific to total coliform, fecal coliform and E. coli are performed. Results are reported in MPN/100 mL for water
and MPN/gram for food and solid samples.

| | | | |
|---|---|---|---|
| FC-MPN-WP | Water | Fecal Coliform | APHA 9221A-C |

The Most Probable Number (MPN) method is based on the Multiple Tube Fermentation technique. The results of examination of replicate tubes and dilutions of a sample are reported after confirmations specific to total coliform, fecal coliform and E. coli are performed. Results are reported in MPN/100 mL for water and MPN/gram for food and solid samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| WP | ALS LABORATORY GROUP - WINNIPEG, MANITOBA, CANADA |

**Chain of Custody Numbers:**

**GLOSSARY OF REPORT TERMS**

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*
*mg/kg - milligrams per kilogram based on dry weight of sample*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample*
*mg/kg lwt - milligrams per kilogram based on lipid weight of sample*
*mg/L - unit of concentration based on volume, parts per million.*
*< - Less than.*
*D.L. - The reporting limit.*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

# Quality Control Report

Workorder: L930982 Report Date: 21-SEP-10 

Client: R.J. BURNSIDE
292 SPEEDVALE AVE., WEST UNIT #7
GUELPH ON N1H 1C4
Contact: Stephanie Charity

| Test | Matrix | Reference | Result | Qualifier | Units | RPD | Limit | Analyzed |
|---|---|---|---|---|---|---|---|---|
| **BOD-WP** | **Water** | | | | | | | |
| **Batch R1471932** | | | | | | | | |
| **WG1166992-3 DUP** | | **L930797-1** | | | | | | |
| Biochemical Oxygen Demand | | 9.2 | 9.2 | J | mg/L | 0.0 | 24 | 20-SEP-10 |
| **WG1166992-4 DUP** | | **L931066-10** | | | | | | |
| Biochemical Oxygen Demand | | 1.7 | 1.5 | J | mg/L | 0.2 | 4 | 20-SEP-10 |
| **WG1166992-5 DUP** | | **L931186-1** | | | | | | |
| Biochemical Oxygen Demand | | 28.4 | 24.8 | J | mg/L | 3.6 | 24 | 20-SEP-10 |
| **WG1166992-6 DUP** | | **L931320-4** | | | | | | |
| Biochemical Oxygen Demand | | 11.4 | 12.6 | | mg/L | 10 | 20 | 20-SEP-10 |
| **WG1166992-2 IRM** | | **61-GG** | | | | | | |
| Biochemical Oxygen Demand | | | 86 | | % | | 85-115 | 20-SEP-10 |
| **WG1166992-1 MB** | | | | | | | | |
| Biochemical Oxygen Demand | | | <1.0 | | mg/L | | 1 | 20-SEP-10 |

# Quality Control Report



**Legend:**

| | |
|---|---|
| Limit | 99% Confidence Interval (Laboratory Control Limits) |
| DUP | Duplicate |
| RPD | Relative Percent Difference |
| N/A | Not Available |
| LCS | Laboratory Control Sample |
| SRM | Standard Reference Material |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| ADE | Average Desorption Efficiency |
| MB | Method Blank |
| IRM | Internal Reference Material |
| CRM | Certified Reference Material |
| CCV | Continuing Calibration Verification |
| CVS | Calibration Verification Standard |
| LCSD | Laboratory Control Sample Duplicate |

**Sample Parameter Qualifier Definitions:**

| Qualifier | Description |
|---|---|
| J | Duplicate results and limits are expressed in terms of absolute difference. |

# Quality Control Report



**Hold Time Exceedances:**

| ALS Product Description | Sample ID | Sampling Date | Date Processed | Rec. HT | Actual HT | Units | Qualifier |
|---|---|---|---|---|---|---|---|
| **Bacteriological Tests** | | | | | | | |
| Escherichia Coli | | | | | | | |
| | 4 | 09-SEP-10 14:45 | 14-SEP-10 12:13 | 48 | 117 | hours | EHTR |
| | 5 | 09-SEP-10 14:25 | 14-SEP-10 12:13 | 48 | 118 | hours | EHTR |
| | 6 | 09-SEP-10 15:10 | 14-SEP-10 12:13 | 48 | 117 | hours | EHTR |
| | 7 | 09-SEP-10 15:45 | 14-SEP-10 12:13 | 48 | 116 | hours | EHTR |
| Fecal Coliform | | | | | | | |
| | 1 | 09-SEP-10 11:50 | 14-SEP-10 12:13 | 48 | 120 | hours | EHTR |
| | 2 | 09-SEP-10 12:05 | 14-SEP-10 12:13 | 48 | 120 | hours | EHTR |
| | 3 | 09-SEP-10 13:43 | 14-SEP-10 12:13 | 48 | 119 | hours | EHTR |
| | 4 | 09-SEP-10 14:45 | 14-SEP-10 12:13 | 48 | 117 | hours | EHTR |
| | 5 | 09-SEP-10 14:25 | 14-SEP-10 12:13 | 48 | 118 | hours | EHTR |
| | 6 | 09-SEP-10 15:10 | 14-SEP-10 12:13 | 48 | 117 | hours | EHTR |
| | 7 | 09-SEP-10 15:45 | 14-SEP-10 12:13 | 48 | 116 | hours | EHTR |
| **Aggregate Organics** | | | | | | | |
| Biochemical Oxygen Demand (BOD) | | | | | | | |
| | 1 | 09-SEP-10 11:50 | 15-SEP-10 08:07 | 48 | 140 | hours | EHTR |
| | 2 | 09-SEP-10 12:05 | 15-SEP-10 08:07 | 48 | 140 | hours | EHTR |
| | 3 | 09-SEP-10 13:43 | 15-SEP-10 08:07 | 48 | 138 | hours | EHTR |
| | 4 | 09-SEP-10 14:45 | 15-SEP-10 08:07 | 48 | 137 | hours | EHTR |
| | 5 | 09-SEP-10 14:25 | 15-SEP-10 08:07 | 48 | 138 | hours | EHTR |
| | 6 | 09-SEP-10 15:10 | 15-SEP-10 08:07 | 48 | 137 | hours | EHTR |
| | 7 | 09-SEP-10 15:45 | 15-SEP-10 08:07 | 48 | 136 | hours | EHTR |

**Legend & Qualifier Definitions:**

| | |
|---|---|
| EHTR-FM: | Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended. |
| EHTR: | Exceeded ALS recommended hold time prior to sample receipt. |
| EHTL: | Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry. |
| EHT: | Exceeded ALS recommended hold time prior to analysis. |
| Rec. HT: | ALS recommended hold time (see units). |

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L930982 were received on 14-SEP-10 08:35.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

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The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

R.J. BURNSIDE & ASSOCIATES LTD
ATTN: STEPHANIE CHARITY / JIM WALLS
292 SPEEDVALE AVE., WEST
UNIT #7
GUELPH ON N1H 1C4
Phone: 519-823-4995

Date Received: 13-SEP-10
Report Date: 22-SEP-10 15:38 (MT)
Version: FINAL

# Certificate of Analysis

Lab Work Order #: L930600
Project P.O. #: NOT SUBMITTED
Job Reference: N-015746
Legal Site Desc:
C of C Numbers:

Paul Nicolas
Account Manager

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L930600-1 ARV-2 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:35 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Nitrate + Nitrite** | | | | | | | |
| **Anions scan (IC)** | | | | | | | |
| Nitrite-N | <0.25 | | 0.25 | mg/L | | 14-SEP-10 | R1467253 |
| Nitrate-N | <0.25 | | 0.25 | mg/L | | 14-SEP-10 | R1467253 |
| Sulfate | 475 | | 2.5 | mg/L | | 14-SEP-10 | R1467253 |
| **Nitrate+Nitrite** | | | | | | | |
| Nitrate and Nitrite as N | <0.35 | | 0.35 | mg/L | | 15-SEP-10 | |
| **Miscellaneous Parameters** | | | | | | | |
| Ammonia as N | 13.3 | | 0.050 | mg/L | | 21-SEP-10 | R1473786 |
| Biochemical Oxygen Demand | <6.0 | | 6.0 | mg/L | 13-SEP-10 | 18-SEP-10 | R1470801 |
| Conductivity | 2630 | | 0.40 | umhos/cm | | 13-SEP-10 | R1465201 |
| Fecal Coliforms | 38 | | 3 | MPN/100mL | | 16-SEP-10 | R1470203 |
| Mercury (Hg)-Total | <0.000050 | | 0.000050 | mg/L | 17-SEP-10 | 17-SEP-10 | R1473006 |
| Phenols (4AAP) | 0.0020 | | 0.0010 | mg/L | 15-SEP-10 | 15-SEP-10 | R1467205 |
| Total Oil and Grease | <1.0 | | 1.0 | mg/L | 16-SEP-10 | 17-SEP-10 | R1470248 |
| Total Suspended Solids | 8.0 | | 5.0 | mg/L | | 16-SEP-10 | R1469793 |
| pH | 8.21 | | 0.10 | pH units | | 13-SEP-10 | R1465201 |
| **Total Metals by ICP-MS** | | | | | | | |
| Aluminum (Al)-Total | 0.0095 | | 0.0050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Antimony (Sb)-Total | 0.00410 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Arsenic (As)-Total | 0.00482 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Barium (Ba)-Total | 0.0458 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Beryllium (Be)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Bismuth (Bi)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Boron (B)-Total | 1.34 | | 0.010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cadmium (Cd)-Total | <0.000010 | | 0.000010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Calcium (Ca)-Total | 230 | | 0.10 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cesium (Cs)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Chromium (Cr)-Total | <0.0010 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cobalt (Co)-Total | 0.00051 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Copper (Cu)-Total | 0.00149 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Iron (Fe)-Total | 0.529 | | 0.020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Lead (Pb)-Total | 0.000145 | | 0.000090 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Lithium (Li)-Total | 0.0318 | | 0.0020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Magnesium (Mg)-Total | 49.0 | | 0.010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Manganese (Mn)-Total | 0.599 | | 0.00030 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Molybdenum (Mo)-Total | 0.00036 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Nickel (Ni)-Total | <0.0020 | | 0.0020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Phosphorus (P)-Total | 0.56 | | 0.20 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Potassium (K)-Total | 44.0 | | 0.020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Rubidium (Rb)-Total | 0.0375 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Selenium (Se)-Total | <0.0010 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Silicon (Si)-Total | 4.79 | | 0.050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Silver (Ag)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Sodium (Na)-Total | 243 | | 0.030 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Strontium (Sr)-Total | 1.66 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tellurium (Te)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Thallium (Tl)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Thorium (Th)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tin (Sn)-Total | 0.00022 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Titanium (Ti)-Total | 0.00299 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tungsten (W)-Total | <0.0010 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L930600-1 ARV-2 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:35 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Total Metals by ICP-MS** | | | | | | | |
| Uranium (U)-Total | 0.00063 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Vanadium (V)-Total | 0.00061 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Zinc (Zn)-Total | 0.0160 | | 0.0050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Zirconium (Zr)-Total | 0.00043 | | 0.00040 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| L930600-2 ARV-4 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:15 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Nitrate + Nitrite** | | | | | | | |
| **Anions scan (IC)** | | | | | | | |
| Nitrite-N | 0.284 | | 0.050 | mg/L | | 14-SEP-10 | R1467253 |
| Nitrate-N | 1.23 | | 0.050 | mg/L | | 14-SEP-10 | R1467253 |
| Sulfate | 6.99 | | 0.50 | mg/L | | 14-SEP-10 | R1467253 |
| **Nitrate+Nitrite** | | | | | | | |
| Nitrate and Nitrite as N | 1.51 | | 0.071 | mg/L | | 15-SEP-10 | |
| **Miscellaneous Parameters** | | | | | | | |
| Ammonia as N | 28.2 | | 0.050 | mg/L | | 21-SEP-10 | R1473786 |
| Biochemical Oxygen Demand | 65.0 | | 6.0 | mg/L | 13-SEP-10 | 18-SEP-10 | R1470801 |
| Conductivity | 1020 | | 0.40 | umhos/cm | | 13-SEP-10 | R1465201 |
| Fecal Coliforms | 2100 | | 3 | MPN/100mL | | 16-SEP-10 | R1470203 |
| Mercury (Hg)-Total | <0.000050 | | 0.000050 | mg/L | 17-SEP-10 | 17-SEP-10 | R1473006 |
| Phenols (4AAP) | <0.01 | DLM | 0.010 | mg/L | 15-SEP-10 | 15-SEP-10 | R1467205 |
| Total Oil and Grease | 1.3 | | 1.0 | mg/L | 16-SEP-10 | 17-SEP-10 | R1470248 |
| Total Suspended Solids | 169 | | 5.0 | mg/L | | 16-SEP-10 | R1469793 |
| pH | 8.12 | | 0.10 | pH units | | 13-SEP-10 | R1465201 |
| **Total Metals by ICP-MS** | | | | | | | |
| Aluminum (Al)-Total | 0.325 | | 0.0050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Antimony (Sb)-Total | 0.00033 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Arsenic (As)-Total | 0.0107 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Barium (Ba)-Total | 0.0349 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Beryllium (Be)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Bismuth (Bi)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Boron (B)-Total | 0.254 | | 0.010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cadmium (Cd)-Total | 0.000092 | | 0.000010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Calcium (Ca)-Total | 22.7 | | 0.10 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cesium (Cs)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Chromium (Cr)-Total | 0.0018 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Cobalt (Co)-Total | 0.00229 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Copper (Cu)-Total | 0.0394 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Iron (Fe)-Total | 5.90 | | 0.020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Lead (Pb)-Total | 0.00152 | | 0.000090 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Lithium (Li)-Total | 0.0067 | | 0.0020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Magnesium (Mg)-Total | 14.4 | | 0.010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Manganese (Mn)-Total | 0.349 | | 0.00030 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Molybdenum (Mo)-Total | 0.00080 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Nickel (Ni)-Total | 0.0088 | | 0.0020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Phosphorus (P)-Total | 5.81 | | 0.20 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Potassium (K)-Total | 24.7 | | 0.020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Rubidium (Rb)-Total | 0.0279 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Selenium (Se)-Total | <0.0010 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Silicon (Si)-Total | 6.32 | | 0.050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# ALS LABORATORY GROUP ANALYTICAL REPORT

| Sample Details/Parameters | Result | Qualifier* | D.L. | Units | Extracted | Analyzed | Batch |
|---|---|---|---|---|---|---|---|
| L930600-2 ARV-4 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 11:15 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Total Metals by ICP-MS** | | | | | | | |
| Silver (Ag)-Total | 0.00025 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Sodium (Na)-Total | 116 | | 0.030 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Strontium (Sr)-Total | 0.323 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tellurium (Te)-Total | <0.00020 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Thallium (Tl)-Total | <0.00010 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Thorium (Th)-Total | 0.00032 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tin (Sn)-Total | 0.00082 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Titanium (Ti)-Total | 0.0196 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Tungsten (W)-Total | <0.0010 | | 0.0010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Uranium (U)-Total | 0.00044 | | 0.00010 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Vanadium (V)-Total | 0.00470 | | 0.00020 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Zinc (Zn)-Total | 0.0241 | | 0.0050 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| Zirconium (Zr)-Total | 0.00199 | | 0.00040 | mg/L | 14-SEP-10 | 14-SEP-10 | R1466569 |
| L930600-3 OLD LAGOON 1 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 14:45 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Miscellaneous Parameters** | | | | | | | |
| Biochemical Oxygen Demand | 7.2 | | 6.0 | mg/L | 13-SEP-10 | 18-SEP-10 | R1470801 |
| Fecal Coliforms | 1500 | | 3 | MPN/100mL | | 16-SEP-10 | R1470183 |
| L930600-4 OLD LAGOON 2 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 14:30 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Miscellaneous Parameters** | | | | | | | |
| Biochemical Oxygen Demand | <6.0 | | 6.0 | mg/L | 13-SEP-10 | 18-SEP-10 | R1470801 |
| Fecal Coliforms | <3 | | 3 | MPN/100mL | | 16-SEP-10 | R1470183 |
| L930600-5 SL-1 | | | | | | | |
| Sampled By: STEPHANIE CHARITY on 10-SEP-10 @ 15:00 | | | | | | | |
| Matrix: WASTE WATER | | | | | | | |
| **Miscellaneous Parameters** | | | | | | | |
| Biochemical Oxygen Demand | 420 | | 6.0 | mg/L | 13-SEP-10 | 18-SEP-10 | R1470801 |
| Fecal Coliforms | 15000 | | 3 | MPN/100mL | | 16-SEP-10 | R1470183 |

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

# Reference Information

## Qualifiers for Individual Samples Listed:

| Sample Numbe | Client ID | Qualifier | Description |
|---|---|---|---|
| L930600-1 | ARV-2 | EHR | Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested |

## Sample Parameter Qualifier Key:

| Qualifier | Description |
|---|---|
| DLM | Detection Limit Adjusted For Sample Matrix Effects |

## Test Method References:

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|
| ANIONS5-IC-WP | Water | Anions scan (IC) | EPA 300.1 IC |
| This analysis is carried out using procedures adapted from EPA Method 300.1 "Determination of Inorganic Anions in Drinking Water by Ion Chromatography". | | | |
| BOD-WP | Water | Biochemical Oxygen Demand (BOD) | APHA 5210 B |
| The sample is incubated for 5 days at 20 degrees Celcius. Comparison of dissolved oxygen content at the beginning and end of incubation provides a measure of biochemical oxygen demand. If carbonaceous BOD is requested, TCMP is added to the sample to chemically inhibit nitrogenous oxygen demand. If soluble BOD is requested, the sample is filtered prior to analysis. Surface waters have a DL of 1 mg/L. Effluents are diluted according to their history and will have a sample DL of 6 mg/L or greater, depending on the dilutions used. | | | |
| EC-WP | Water | Conductivity | APHA 2510B |
| Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes. | | | |
| FC-MPN-WP | Water | Fecal Coliform | APHA 9221A-C |
| The Most Probable Number (MPN) method is based on the Multiple Tube Fermentation technique. The results of examination of replicate tubes and dilutions of a sample are reported after confirmations specific to total coliform, fecal coliform and E. coli are performed. Results are reported in MPN/100 mL for water and MPN/gram for food and solid samples. | | | |
| HG-T-CVAF-WP | Water | Mercury Total | EPA245.7 V2.0 |
| Mercury in filtered and unfiltered waters is oxidized with Bromine monochloride and analyzed by cold-vapour atomic fluorescence spectrometry. | | | |
| MET-T-L-MS-WP | Water | Total Metals by ICP-MS | U.S. EPA 200.8-TL |
| Total Metals by ICP-MS: This analysis is carried out using sample preparation procedures adapted from Standard Methods for the examination of Water and Wastewater Method 3030E and analytical procedures adapted from U.S EPA Method 200.8 for analyis of metals by inductively coupled-mass spectrometery. | | | |
| NH3-COL-WP | Water | Ammonia by colour | APHA 4500 NH3 F |
| Ammonia - Colourimeric using Salicylate-nitroprusside and hypochlorite, in an alkaline phosphate buffer. | | | |
| NO2+NO3-CALC-WP | Water | Nitrate+Nitrite | CALCULATION |
| OGG-IR-WP | Water | Total Oil and Grease | APHA METHOD 5520C |
| PH-WP | Water | pH | APHA 4500H |
| pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode. | | | |
| PHENOLS-4AAP-WT | Water | Phenols (4AAP) | EPA 9066 |
| An automated method is used to distill the sample. The distillate is then buffered to pH 9.4 which reacts with 4AAP and potassium ferricyanide to form a red complex which is measured colorimetrically. | | | |
| SOLIDS-TOTSUS-WP | Water | Total Suspended Solids | APHA 2540 |
| The residue retained by a prepared 1.5 um Whatman 934-AH glass microfibre filter dried at 105 degrees C. | | | |

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

# Reference Information

**Test Method References:**

| ALS Test Code | Matrix | Test Description | Method Reference** |
|---|---|---|---|

*The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:*

| Laboratory Definition Code | Laboratory Location |
|---|---|
| WP | ALS LABORATORY GROUP - WINNIPEG, MANITOBA, CANADA |
| WT | ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA |

**Chain of Custody Numbers:**

**GLOSSARY OF REPORT TERMS**

*Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.*
*mg/kg - milligrams per kilogram based on dry weight of sample*
*mg/kg wwt - milligrams per kilogram based on wet weight of sample*
*mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight*
*mg/L - unit of concentration based on volume, parts per million.*
*< - Less than.*
*D.L. - The reporting limit.*
*N/A - Result not available. Refer to qualifier code and definition for explanation.*

*Test results reported relate only to the samples as received by the laboratory.*
*UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.*
*Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.*

AGAT Laboratories

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 Metals & Inorganics in Soil - Table 1

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | Old Lagoon 1-Soil 1988833 | Old Lagoon 2-Soil 1988834 | Active Lagoon 1988835 |
|---|---|---|---|---|---|---|
| Antimony | g/g | 1.0 | 0.8 | 1.4 | 2.8 | 2.1 |
| Arsenic | g/g | 17 | 1 | 3 | 3 | 1 |
| Barium | g/g | 210 | 2 | 140 | 89 | 56 |
| Beryllium | g/g | 1.2 | 0.5 | <0.5 | <0.5 | <0.5 |
| Boron | g/g | | 5 | 10 | 12 | <5 |
| Boron (Hot Water Extractable) | g/g | | 0.10 | 2.62 | 3.96 | 0.88 |
| Cadmium | g/g | 1.0 | 0.5 | 1.6 | 1.1 | <0.5 |
| Chromium | g/g | 71 | 2 | 19 | 17 | 14 |
| Cobalt | g/g | 21 | 0.5 | 3.9 | 4.4 | 2.6 |
| Copper | g/g | 85 | 1 | 273 | 251 | 171 |
| Lead | g/g | 120 | 1 | 45 | 20 | 9 |
| Molybdenum | g/g | 2.5 | 0.5 | 2.8 | 3.3 | 1.2 |
| Nickel | g/g | 43 | 1 | 13 | 13 | 9 |
| Selenium | g/g | 1.9 | 0.4 | 2.5 | 1.8 | 3.0 |
| Silver | g/g | 0.42 | 0.2 | 5.8 | 4.8 | 2.7 |
| Thallium | g/g | 2.5 | 0.4 | <0.4 | <0.4 | <0.4 |
| Uranium | ug/g | | 0.5 | 1.1 | 1.6 | 0.9 |
| Vanadium | g/g | 91 | 1 | 13 | 18 | 13 |
| Zinc | g/g | 160 | 5 | 533 | 369 | 242 |
| Chromium, Hexavalent | g/g | 2.5 | 0.2 | <0.2 | <0.2 | <0.2 |
| Cyanide, Free | g/g | 0.12 | 0.05 | <0.05 | <0.05 | <0.05 |
| Mercury | g/g | 0.23 | 0.01 | 1.00 | 0.41 | 0.31 |
| Electrical Conductivity (2:1) | mS/cm | 0.57 | 0.002 | 0.703 | 1.56 | 0.792 |
| Sodium Adsorption Ratio (2:1) | N/A | 2.4 | N/A | 1.63 | 1.70 | 2.38 |
| pH, 2:1 CaCl2 Extraction | pH Units | | | 6.36 | 6.09 | 5.51 |
| Chloride (2:1) | g/g | 330 | 2 | 83 | 161 | 94 |
| Nitrate Nitrite | g/g | 61 | 1 | <1 | <1 | <1 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)

1988833-1988835 EC, SAR, Chloride & Nitrate/Nitrite were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the extract obtained from the 2:1 leaching procedure (2 parts 0.01M CaCl2:1 part soil).

Certified By:

AGAT Laboratories

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 Metals in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| Antimony | g/g | 1.0 | 0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 |
| Arsenic | g/g | 17 | 1 | 3 | 1 | 2 | 1 | 2 | 4 | 2 |
| Barium | g/g | 210 | 2 | 26 | 35 | 31 | 31 | 22 | 23 | 21 |
| Beryllium | g/g | 1.2 | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Boron | g/g | | 5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Cadmium | g/g | 1.0 | 0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chromium | g/g | 71 | 2 | 11 | 15 | 13 | 12 | 8 | 15 | 9 |
| Cobalt | g/g | 21 | 0.5 | 2.7 | 3.9 | 3.2 | 3.2 | 2.4 | 2.7 | 2.4 |
| Copper | g/g | 85 | 1 | 11 | 10 | 18 | 9 | 7 | 6 | 9 |
| Lead | g/g | 120 | 1 | 4 | 4 | 9 | 5 | 4 | 3 | 3 |
| Molybdenum | g/g | 2.5 | 0.5 | 0.7 | <0.5 | 0.6 | <0.5 | <0.5 | 1.0 | 0.5 |
| Nickel | g/g | 43 | 1 | 6 | 9 | 8 | 7 | 5 | 7 | 5 |
| Selenium | g/g | 1.9 | 0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Silver | g/g | 0.42 | 0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Thallium | g/g | 2.5 | 0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Uranium | ug/g | | 0.5 | 1.2 | 1.4 | 1.0 | 1.3 | 0.9 | 0.9 | 1.2 |
| Vanadium | g/g | 91 | 1 | 14 | 18 | 14 | 16 | 12 | 13 | 14 |
| Zinc | g/g | 160 | 5 | 25 | 34 | 54 | 20 | 159 | 125 | 31 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## Phenols in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| Phenols, Total | mg/kg | | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## (P & T) BTEX - Soil (GC/MS)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | g/g | 0.002 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Toluene | g/g | 0.002 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Ethylbenzene | g/g | 0.002 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| m & p-Xylene | g/g | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| o-Xylene | g/g | | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Xylene Mixture (Total) | g/g | 0.002 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Surrogate | Unit | Acceptable Limits | | | | | | | | |
| Toluene-d8 | % Recovery | 60-130 | | 113 | 106 | 112 | 94 | 100 | 113 | 99 |
| 4-Bromofluorobenzene | % Recovery | 70-130 | | 115 | 103 | 109 | 122 | 120 | 104 | 113 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to T1(All)
1988818-1988845 Results are based on the dry weight of the soil.

Certified By: Jordy Takewaki

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AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg 153 Petroleum Hydrocarbon F1 - F4 in Water (With PAHs)

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1988848 |
|---|---|---|---|---|
| C6 - C10 (F1) | g/L | | 25 | <25 |
| C6 - C10 (F1 minus BTEX) | g/L | | 25 | <25 |
| C>10 - C16 (F2) | g/L | | 100 | <100 |
| C>10 - C16 (F2 minus Naphthalene) | g/L | | 100 | <100 |
| C6 - C16 (F1 F2) | g/L | | 100 | <100 |
| C>16 - C34 (F3) | g/L | | 100 | <100 |
| C>16 - C34 (F3 minus PAHs) | g/L | | 100 | <100 |
| C>34 - C50 (F4) | g/L | | 100 | <100 |
| C>16 - C50 (F3 F4) | g/L | | 100 | <100 |
| Gravimetric Heavy Hydrocarbons | g/L | | 500 | NA |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988848
The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

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AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 - Petroleum Hydrocarbons F1 - F4 (C6 - C50) in Soil (PAHs Incl.)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| C6 - C10 (F1) | g/g | | 5 | <5 | 11 | <5 | <5 | <5 | <5 | <5 |
| C6 - C10 (F1 minus BTEX) | g/g | | 5 | <5 | 11 | <5 | <5 | <5 | <5 | <5 |
| C>10 - C16 (F2) | g/g | | 10 | 1200 | 3400 | 240 | 130 | <10 | <10 | <10 |
| C>10 - C16 (F2 minus Naphthalene) | g/g | | 10 | 1200 | 3400 | 240 | 130 | <10 | <10 | <10 |
| C>16 - C34 (F3) | g/g | | 50 | 430 | 1800 | 9100 | 130 | 26000 | 32000 | 24000 |
| C>16 - C34 (F3 minus PAHs) | g/g | | 50 | 430 | 1800 | 9100 | 130 | 26000 | 32000 | 24000 |
| C>34 - C50 (F4) | g/g | | 50 | <50 | <50 | 730 | 79 | 4800 | 6000 | 4400 |
| Gravimetric Heavy Hydrocarbons | g/g | | 50 | NA | NA | NA | NA | NA | NA | NA |
| Moisture Content | % | | 0.1 | 7.2 | 8.4 | 4.2 | 3.0 | 7.5 | 2.2 | 6.3 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988818-1988845 Results are based on sample dry weight.
The C6-C10 fraction is calculated using toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
Total C6 - C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 PAHs in Soil

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | g/g | | 0.03 | <0.03 | 0.04 | 0.04 | <0.03 | 0.03 | <0.03 | 0.05 |
| Acenaphthylene | g/g | | 0.02 | <0.02 | 0.04 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Acenaphthene | g/g | | 0.03 | <0.03 | 0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| Fluorene | g/g | | 0.02 | 0.02 | 0.15 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Phenanthrene | g/g | | 0.02 | <0.02 | 0.03 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Anthracene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Fluoranthene | g/g | | 0.02 | <0.02 | 0.03 | <0.02 | <0.02 | 0.02 | <0.02 | <0.02 |
| Pyrene | g/g | | 0.02 | 0.02 | 0.06 | 0.03 | <0.02 | 0.04 | 0.02 | 0.03 |
| Benzo(a)anthracene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.21 | 0.11 | 0.14 |
| Chrysene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.11 | 0.07 | 0.10 |
| Benzo(b)fluoranthene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.07 | 0.05 | 0.04 |
| Benzo(k)fluoranthene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.02 | <0.02 | 0.02 |
| Benzo(a)pyrene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.13 | 0.09 | 0.07 |
| Indeno(1,2,3-cd)pyrene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.05 | 0.03 | 0.03 |
| Dibenz(a,h)anthracene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Benzo(g,h,i)perylene | g/g | | 0.02 | <0.02 | <0.02 | <0.02 | <0.02 | 0.08 | 0.05 | 0.04 |
| 2-and 1-methyl Naphthalene | g/g | | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.05 | <0.05 | <0.05 |
| Surrogate | Unit | Acceptable Limits | | | | | | | | |
| Chrysene-d12 | % | 60-130 | | 79 | 89 | 100 | 93 | 89 | 95 | 89 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard
1988818-1988845 Results are based on the dry weight of the soil.

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AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Reg. 153 PAHs in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1988848 |
|---|---|---|---|---|
| Naphthalene | g/L | | 0.12 | <0.12 |
| Acenaphthylene | g/L | | 0.11 | <0.11 |
| Acenaphthene | g/L | | 0.10 | <0.10 |
| Fluorene | g/L | | 0.09 | <0.09 |
| Phenanthrene | g/L | | 0.10 | <0.10 |
| Anthracene | g/L | | 0.07 | <0.07 |
| Fluoranthene | g/L | | 0.12 | <0.12 |
| Pyrene | g/L | | 0.12 | <0.12 |
| Benzo(a)anthracene | g/L | | 0.08 | <0.08 |
| Chrysene | g/L | | 0.05 | <0.05 |
| Benzo(b)fluoranthene | g/L | | 0.05 | <0.05 |
| Benzo(k)fluoranthene | g/L | | 0.06 | <0.06 |
| Benzo(a)pyrene | g/L | | 0.01 | <0.01 |
| Indeno(1,2,3-cd)pyrene | g/L | | 0.03 | <0.03 |
| Dibenzo(a,h)anthracene | g/L | | 0.09 | <0.09 |
| Benzo(g,h,i)perylene | g/L | | 0.06 | <0.06 |
| 2-and 1-methyl Napthalene | g/L | | 0.20 | <0.20 |
| **Surrogate** | **Unit** | **Acceptable Limits** | | |
| Chrysene-d12 | % | 60-130 | | 98 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1988848 |
|---|---|---|---|---|
| Dichlorodifluoromethane | g/L | | 0.80 | <0.80 |
| Chloromethane | g/L | | 1.60 | <1.60 |
| Vinyl Chloride | g/L | | 0.68 | <0.68 |
| Bromomethane | g/L | | 0.80 | <0.80 |
| Chloroethane | g/L | | 0.80 | <0.80 |
| Trichlorofluoromethane | g/L | | 1.60 | <1.60 |
| Acetone | g/L | | 4.0 | <4.0 |
| 1,1 Dichloroethylene | g/L | | 1.20 | <1.20 |
| Methylene Chloride | g/L | | 1.20 | <1.20 |
| trans- 1,2-dichloroethylene | g/L | | 0.80 | <0.80 |
| Methyl tert-butyl ether | g/L | | 0.80 | <0.80 |
| 1,1-Dichloroethane | g/L | | 1.20 | <1.20 |
| Methyl Ethyl Ketone | g/L | | 4.0 | <4.0 |
| cis- 1,2-Dichloroethylene | g/L | | 0.80 | <0.80 |
| Chloroform | g/L | | 0.80 | <0.80 |
| 1,2 - Dichloroethane | g/L | | 0.80 | <0.80 |
| 1,1,1-Trichloroethane | g/L | | 1.20 | <1.20 |
| Carbon Tetrachloride | g/L | | 0.80 | <0.80 |
| Benzene | g/L | | 0.80 | <0.80 |
| 1,2-Dichloropropane | g/L | | 0.80 | <0.80 |
| Trichloroethylene | g/L | | 0.80 | <0.80 |
| Bromodichloromethane | g/L | | 0.80 | <0.80 |
| cis-1,3-Dichloropropene | ug/L | | 0.80 | <0.80 |
| Methyl Isobutyl Ketone | g/L | | 4.0 | <4.0 |
| trans-1,3-Dichloropropene | g/L | | 1.20 | <1.20 |
| 1,1,2-Trichloroethane | g/L | | 0.80 | <0.80 |
| Toluene | g/L | | 0.80 | <0.80 |
| 2-Hexanone | g/L | | 1.20 | <1.20 |
| Dibromochloromethane | g/L | | 0.40 | <0.40 |
| Ethylene Dibromide | g/L | | 0.80 | <0.80 |
| Tetrachloroethylene | g/L | | 0.80 | <0.80 |
| 1,1,1,2-Tetrachloroethane | g/L | | 0.40 | <0.40 |
| Chlorobenzene | g/L | | 0.40 | <0.40 |

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 1988848 |
|---|---|---|---|---|
| Ethylbenzene | g/L | | 0.40 | <0.40 |
| m & p-Xylene | g/L | | 0.80 | <0.80 |
| Bromoform | g/L | | 0.40 | <0.40 |
| Styrene | g/L | | 0.40 | <0.40 |
| 1,1,2,2-Tetrachloroethane | g/L | | 0.40 | <0.40 |
| o-Xylene | g/L | | 0.40 | <0.40 |
| 1,3-Dichlorobenzene | g/L | | 0.40 | <0.40 |
| 1,4-Dichlorobenzene | g/L | | 0.40 | <0.40 |
| 1,2-Dichlorobenzene | g/L | | 0.40 | <0.40 |
| 1,2,4-Trichlorobenzene | g/L | | 1.20 | <1.20 |
| 1,3-Dichloropropene (Cis Trans) | g/L | | 1.20 | <1.20 |
| Xylene Mixture (Total) | g/L | | 0.80 | <0.80 |
| n-Hexane | g/L | | 0.80 | <0.80 |
| **Surrogate** | **Unit** | **Acceptable Limits** | | |
| Toluene-d8 | % Recovery | 60-130 | | 99 |
| 4-Bromofluorobenzene | % Recovery | 70-130 | | 92 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

1988848 Dilution factor=4
The sample was diluted because the sample was foamy. The reporting detection limit has been corrected for the dilution factor used.

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AGAT WORK ORDER: 10T434896
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CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## PCBs (soil)

DATE SAMPLED: Sep 09, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | BW-P1-A 1988818 | BW-P1-B 1988823 | BW-P2-A 1988827 | BW-P2-B 1988830 | HW-1 1988837 | HW-2 1988842 | HW-3 1988845 |
|---|---|---|---|---|---|---|---|---|---|---|
| PCBs | g/g | | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Surrogate | Unit | Acceptable Limits | | | | | | | | |
| Decachlorobiphenyl | % | 60-130 | | 97 | 120 | 80 | 90 | 63 | 82 | 89 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard
1988818-1988845 Results are based on the dry weight of soil extracted.

Certified By: Jordy Takewaki

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ATTENTION TO: Stephanie Charity

## BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | Old Lagoon 1-Water 1988850 | Old Lagoon 2-Water 1989165 | SL-1 1989172 |
|---|---|---|---|---|---|---|
| Aluminum | mg/L | | 0.004 | 0.142 | 0.234 | 0.256 |
| Arsenic | mg/L | | 0.003 | 0.004 | <0.003 | <0.003 |
| Barium | mg/L | | 0.002 | 0.011 | 0.007 | 0.006 |
| Boron | mg/L | | 0.010 | 0.108 | 0.082 | 0.162 |
| Cadmium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Calcium | mg/L | | 0.05 | 19.3 | 12.5 | 7.10 |
| Chromium | mg/L | | 0.003 | <0.003 | <0.003 | <0.003 |
| Copper | mg/L | | 0.003 | 0.009 | 0.009 | 0.067 |
| Iron | mg/L | | 0.010 | 2.15 | 1.31 | 0.455 |
| Potassium | mg/L | | 0.05 | 12.1 | 8.48 | 17.9 |
| Magnesium | mg/L | | 0.05 | 7.91 | 4.99 | 2.96 |
| Mercury | mg/L | | 0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Manganese | mg/L | | 0.002 | 0.266 | 0.052 | 0.047 |
| Molybdenum | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Sodium | mg/L | | 0.05 | 47.3 | 29.9 | 54.3 |
| Nickel | mg/L | | 0.003 | 0.004 | <0.003 | <0.003 |
| Total Phosphorus | mg/L | | 0.05 | 1.96 | 1.93 | 7.23 |
| Lead | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Selenium | mg/L | | 0.004 | <0.004 | <0.004 | <0.004 |
| Silver | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Strontium | mg/L | | 0.005 | 0.107 | 0.057 | 0.022 |
| Thallium | mg/L | | 0.006 | <0.006 | <0.006 | <0.006 |
| Titanium | mg/L | | 0.002 | 0.003 | 0.004 | 0.005 |
| Uranium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Vanadium | mg/L | | 0.002 | <0.002 | <0.002 | <0.002 |
| Zinc | mg/L | | 0.005 | 0.006 | 0.013 | 0.060 |
| Fluoride | mg/L | | 0.05 | 0.21 | 0.15 | 0.42 |
| Chloride | mg/L | | 0.10 | 60.9 | 38.6 | 55.8 |
| Nitrite as N | mg/L | | 0.05 | <0.05 | 0.12 | <0.05 |
| Ortho phosphate as P | mg/L | | 0.10 | <0.10 | <0.10 | <0.10 |
| Bromide | mg/L | | 0.05 | 0.19 | 0.15 | <0.05 |
| Nitrate as N | mg/L | | 0.05 | <0.05 | 0.67 | <0.05 |

Certified By:

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## BURNSIDE - Water Quality Assessment

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | Old Lagoon 1-Water 1988850 | Old Lagoon 2-Water 1989165 | SL-1 1989172 |
|---|---|---|---|---|---|---|
| Sulphate | mg/L | | 0.10 | 11.2 | 10.3 | 11.1 |
| pH | pH Units | | NA | 7.95 | 7.73 | 7.90 |
| Ammonia as N | mg/L | | 0.02 | 20.9 | 7.64 | 49.7 |
| Total Organic Carbon | mg/L | | 0.5 | 28.7 | 23.9 | 113 |
| Electrical Conductivity | uS/cm | | 2 | 523 | 324 | 737 |
| Total Dissolved Solids | mg/L | | 20 | 294 | 200 | 298 |
| Saturation pH | | | | 7.72 | 8.20 | 7.95 |
| % Difference/ Ion Balance | | | 0.1 | 2.7 | 1.1 | 0.6 |
| Total Hardness (as CaCO3) | mg/L | | 10 | 81 | 52 | 30 |
| Langlier Index | | | | 0.23 | -0.47 | -0.05 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 | <5 | <5 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 161 | 83 | 253 |
| Turbidity | NTU | | 0.5 | 6.7 | 4.7 | 23.0 |
| Alkalinity (as CaCO3) | mg/L | | 5 | 161 | 83 | 253 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 | <5 | <5 |
| Reactive Silica | mg/L | | 0.05 | 9.25 | 7.02 | 14.7 |
| Colour | TCU | | 5 | 110 | 86 | 208 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

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# Certificate of Analysis

AGAT WORK ORDER: 10T434896
PROJECT NO: N-015746

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

## TSS (Water)

DATE SAMPLED: Sep 10, 2010 | DATE RECEIVED: Sep 13, 2010 | DATE REPORTED: Sep 24, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | Old Lagoon 1-Water 1988850 | Old Lagoon 2-Water 1989165 | SL-1 1989172 |
|---|---|---|---|---|---|---|
| Total Suspended Solids | mg/L | | 10 | <10 | <10 | 156 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

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# Guideline Violation

AGAT WORK ORDER: 10T434896

PROJECT NO: N-015746

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CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD

ATTENTION TO: Stephanie Charity

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Antimony | 1.0 | 1.4 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Cadmium | 1.0 | 1.6 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Copper | 85 | 273 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Electrical Conductivity (2:1) | 0.57 | 0.703 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Mercury | 0.23 | 1.00 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Molybdenum | 2.5 | 2.8 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Selenium | 1.9 | 2.5 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Silver | 0.42 | 5.8 |
| 1988833 | Old Lagoon 1-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Zinc | 160 | 533 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Antimony | 1.0 | 2.8 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Cadmium | 1.0 | 1.1 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Copper | 85 | 251 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Electrical Conductivity (2:1) | 0.57 | 1.56 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Mercury | 0.23 | 0.41 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Molybdenum | 2.5 | 3.3 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Silver | 0.42 | 4.8 |
| 1988834 | Old Lagoon 2-Soil | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Zinc | 160 | 369 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Antimony | 1.0 | 2.1 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Copper | 85 | 171 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Electrical Conductivity (2:1) | 0.57 | 0.792 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Mercury | 0.23 | 0.31 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Selenium | 1.9 | 3.0 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Silver | 0.42 | 2.7 |
| 1988835 | Active Lagoon | T1(All) | O. Reg. 153 Metals & Inorganics in Soil - Table 1 | Zinc | 160 | 242 |

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# Certificate of Analysis

AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Microbiological Analysis (water)

DATE SAMPLED: Nov 02, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 2104291 |
|---|---|---|---|---|
| Fecal Coliform | CFU/100mL | 1 | 1 | TNTC |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to SDWA -Schedule 23
2104291 TNTC – Too numerous to count, refers to overgrown colonies.

Certified By: Elizabeth Rolakowska

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# Certificate of Analysis

AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Microbiological Analysis (water)

DATE SAMPLED: Nov 02, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-4 2104288 |
|---|---|---|---|---|
| Escherichia coli | CFU/100mL | 1 | 1 | 14 |
| Total Coliforms | CFU/1mL | 1 | 1 | 4400 |
| Fecal Coliform | CFU/100mL | 1 | 1 | 5 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard: Refers to SDWA -Schedule 23

2104288 TC counts refer to a 1 ml sample aliquot diluted prior to filtration a larger aliquot resulted in overgrown colonies. The RDL has been adjusted.

Certified By: Elizabeth Rolakowska

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AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Particle Size Analysis

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | ARV-5-1 2104259 | ARV-5-2 2104261 | ARV-4-1 2104263 |
|---|---|---|---|---|---|---|
| Sieve Analysis - 4.75 mm | % | | N/A | 7.98 | 0.00 | 10.42 |
| Sieve Analysis - 2.36 mm | % | | N/A | 1.85 | 0.05 | 3.75 |
| Sieve Analysis - 1.18 mm | % | | N/A | 2.15 | 0.10 | 8.09 |
| Sieve Analysis - 600 microns | % | | N/A | 3.29 | 0.19 | 25.98 |
| Sieve Analysis - 300 microns | % | | N/A | 7.47 | 1.47 | 45.95 |
| Sieve Analysis - 150 microns | % | | N/A | 9.57 | 3.16 | 5.03 |
| Sieve Analysis - 75 microns | % | | N/A | 14.71 | 11.28 | 0.34 |
| Sieve Analysis - Retaining Pan | % | | N/A | 52.98 | 83.75 | 0.44 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By: Tony Nash

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AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Soil Analysis - Texture

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Soil

| Parameter | Unit | G / S | RDL | ARV-5-1 2104259 | ARV-5-2 2104261 |
|---|---|---|---|---|---|
| Particle Size Distribution (Sand) | % | | 1 | 52 | 16 |
| Particle Size Distribution (Silt) | % | | 1 | 40 | 68 |
| Particle Size Distribution (Clay) | % | | 1 | 8 | 16 |
| Soil Texture | | | | Sandy Loam | Silt Loam |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

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AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## O. Reg 153 Petroleum Hydrocarbon F1 - F4 in Water (-BTEX)

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-5 2104265 | RDL | ARV-5-2 2104274 |
|---|---|---|---|---|---|---|
| C6 - C10 (F1) | g/L | | 25 | <25 | 50 | <50 |
| C6 - C10 (F1 minus BTEX) | g/L | | 25 | <25 | 50 | <50 |
| C>10 - C16 (F2) | g/L | | 100 | <100 | 100 | <100 |
| C6 - C16 (F1 F2) | g/L | | 100 | <100 | 100 | <100 |
| C>16 - C34 (F3) | g/L | | 100 | <100 | 100 | <100 |
| C>34 - C50 (F4) | g/L | | 100 | <100 | 100 | <100 |
| C>16 - C50 (F3 F4) | g/L | | 100 | <100 | 100 | <100 |
| Gravimetric Heavy Hydrocarbons | g/L | | 500 | NA | 500 | NA |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

2104265-2104274 The C6-C10 fraction is calculated using Toluene response factor.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and nC34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16 - C50 and are only determined if the chromatogram of the C34 - C50 Hydrocarbons indicated that hydrocarbons >C50 are present.
Total C6-C50 results are corrected for BTEX and PAH contributions.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 nC16 nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified without the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.

Certified By: Jordy Takewaki

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AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-5 2104265 | RDL | ARV-5-2 2104274 |
|---|---|---|---|---|---|---|
| Dichlorodifluoromethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Chloromethane | g/L | | 0.80 | <0.80 | 4.00 | <4.00 |
| Vinyl Chloride | g/L | | 0.34 | <0.34 | 1.70 | <1.70 |
| Bromomethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Chloroethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Trichlorofluoromethane | g/L | | 0.80 | <0.80 | 4.00 | <4.00 |
| Acetone | g/L | | 2.0 | <2.0 | 10.0 | <10.0 |
| 1,1 Dichloroethylene | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| Methylene Chloride | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| trans- 1,2-dichloroethylene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Methyl tert-butyl ether | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 1,1-Dichloroethane | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| Methyl Ethyl Ketone | g/L | | 2.0 | <2.0 | 10.0 | <10.0 |
| cis- 1,2-Dichloroethylene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Chloroform | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 1,2 - Dichloroethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 1,1,1-Trichloroethane | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| Carbon Tetrachloride | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Benzene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 1,2-Dichloropropane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Trichloroethylene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Bromodichloromethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| cis-1,3-Dichloropropene | ug/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Methyl Isobutyl Ketone | g/L | | 2.0 | <2.0 | 10.0 | <10.0 |
| trans-1,3-Dichloropropene | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| 1,1,2-Trichloroethane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Toluene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 2-Hexanone | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| Dibromochloromethane | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| Ethylene Dibromide | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Tetrachloroethylene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| 1,1,1,2-Tetrachloroethane | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| Chlorobenzene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## O. Regulation 153 - Volatile Organic Compounds in Water

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-5 2104265 | RDL | ARV-5-2 2104274 |
|---|---|---|---|---|---|---|
| Ethylbenzene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| m & p-Xylene | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| Bromoform | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| Styrene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| 1,1,2,2-Tetrachloroethane | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| o-Xylene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| 1,3-Dichlorobenzene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| 1,4-Dichlorobenzene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| 1,2-Dichlorobenzene | g/L | | 0.20 | <0.20 | 1.00 | <1.00 |
| 1,2,4-Trichlorobenzene | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| 1,3-Dichloropropene (Cis Trans) | g/L | | 0.60 | <0.60 | 3.00 | <3.00 |
| Xylene Mixture (Total) | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| n-Hexane | g/L | | 0.40 | <0.40 | 2.00 | <2.00 |
| **Surrogate** | **Unit** | **Acceptable Limits** | | | | |
| Toluene-d8 | % Recovery | 60-130 | | 76 | | 74 |
| 4-Bromofluorobenzene | % Recovery | 70-130 | | 89 | | 85 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

2104265 Dilution factor=2
The sample was diluted becauce it was foamy. The reporting detection limit has been corrected for the dilution factor used.

2104274 Dilution factor=10
The sample was diluted becauce it was foamy. The reporting detection limit has been corrected for the dilution factor used.

Certified By: Jordy Takewaki

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# Certificate of Analysis

AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## BOD (Water)

DATE SAMPLED: Nov 02, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-2 2104291 |
|---|---|---|---|---|
| BOD (5) | mg/L | | 5 | 34 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

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AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## BOD, EC, pH & TSS (Water)

DATE SAMPLED: Nov 02, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-4 2104288 |
|---|---|---|---|---|
| BOD (5) | mg/L | | 5 | 30 |
| Electrical Conductivity | uS/cm | | 2 | 2510 |
| pH | pH Units | | NA | 7.92 |
| Total Suspended Solids | mg/L | | 10 | 368 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

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# Certificate of Analysis

AGAT WORK ORDER: 10T449096
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CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Water Quality Assessment

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-5 2104265 | RDL | ARV-5-2 2104274 |
|---|---|---|---|---|---|---|
| Aluminum | mg/L | | 0.004 | 3.92 | 0.040 | 6.13 |
| Arsenic | mg/L | | 0.003 | 0.008 | 0.003 | 0.012 |
| Barium | mg/L | | 0.002 | 0.073 | 0.002 | 0.074 |
| Boron | mg/L | | 0.010 | 0.045 | 0.010 | 0.769 |
| Cadmium | mg/L | | 0.002 | <0.002 | 0.002 | 0.003 |
| Calcium | mg/L | | 0.05 | 45.5 | 0.05 | 106 |
| Chromium | mg/L | | 0.003 | 0.010 | 0.003 | 0.111 |
| Copper | mg/L | | 0.003 | 0.010 | 0.003 | 0.039 |
| Iron | mg/L | | 0.010 | 5.85 | 0.100 | 131 |
| Potassium | mg/L | | 0.05 | 7.66 | 0.05 | 57.1 |
| Magnesium | mg/L | | 0.05 | 32.7 | 0.05 | 290 |
| Mercury | mg/L | | 0.0001 | <0.0001 | 0.0001 | <0.0001 |
| Manganese | mg/L | | 0.002 | 0.490 | 0.002 | 0.831 |
| Molybdenum | mg/L | | 0.002 | <0.002 | 0.002 | 0.003 |
| Sodium | mg/L | | 0.05 | 160 | 0.05 | 1640 |
| Nickel | mg/L | | 0.003 | 0.012 | 0.003 | 0.049 |
| Total Phosphorus | mg/L | | 0.05 | 0.87 | 0.05 | 2.42 |
| Lead | mg/L | | 0.002 | 0.008 | 0.002 | 0.010 |
| Selenium | mg/L | | 0.004 | <0.004 | 0.004 | <0.004 |
| Silver | mg/L | | 0.002 | <0.002 | 0.002 | <0.002 |
| Strontium | mg/L | | 0.005 | 0.408 | 0.005 | 1.50 |
| Thallium | mg/L | | 0.006 | <0.006 | 0.006 | <0.006 |
| Titanium | mg/L | | 0.002 | 0.114 | 0.002 | 0.132 |
| Uranium | mg/L | | 0.002 | <0.002 | 0.002 | 0.004 |
| Vanadium | mg/L | | 0.002 | 0.022 | 0.002 | 0.056 |
| Zinc | mg/L | | 0.005 | 0.068 | 0.005 | 0.079 |
| Fluoride | mg/L | | 0.05 | <0.05 | 0.50 | <0.50 |
| Chloride | mg/L | | 0.10 | 340 | 1.00 | 3110 |
| Nitrite as N | mg/L | | 0.05 | <0.05 | 0.50 | <0.50 |
| Ortho phosphate as P | mg/L | | 0.10 | <0.10 | 1.00 | <1.00 |
| Bromide | mg/L | | 0.05 | 1.28 | 0.50 | 12.3 |
| Nitrate as N | mg/L | | 0.05 | <0.05 | 0.50 | <0.50 |
| Sulphate | mg/L | | 0.10 | 55.9 | 1.00 | 636 |

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

# Certificate of Analysis

AGAT WORK ORDER: 10T449096
PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

## Water Quality Assessment

DATE SAMPLED: Nov 01, 2010 | DATE RECEIVED: Nov 03, 2010 | DATE REPORTED: Nov 23, 2010 | SAMPLE TYPE: Water

| Parameter | Unit | G / S | RDL | ARV-5 2104265 | RDL | ARV-5-2 2104274 |
|---|---|---|---|---|---|---|
| pH | pH Units | | NA | 6.61 | NA | 6.31 |
| Ammonia as N | mg/L | | 0.02 | <0.02 | 0.02 | 20.8 |
| Total Organic Carbon | mg/L | | 0.5 | 53.6 | 0.5 | 240 |
| Electrical Conductivity | uS/cm | | 2 | 1200 | 2 | 9230 |
| Total Dissolved Solids | mg/L | | 20 | 816 | 20 | 5930 |
| Saturation pH | | | | 7.83 | | 6.66 |
| % Difference/ Ion Balance | | | 0.1 | 1.7 | 0.1 | <0.1 |
| Total Hardness (as CaCO3) | mg/L | | 10 | 248 | 10 | 1460 |
| Langlier Index | | | | -1.22 | | -0.35 |
| Carbonate (as CaCO3) | mg/L | | 5 | <5 | 5 | <5 |
| Bicarbonate (as CaCO3) | mg/L | | 5 | 47 | 5 | 118 |
| Turbidity | NTU | | 0.5 | 369 | 0.5 | 239 |
| Alkalinity (as CaCO3) | mg/L | | 5 | 47 | 5 | 118 |
| Hydroxide (as CaCO3) | mg/L | | 5 | <5 | 5 | <5 |
| Reactive Silica | mg/L | | 0.05 | 13.8 | 0.05 | 31.8 |
| Colour | TCU | | 5 | 113 | 5 | 1050 |

Comments: RDL - Reported Detection Limit G / S - Guideline / Standard

Certified By:

AGAT Laboratories

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http://www.agatlabs.com

# Guideline Violation

AGAT WORK ORDER: 10T449096

PROJECT NO: NAO157460.0002

CLIENT NAME: R.J. BURNSIDE & ASSOCIATES LTD.

ATTENTION TO: Stephanie Charity

| SAMPLEID | SAMPLE TITLE | GUIDELINE | ANALYSIS PACKAGE | PARAMETER | GUIDEVALUE | RESULT |
|---|---|---|---|---|---|---|
| 2104288 | ARV-4 | SDWA -Schedule 23 | Microbiological Analysis (water) | Escherichia coli | 1 | 14 |
| 2104288 | ARV-4 | SDWA -Schedule 23 | Microbiological Analysis (water) | Fecal Coliform | 1 | 5 |
| 2104288 | ARV-4 | SDWA -Schedule 23 | Microbiological Analysis (water) | Total Coliforms | 1 | 4400 |

AQUATOX
AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

# TOXICITY TEST REPORT
*Daphnia magna*



Work Order : 217681
Sample Number : 28312

## SAMPLE IDENTIFICATION

| | | | |
|---|---|---|---|
| Company : | R.J Burnside & Associates Ltd. | Time Collected : | 17:30 |
| Location : | Orangeville ON | Date Collected : | 2010-09-08 |
| Substance : | ARV Sewage Lagoon | Date Received : | 2010-09-10 |
| Sampling Method : | Not given | Date Tested : | 2010-09-10 |
| Sampled By : | R.J. | Temp. on arrival : | 7.0 °C |
| Sample Description : | Cloudy, green, earthy odour. | | |

Test Method : Reference Method for Determining Acute Lethality of Effluents to *Daphnia magna.* Environment Canada EPS 1/RM/14 (Second Edition, December 2000).

## 48-h TEST RESULTS

| Substance | Effect | Value |
|---|---|---|
| Control | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |
| 100% | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |

The results reported relate only to the sample tested.

## SODIUM CHLORIDE REFERENCE TOXICANT DATA

| | | | |
|---|---|---|---|
| Organism Batch : | Dm10-17 | | |
| Date Tested (yyyy/mm/dd) : | 2010-09-13 | Historical Mean LC50 : | 6.7 g/L |
| LC50 (95% Confidence Limits) : | 6.5 g/L (6.1 - 6.9) | Warning Limits (± 2SD) : | 6.1 - 7.4 g/L |
| Statistical Method : | Probit | Analyst(s) : | LB/SM |

## *Daphnia magna* CULTURE HEALTH DATA

| | | | |
|---|---|---|---|
| Time to First Brood : | 7.6 days | Mean Young Per Brood : | 30.6 |
| Culture Mortality : | 0% (previous 7 days) | | |

## TEST CONDITIONS

| | | | |
|---|---|---|---|
| Sample Treatment : | None | Number of Replicates : | 3 |
| pH Adjustment : | None | Test Organisms / Replicate : | 10 |
| Test Aeration : | None | Total Organisms / Test Level : | 30 |
| Organism Batch : | Dm10-17 | Organism Loading Rate : | 15.0 mL/organism |

*Date:* 2010-09-29
*yyyy-mm-dd*

*Approved by:* K Dube
*Project Manager*

Work Order: 217681
Sample Number: 28312

| | Hardness (mg/L as $CaCO_3$) | Hardness Adjustment | pH | D.O. (mg/L) | Cond. (µmhos/cm) | Temp. (°C) | $O_2$ Sat. (%)* | Total Pre-Aeration Time (h) @ 30 mL/min/L |
|---|---|---|---|---|---|---|---|---|
| **Initial Water Chemistry:** | 120 | None | 7.7 | 3.7 | 931 | 20.0 | 42 | 0:00 |

**0 hours**

Date & Time 2010-09-10 14:30
Technician: LB

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. | $O_2$ Sat. (%)* | Hardness |
|---|---|---|---|---|---|---|---|---|
| 100A | 0 | 0 | 7.7 | 3.7 | 931 | 20.0 | 42 | 120 |
| 100B | 0 | 0 | 7.7 | 3.7 | 931 | 20.0 | | |
| 100C | 0 | 0 | 7.7 | 3.7 | 931 | 20.0 | | |
| Control A | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | | |
| Control B | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | | |
| Control C | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | 99 | 220 |

Notes: Indigenous organisms, were attempted to be removed from 100% effluent prior to test initiation.
Dark coloured sample.

**24 hours**

Date & Time 2010-09-11 14:30
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100A | 0 | 1 | – | – | – | 21.0 |
| 100B | 0 | 0 | – | – | – | 21.0 |
| 100C | 0 | 0 | – | – | – | 21.0 |
| Control A | 0 | 0 | – | – | – | 21.0 |
| Control B | 0 | 0 | – | – | – | 21.0 |
| Control C | 0 | 0 | – | – | – | 21.0 |

Notes:

**48 hours**

Date & Time 2010-09-12 14:30
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100A | 0 | 0 | 8.6 | 9.6 | 912 | 20.0 |
| 100B | 0 | 0 | 8.6 | 9.6 | 914 | 20.0 |
| 100C | 0 | 0 | 8.6 | 10.0 | 907 | 20.0 |
| Control A | 0 | 0 | 8.5 | 8.5 | 395 | 20.0 |
| Control B | 0 | 0 | 8.6 | 8.6 | 399 | 20.0 |
| Control C | 0 | 0 | 8.6 | 8.5 | 402 | 20.0 |

Notes: >30 live organisms counted. No dead daphnids or carapaces found within sample.

# of control organisms showing stress: 0
*Daphnia* Batch #: Dm10-17

Number immobile does not include number of mortalities.

– = not measured
* adjusted for actual temp. & barometric pressure

Test Data Reviewed By: KEH
Date: 2010-09-29

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
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Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

# TOXICITY TEST REPORT
## Rainbow Trout



Work Order : 217681
Sample Number : 28312

## SAMPLE IDENTIFICATION

| | | | |
|---|---|---|---|
| Company : | R.J Burnside & Associates Ltd. | Time Collected : | 17:30 |
| Location : | Orangeville ON | Date Collected : | 2010-09-08 |
| Substance : | ARV Sewage Lagoon | Date Received : | 2010-09-10 |
| Sampling Method : | Not given | Date Tested : | 2010-09-10 |
| Sampled By : | R.J. | Temp. on arrival : | 7.0°C |
| Sample Description : | Cloudy, green, earthy odour. | | |

Test Method : Reference Method for Determining Acute Lethality of Liquid Effluents to Rainbow Trout. Environment Canada, EPS 1/RM/13 (2nd Edition, December 2000, with May 2007 amendments).

## 96-h TEST RESULTS

| Substance | Effect | Value |
|---|---|---|
| Control | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |
| 100% | Mean Immobility | 0.0 % |
| | Mean Mortality | 100.0 % |

The results reported relate only to the sample tested.

## POTASSIUM CHLORIDE REFERENCE TOXICANT DATA

| | | | |
|---|---|---|---|
| Organism Batch : | T10-12 | | |
| Date Tested (yyyy-mm-dd) : | 2010-09-01 | Historical Mean LC50 : | 4004 mg/L |
| LC50 (95% Confidence Limits) : | 3560 mg/L (3187 - 3961) | Warning Limits (± 2SD) : | 3365 - 4766 mg/L |
| Statistical Method : | Probit | Analyst(s) : | MP/FS/TL |

## TEST FISH

| | | | |
|---|---|---|---|
| Control Fish Sample Size : | 10 | Cumulative stock tank mortality: | 0 % (prev. 7 days) |
| Mean Fish Weight (± 2 SD) : | 0.91 ± 0.44 g | Mean Fish Fork Length (± 2 SD) : | 45.2 ± 7.3 mm |
| Range of Weights : | 0.59 - 1.27 g | Range of Fork Lengths (mm) : | 40 - 50 mm |
| Fish Loading Rate : | 0.4 g/L | | |

## TEST CONDITIONS

| | | | |
|---|---|---|---|
| Sample Treatment : | None | Volume Tested (L) : | 21 |
| pH Adjustment : | None | Number of Replicates : | 1 |
| Test Aeration : | Yes | Organisms Per Replicate : | 10 |
| Pre-aeration/Aeration Rate : | 6.5 ± 1 mL/min/L | Total Organisms Per Test Level : | 10 |
| Organism Batch : | T10-12 | | |

*Date:* 2010-09-20
*yyyy-mm-dd*

*Approved by:* _____
*Project Manager*

Work Order: 217681
Sample Number: 28312

| Total Pre-Aeration Time (h) | | pH | D.O. (mg/L) | Cond. (µmhos/cm) | Temp. (°C) | $O_2$ Sat. (%)* |
|---|---|---|---|---|---|---|
| 2:00 | **Initial Water Chemistry:** | 7.4 | 2.6 | 835 | 16.0 | – |
| | Chemistry after 30min air: | 7.4 | 4.5 | 826 | 16.0 | 49 |

**0 hours**

Date & Time 2010-09-10 16:10
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. | $O_2$ Sat. (%)* |
|---|---|---|---|---|---|---|---|
| 100 | 0 | 0 | 7.4 | 7.3 | 825 | 15.5 | 76 |
| Control | 0 | 0 | 7.9 | 9.6 | 535 | 15.0 | 100 |

Notes:

**24 hours**

Date & Time 2010-09-11 16:10
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 9 | 0 | 7.8 | 7.2 | 811 | 15.5 |
| Control | 0 | 0 | – | – | – | 15.5 |

Notes:

**48 hours**

Date & Time 2010-09-12 16:10
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 10 | 0 | 7.9 | 7.8 | 821 | 15.0 |
| Control | 0 | 0 | – | – | – | 15.0 |

Notes:

**72 hours**

Date & Time 2010-09-13 16:10
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 10 | 0 | – | – | – | – |
| Control | 0 | 0 | – | – | – | 15.0 |

Notes:

**96 hours**

Date & Time 2010-09-14 16:10
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 10 | 0 | – | – | – | – |
| Control | 0 | 0 | 8.2 | 9.4 | 519 | 15.0 |

Notes:

# of control organisms showing stress: 0
Trout Batch #: T10-12

"–" = not measured
Number immobile does not include number of mortalities.
* adjusted for actual temp. & barometric pressure

Test Data Reviewed By: KFH
Date: 2010-09-16

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

# TOXICITY TEST REPORT
*Daphnia magna*



Work Order : 217681
Sample Number : 28313

## SAMPLE IDENTIFICATION

| | | | |
|---|---|---|---|
| Company : | R.J Burnside & Associates Ltd. | Time Collected : | 17:45 |
| Location : | Orangeville ON | Date Collected : | 2010-09-08 |
| Substance : | ARV Landfill | Date Received : | 2010-09-10 |
| Sampling Method : | Not given | Date Tested : | 2010-09-10 |
| Sampled By : | R.J. | Temp. on arrival : | 7.0 °C |
| Sample Description : | Cloudy, green, earthy odour. | | |

Test Method : Reference Method for Determining Acute Lethality of Effluents to *Daphnia magna.* Environment Canada EPS 1/RM/14 (Second Edition, December 2000).

## 48-h TEST RESULTS

| Substance | Effect | Value |
|---|---|---|
| Control | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |
| 100% | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |

The results reported relate only to the sample tested.

## SODIUM CHLORIDE REFERENCE TOXICANT DATA

| | | | |
|---|---|---|---|
| Organism Batch : | Dm10-17 | | |
| Date Tested (yyyy/mm/dd) : | 2010-09-13 | Historical Mean LC50 : | 6.7 g/L |
| LC50 (95% Confidence Limits) : | 6.5 g/L (6.1 - 6.9) | Warning Limits (± 2SD) : | 6.1 - 7.4 g/L |
| Statistical Method : | Probit | Analyst(s) : | LB/SM |

## *Daphnia magna* CULTURE HEALTH DATA

| | | | |
|---|---|---|---|
| Time to First Brood : | 7.6 days | Mean Young Per Brood : | 30.6 |
| Culture Mortality : | 0% (previous 7 days) | | |

## TEST CONDITIONS

| | | | |
|---|---|---|---|
| Sample Treatment : | None | Number of Replicates : | 3 |
| pH Adjustment : | None | Test Organisms / Replicate : | 10 |
| Test Aeration : | None | Total Organisms / Test Level : | 30 |
| Organism Batch : | Dm10-17 | Organism Loading Rate : | 15.0 mL/organism |

*Date:* 2010-09-27
*yyyy-mm-dd*

*Approved by:* K Dube
*Project Manager*

Work Order: 217681
Sample Number: 28313

| | Hardness (mg/L as $CaCO_3$) | Hardness Adjustment | pH | D.O. (mg/L) | Cond. (µmhos/cm) | Temp. (°C) | $O_2$ Sat. (%)* | Total Pre-Aeration Time (h) @ 30 mL/min/L |
|---|---|---|---|---|---|---|---|---|
| **Initial Water Chemistry:** | 820 | None | 7.9 | 6.2 | 2471 | 21.0 | 72 | 0:00 |

**0 hours**

Date & Time 2010-09-10 14:35
Technician: LB

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. | $O_2$ Sat. (%)* | Hardness |
|---|---|---|---|---|---|---|---|---|
| 100A | 0 | 0 | 7.9 | 6.2 | 2471 | 21.0 | 72 | 820 |
| 100B | 0 | 0 | 7.9 | 6.2 | 2471 | 21.0 | | |
| 100C | 0 | 0 | 7.9 | 6.2 | 2471 | 21.0 | | |
| Control A | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | | |
| Control B | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | | |
| Control C | 0 | 0 | 8.5 | 8.6 | 397 | 21.0 | 99 | 220 |

Notes: Indigenous organisms, were attempted to be removed from 100% effluent prior to test initiation.
Dark coloured sample.

**24 hours**

Date & Time 2010-09-11 14:35
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100A | 0 | 0 | – | – | – | 21.0 |
| 100B | 0 | 0 | – | – | – | 21.0 |
| 100C | 0 | 0 | – | – | – | 21.0 |
| Control A | 0 | 0 | – | – | – | 21.0 |
| Control B | 0 | 0 | – | – | – | 21.0 |
| Control C | 0 | 0 | – | – | – | 21.0 |

Notes:

**48 hours**

Date & Time 2010-09-12 14:35
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100A | 0 | 0 | 8.4 | 9.7 | 2218 | 20.0 |
| 100B | 0 | 0 | 8.4 | 9.8 | 2236 | 20.0 |
| 100C | 0 | 0 | 8.5 | 9.8 | 2257 | 20.0 |
| Control A | 0 | 0 | 8.4 | 8.7 | 399 | 20.0 |
| Control B | 0 | 0 | 8.5 | 8.6 | 406 | 20.0 |
| Control C | 0 | 0 | 8.5 | 8.6 | 395 | 20.0 |

Notes:

# of control organisms showing stress: 0
*Daphnia* Batch #: Dm10-17

Number immobile does not include number of mortalities.

– = not measured
* adjusted for actual temp. & barometric pressure

Test Data Reviewed By: KEH
Date: 2010-09-23

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Tel: (519) 763-4412 Fax: (519) 763-4419

# TOXICITY TEST REPORT
## Rainbow Trout



Work Order : 217681
Sample Number : 28313

## SAMPLE IDENTIFICATION

| | | | |
|---|---|---|---|
| Company : | R.J Burnside & Associates Ltd. | Time Collected : | 17:45 |
| Location : | Orangeville ON | Date Collected : | 2010-09-08 |
| Substance : | ARV Landfill | Date Received : | 2010-09-10 |
| Sampling Method : | Not given | Date Tested : | 2010-09-10 |
| Sampled By : | R.J. | Temp. on arrival : | 7.0°C |
| Sample Description : | Cloudy, green, earthy odour. | | |

Test Method : Reference Method for Determining Acute Lethality of Liquid Effluents to Rainbow Trout. Environment Canada, EPS 1/RM/13 (2nd Edition, December 2000, with May 2007 amendments).

## 96-h TEST RESULTS

| Substance | Effect | Value |
|---|---|---|
| Control | Mean Immobility | 0.0 % |
| | Mean Mortality | 0.0 % |
| 100% | Mean Immobility | 0.0 % |
| | Mean Mortality | 100.0 % |

The results reported relate only to the sample tested.

## POTASSIUM CHLORIDE REFERENCE TOXICANT DATA

| | | | |
|---|---|---|---|
| Organism Batch : | T10-12 | | |
| Date Tested (yyyy-mm-dd) : | 2010-09-01 | Historical Mean LC50 : | 4004 mg/L |
| LC50 (95% Confidence Limits) : | 3560 mg/L (3187 - 3961) | Warning Limits (± 2SD) : | 3365 - 4766 mg/L |
| Statistical Method : | Probit | Analyst(s) : | MP/FS/TL |

## TEST FISH

| | | | |
|---|---|---|---|
| Control Fish Sample Size : | 10 | Cumulative stock tank mortality: | 0 % (prev. 7 days) |
| Mean Fish Weight (± 2 SD) : | 0.72 ± 0.20 g | Mean Fish Fork Length (± 2 SD) : | 42.8 ± 5.1 mm |
| Range of Weights : | 0.62 - 0.95 g | Range of Fork Lengths (mm) : | 40 - 48 mm |
| Fish Loading Rate : | 0.4 g/L | | |

## TEST CONDITIONS

| | | | |
|---|---|---|---|
| Sample Treatment : | None | Volume Tested (L) : | 17 |
| pH Adjustment : | None | Number of Replicates : | 1 |
| Test Aeration : | Yes | Organisms Per Replicate : | 10 |
| Pre-aeration/Aeration Rate : | 6.5 ± 1 mL/min/L | Total Organisms Per Test Level : | 10 |
| Organism Batch : | T10-12 | | |

*Date:* 2010-09-20
*yyyy-mm-dd*

*Approved by:* K Dube
*Project Manager*

Work Order: 217681
Sample Number: 28313

| Total Pre-Aeration Time (h) | | pH | D.O. (mg/L) | Cond. (µmhos/cm) | Temp. (°C) | $O_2$ Sat. (%)* |
|---|---|---|---|---|---|---|
| 1:30 | Initial Water Chemistry: | 7.7 | 5.5 | 2290 | 16.0 | – |
| | Chemistry after 30min air: | 7.9 | 6.4 | 2165 | 16.0 | 68 |

**0 hours**

Date & Time 2010-09-10 15:40
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. | $O_2$ Sat. (%)* |
|---|---|---|---|---|---|---|---|
| 100 | 0 | 0 | 7.8 | 7.1 | 2152 | 16.0 | 74 |
| Control | 0 | 0 | 7.9 | 9.6 | 535 | 15.0 | 100 |

Notes:

**24 hours**

Date & Time 2010-09-11 15:40
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 4 | 0 | – | – | – | 15.5 |
| Control | 0 | 0 | – | – | – | 15.5 |

Notes:

**48 hours**

Date & Time 2010-09-12 15:40
Technician: DK

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 8 | 0 | 8.1 | 8.4 | 2055 | 15.0 |
| Control | 0 | 0 | – | – | – | 15.0 |

Notes:

**72 hours**

Date & Time 2010-09-13 15:40
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 9 | 1 | – | – | – | 15.0 |
| Control | 0 | 0 | – | – | – | 15.0 |

Notes: Remaining test organism in 100% effluent is on side at bottom of test chamber.

**96 hours**

Date & Time 2010-09-14 15:40
Technician: FS

| Test Conc. (%) | Mortality | Immobility | pH | D.O. | Cond. | Temp. |
|---|---|---|---|---|---|---|
| 100 | 10 | 0 | 8.1 | 8.2 | 2036 | 15.0 |
| Control | 0 | 0 | 8.3 | 9.3 | 544 | 15.0 |

Notes:

# of control organisms showing stress: 0
Trout Batch #: T10-12

"–" = not measured
Number immobile does not include number of mortalities.
* adjusted for actual temp. & barometric pressure

Test Data Reviewed By: KEH
Date: 2010-09-16

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# Appendix E
# CCME Guidelines

# Canadian Water Quality Guidelines for the Protection of Aquatic Life

## SUMMARY TABLE

**Update 7.0**
**September 2007**

**Summary of Canadian water quality guidelines for the protection of aquatic life.**

| | Freshwater | | Marine | |
|---|---|---|---|---|
| **Parameter[a]** | **Concentration (µg·L$^{-1}$)** | **Date[b]** | **Concentration (µg·L$^{-1}$)** | **Date[b]** |
| Acenaphthene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Acridine [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Aldicarb | 1[c] | 1993 | 0.15[c] | 1993 |
| Aldrin + Dieldrin[d] | ~~0.004~~[e,f] | 1987 | | |
| Aluminium[d] | 5–100[g] | 1987 | | |
| Ammonia (total) | see factsheet | 2001 | | |
| Ammonia (un-ionized) | 19[h] | 2001 | | |
| Aniline | 2.2[i] | 1993 | Insufficient data | 1993 |
| Anthracene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Arsenic[j] | 5.0[k] | 1997 | 12.5[c] | 1997 |
| Atrazine | 1.8[i] | 1989 | | |
| Benz*(a)*anthracene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Benzene[j] | 370[c, k] | 1999 | 110[c] | 1999 |
| Benzo*(a)*pyrene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| 2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane [See DDT (total)] | | | | |
| Bromacil | 5.0[c,i] | 1997 | Insufficient data | 1997 |
| Bromoform [See Halogenated methanes, Tribromomethane] | | | | |
| Bromoxynil | 5.0[i] | 1993 | Insufficient data | 1993 |
| Cadmium | 0.017[c,l] | 1996 | 0.12[i] | 1996 |
| Captan | 1.3[c] | 1991 | | |
| Carbaryl | 0.20[i] | 1997 | 0.32[c,i] | 1997 |
| Carbofuran | 1.8[i] | 1989 | | |
| Carbon tetrachloride [See Halogenated methanes, Tetrachloromethane] | | | | |
| Chlordane[d] | ~~0.006~~[e,f] | 1987 | | |
| Chlorinated benzenes | | | | |
| Monochlorobenzene | 1.3[c,k] | 1997 | 25[c,k] | 1997 |
| 1,2-Dichlorobenzene | 0.70[c,k] | 1997 | 42[c,k] | 1997 |
| 1,3-Dichlorobenzene | 150[c,k] | 1997 | Insufficient data[k] | 1997 |
| 1,4-Dichlorobenzene | 26[c,k] | 1997 | Insufficient data[k] | 1997 |
| 1,2,3-Trichlorobenzene | 8.0[c,k] | 1997 | Insufficient data[k] | 1997 |
| 1,2,4-Trichlorobenzene | 24[c,k] | 1997 | 5.4[c,k] | 1997 |
| 1,3,5-Trichlorobenzene[d] | Insufficient data[k] | 1997 | Insufficient data[k] | 1997 |

*Continued.*

| Parameter[a] | Freshwater | | Marine | |
|---|---|---|---|---|
| | Concentration ($\mu g \cdot L^{-1}$) | Date[b] | Concentration ($\mu g \cdot L^{-1}$) | Date[b] |
| Chlorinated benzenes—Continued | | | | |
| 1,2,3,4-Tetrachlorobenzene | 1.8[c,k] | 1997 | Insufficient data[k] | 1997 |
| 1,2,3,5-Tetrachlorobenzene[d] | Insufficient data[k] | 1997 | Insufficient data[k] | 1997 |
| 1,2,4,5-Tetrachlorobenzene[d] | Insufficient data[k] | 1997 | Insufficient data[k] | 1997 |
| Pentachlorobenzene | 6.0[c,k] | 1997 | Insufficient data[k] | 1997 |
| Hexachlorobenzene[d] | Insufficient data[e,f,k] | 1997 | Insufficient data[k] | 1997 |
| Chlorinated ethanes | | | | |
| 1,2-Dichloroethane | 100[c,i] | 1991 | Insufficient data | 1991 |
| 1,1,1-Trichloroethane | Insufficient data | 1991 | Insufficient data | 1991 |
| 1,1,2,2-Tetrachloroethane | Insufficient data | 1991 | Insufficient data | 1991 |
| Chlorinated ethenes | | | | |
| 1,1,2-Trichloroethene (Tichloroethylene; TCE) | 21[c,i] | 1991 | Insufficient data | 1991 |
| 1,1,2,2-Tetrachloroethene (Tetrachloroethylene; PCE) | 111[c,i] | 1993 | Insufficient data | 1993 |
| Chlorinated methanes [See Halogenated methanes] | | | | |
| Chlorinated phenols[d] | | | | |
| Monochlorophenols | 7 | 1987 | | |
| Dichlorophenols | 0.2 | 1987 | | |
| Trichlorophenols | 18 | 1987 | | |
| Tetrachlorophenols | 1 | 1987 | | |
| Pentachlorophenol (PCP) | 0.5 | 1987 | | |
| Chlorine, reactive [See Reactive chlorine species] | | | | |
| Chloroform [See Halogenated methanes, Trichloromethane] | | | | |
| 4-Chloro-2-methyl phenoxy acetic acid [See MCPA] | | | | |
| Chlorothalonil | 0.18[c] | 1994 | 0.36[c] | 1994 |
| Chlorpyrifos | 0.0035 | 1997 | 0.002[c] | 1997 |
| Chromium | | | | |
| Trivalent chromium (Cr(III)) | 8.9[c,k] | 1997 | 56[c,k] | 1997 |
| Hexavalent chromium (Cr(VI)) | 1.0[k] | 1997 | 1.5[k] | 1997 |
| Chrysene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Colour | Narrative | 1999 | Narrative | 1999 |
| Copper[d] | 2–4[m] | 1987 | | |
| Cyanazine | 2.0[c,i] | 1990 | | |
| Cyanide[d] | 5 (as free CN) | 1987 | | |
| DDAC (Didecyl dimethyl ammonium chloride) | 1.5[c] | 1999 | Insufficient data | 1999 |
| DDT (total)[d] (2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane; dichloro diphenyl trichloroethane) | ~~0.001~~[e,f] | 1987 | | |
| Debris (litter/settleable matter) | | | Narrative[c] | 1996 |

*Continued.*

| | Freshwater | | Marine | |
|---|---|---|---|---|
| **Parameter[a]** | **Concentration (µg·L$^{-1}$)** | **Date[b]** | **Concentration (µg·L$^{-1}$)** | **Date[b]** |
| Deltamethrin | 0.0004 | 1997 | Insufficient data | 1997 |
| Deposited bedload sediment [See Total particulate matter] | | | | |
| Dibromochloromethane [See Halogenated methanes] | | | | |
| Dicamba | 10[c,i] | 1993 | | |
| Dichlorobenzene [See Chlorinated benzenes] | | | | |
| Dichlorobromomethane [See Halogenated methanes] | | | | |
| Dichloro diphenyl trichloroethane [See DDT (total)] | | | | |
| Dichloroethane [See Chlorinated ethanes] | | | | |
| Dichloroethylene [See Chlorinated ethanes, 1,2-Dichloroethane] | | | | |
| Dichloromethane [See Halogenated methanes] | | | | |
| Dichlorophenols [See Chlorinated phenols] | | | | |
| 2,4-Dichlorophenoxyacetic acid [see Phenoxy herbicides] | | | | |
| Diclofop-methyl | 6.1 | 1993 | | |
| Didecyl dimethyl ammonium chloride [See DDAC] | | | | |
| Diethylene glycol [See Glycols] | | | | |
| Di(2-ethylhexyl) phthalate [See Phthalate esters] | | | | |
| Diisopropanolamine (DIPA)[aa] | 1600[c] | 2005 | Insufficient data | 2005 |
| Dimethoate | 6.2[c] | 1993 | Insufficient data | 1993 |
| Di-*n*-butyl phthalate [See Phthalate esters] | | | | |
| Di-*n*-octyl phthalate [See Phthalate esters] | | | | |
| Dinoseb | 0.05 | 1992 | | |
| Dissolved gas supersaturation | Narrative | 1999 | Narrative | 1999 |
| Dissolved oxygen | 5500–9500[k,n] | 1999 | >8000 and Narrative[c,k] | 1996 |
| Endosulfan[d] | 0.02 | 1987 | | |
| Endrin[d] | ~~0.0023~~[e,f] | 1987 | | |
| Ethylbenzene[j] | 90[c,k] | 1996 | 25[c,k] | 1996 |
| Ethylene glycol [See Glycols] | | | | |
| Fluoranthene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Fluorene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Glycols | | | | |
| Ethylene glycol | 192 000[k] | 1997 | Insufficient data | 1997 |
| Diethylene glycol | Insufficient data[k] | 1997 | Insufficient data | 1997 |
| Propylene glycol | 500 000[k] | 1997 | Insufficient data | 1997 |
| Glyphosate | 65[c] | 1989 | | |

*Continued*

| Parameter[a] | Freshwater | | Marine | |
|---|---|---|---|---|
| | Concentration ($\mu g \cdot L^{-1}$) | Date[b] | Concentration ($\mu g \cdot L^{-1}$) | Date[b] |
| Halogenated methanes | | | | |
| Monochloromethane (Methyl chloride)[d] | Insufficient data | 1992 | Insufficient data | 1992 |
| Dichloromethane (Methylene chloride) | 98.1[c,i] | 1992 | Insufficient data | 1992 |
| Trichloromethane (Chloroform) | 1.8[c,i] | 1992 | Insufficient data | 1992 |
| Tetrachloromethane (Carbon tetrachloride) | 13.3[c,i] | 1992 | Insufficient data | 1992 |
| Monobromomethane (Methyl bromide)[d] | Insufficient data | 1992 | Insufficient data | 1992 |
| Tribromomethane (Bromoform)[d] | Insufficient data | 1992 | Insufficient data | 1992 |
| Dibromochloromethane[d] | Insufficient data | 1992 | Insufficient data | 1992 |
| Dichlorobromomethane[d] | Insufficient data | 1992 | Insufficient data | 1992 |
| HCBD [See Hexachlorobutadiene (HCBD)] | | | | |
| Heptachlor (Heptachlor epoxide)[d] | ~~0.01~~[e,f] | 1987 | | |
| Hexachlorobenzene [See Chlorinated benzenes] | | | | |
| Hexachlorobutadiene (HCBD) | 1.3[c, k] | 1999 | | |
| Hexachlorocyclohexane (Lindane)[d] | 0.01 | 1987 | | |
| Hypochlorous acid [See Reactive chlorine species] | | | | |
| Imidacloprid[aa] | 0.23[c] | 2007 | 0.65[c] | 2007 |
| Inorganic fluorides | 120[c] | 2002 | | |
| 3-Iodo-2-propynyl butyl carbamate [See IPBC] | | | | |
| IPBC (3-Iodo-2-propynyl butyl carbamate) | 1.9[c] | 1999 | | |
| Iron[d] | 300 | 1987 | | |
| Lead[d] | 1.7[c] | 1987 | | |
| Lindane [See Hexachlorocyclohexane] | | | | |
| Linuron | 7.0[c] | 1995 | Insufficient data | 1995 |
| MCPA (4-Chloro-2-methyl phenoxy acetic acid; 2-methyl-4-chloro phenoxy acetic acid) | 2.6[c] | 1995 | 4.2[c] | 1995 |
| Mercury[v] | | | | |
| Inorganic Mercury[v] | 0.026 | 2003 | 0.016[c,w] | 2003 |
| Methylmercury[v] | 0.004[c,w] | 2003 | | |
| Methyl bromide [See Halogenated methanes, Monobromomethane] | | | | |
| Methyl chloride [See Halogenated methanes, Monochloromethane] | | | | |
| 2-Methyl-4-chloro phenoxy acetic acid [See MCPA] | | | | |
| Methylene chloride [See Halogenated methanes, Dichloromethane] | | | | |
| Methyl *tertiary*-butyl ether [See MTBE] | | | | |
| Metolachlor | 7.8[c] | 1991 | | |
| Metribuzin | 1.0[c] | 1990 | | |
| Molybdenum[j] | 73[c] | 1999 | | |
| Monobromomethane [See Halogenated methanes] | | | | |
| Monochloramine [See Reactive chlorine species] | | | | |

*Continued.*

| | Freshwater | | Marine | |
|---|---|---|---|---|
| **Parameter**[a] | **Concentration ($\mu g \cdot L^{-1}$)** | **Date**[b] | **Concentration ($\mu g \cdot L^{-1}$)** | **Date**[b] |
| Monochlorobenzene [See Chlorinated benzenes] | | | | |
| Monochloromethane [See Halogenated methanes] | | | | |
| Monochlorophenols [See Chlorinated phenols] | | | | |
| MTBE (methyl *tertiary*-butyl ether) | 10 000[c] | 2003 | 5 000[c] | 2003 |
| Naphthalene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Nickel[d] | 25–150[p] | 1987 | | |
| Nitrate | 13 000[c,u,y] | 2003 | 16 000[c,u,y] | 2003 |
| Nitrite[d] | 60[z] | 1987 | | |
| Nonylphenol and its ethoxylates | 1.0[c,t] | 2002 | 0.7[c,t] | 2002 |
| Nutrients | Guidance Framework[x] | 2004 | Guidance Framework [aa,bb] | 2007 |
| Organotins | | | | |
| Tributyltin | 0.008[c] | 1992 | 0.001[c] | 1992 |
| Tricyclohexyltin | Insufficient data | 1992 | Insufficient data | 1992 |
| Triphenyltin | 0.022[c,i] | 1992 | Insufficient data | 1992 |
| Oxygen, dissolved [See Dissolved oxygen] | | | | |
| PAHs [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| PCBs [See Polychlorinated biphenyls (PCBs)(total)] | | | | |
| PCE [See Chlorinated ethenes, 1,1,2,2-Tetrachloroethene] | | | | |
| PCP [See Chlorinated phenols, Pentachlorophenol] | | | | |
| Pentachlorobenzene [See Chlorinated benzenes] | | | | |
| Pentachlorophenol [See Chlorinated phenols] | | | | |
| Permethrin[aa] | 0.004[c] | 2006 | 0.001[c] | 2006 |
| pH[d] | 6.5–9 | 1987 | 7.0–8.7 and Narrative | 1996 |
| Phenanthrene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Phenols (mono- & dihydric) | 4.0[k] | 1999 | | |
| Phenoxy herbicides[d, q] | 4.0 | 1987 | | |
| Phosphorus | Guidance Framework[x] | 2004 | Guidance Framework[bb] | 2007 |
| Phthalate esters | | | | |
| Di-*n*-butyl phthalate | 19[c] | 1993 | Insufficient data | 1993 |
| Di(2-ethylhexyl) phthalate | 16[c] | 1993 | Insufficient data | 1993 |
| Di-*n*-octyl phthalate | Insufficient data | 1993 | Insufficient data | 1993 |
| Picloram | 29[c] | 1990 | | |
| Polychlorinated biphenyls (PCBs) (total)[d] | ~~0.001~~[e,f] | 1987 | ~~0.01~~[e,f] | 1991 |

*Continued.*

| | Freshwater | | Marine | |
|---|---|---|---|---|
| **Parameter**[a] | **Concentration (µg·L$^{-1}$)** | **Date**[b] | **Concentration (µg·L$^{-1}$)** | **Date**[b] |
| Polycyclic aromatic hydrocarbons (PAHs) | | | | |
| Acenaphthene | 5.8[c] | 1999 | Insufficient data | 1999 |
| Acridine | 4.4[c] | 1999 | Insufficient data | 1999 |
| Anthracene | 0.012[c] | 1999 | Insufficient data | 1999 |
| Benz*(a)*anthracene | 0.018[c] | 1999 | Insufficient data | 1999 |
| Benzo*(a)*pyrene | 0.015[c] | 1999 | Insufficient data | 1999 |
| Chrysene | Insufficient data | 1999 | Insufficient data | 1999 |
| Fluoranthene | 0.04[c] | 1999 | Insufficient data | 1999 |
| Fluorene | 3.0[c] | 1999 | Insufficient data | 1999 |
| Naphthalene | 1.1[c] | 1999 | 1.4[c] | 1999 |
| Phenanthrene | 0.4[c] | 1999 | Insufficient data | 1999 |
| Pyrene | 0.025[c] | 1999 | Insufficient data | 1999 |
| Quinoline | 3.4[c] | 1999 | Insufficient data | 1999 |
| Propylene glycol [See Glycols] | | | | |
| Pyrene [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Quinoline [See Polycyclic aromatic hydrocarbons (PAHs)] | | | | |
| Reactive chlorine species (hypochlorous acid and monochloramine) | 0.5 and Narrative | 1999 | 0.5 and Narrative | 1999 |
| Salinity | | | ≤10% fluctuation[c] | 1996 |
| Selenium[d] | 1.0 | 1987 | | |
| Silver[d] | 0.1 | 1987 | | |
| Simazine | 10 | 1991 | | |
| Streambed substrate [See Total particulate matter] | | | | |
| Styrene | 72[c] | 1999 | | |
| Sulfolane[aa] | 50 000[c] | 2005 | Insufficient data | 2005 |
| Suspended sediments [See Total particulate matter] | | | | |
| TCE [See Chlorinated ethenes, 1,1,2-Trichloroethene] | | | | |
| Tebuthiuron | 1.6[c] | 1995 | Insufficient data | 1995 |
| Temperature | Narrative[s] | 1987 | Not to exceed ±1°C and Narrative[c] | 1996 |
| Tetrachlorobenzene [See Chlorinated benzenes] | | | | |
| Tetrachloroethane [See Chlorinated ethanes] | | | | |
| Tetrachloroethene [See Chlorinated ethenes] | | | | |
| Tetrachloroethylene [See Chlorinated ethenes, 1,1,2,2-Tetrachloroethene] | | | | |

*Continued.*

| Parameter[a] | Freshwater | | Marine | |
|---|---|---|---|---|
| | Concentration ($\mu g \cdot L^{-1}$) | Date[b] | Concentration ($\mu g \cdot L^{-1}$) | Date[b] |
| Tetrachloromethane [See Halogenated methanes] | | | | |
| Tetrachlorophenols [See Chlorinated phenols] | | | | |
| Thallium[j] | 0.8 | 1999 | | |
| Toluene | 2.0[c,j,k] | 1996 | 215[c,k] | 1996 |
| Total particulate matter | | | | |
| Deposited bedload sediment | Insufficient data | 1999 | Insufficient data | 1999 |
| Streambed substrate | Narrative | 1999 | Narrative | 1999 |
| Suspended sediments | Narrative | 1999 | Narrative | 1999 |
| Turbidity | Narrative | 1999 | Narrative | 1999 |
| Toxaphene[d] | ~~0.008~~ [e,f] | 1987 | | |
| Triallate | 0.24[e] | 1992 | | |
| Tribromomethane [See Halogenated methanes] | | | | |
| Tributyltin [See Organotins] | | | | |
| Trichlorobenzene [See Chlorinated benzenes] | | | | |
| Trichloroethane [See Chlorinated ethanes] | | | | |
| Trichloroethene [See Chlorinated ethenes] | | | | |
| Trichloroethylene [See Chlorinated ethenes, 1,1,2-Trichloroethene] | | | | |
| Trichloromethane [See Halogenated methanes] | | | | |
| Trichlorophenols [See Chlorinated phenols] | | | | |
| Tricyclohexyltin [See Organotins] | | | | |
| Trifluralin | 0.20[i] | 1993 | | |
| Triphenyltin [See Organotins] | | | | |
| Turbidity [See Total particulate matter] | | | | |
| Zinc[d] | 30 | 1987 | | |

[a] Unless otherwise indicated, supporting documents are available from the National Guidelines and Standards Office, Environment Canada.

[b] The guidelines dated 1987 have been carried over from *Canadian Water Quality Guidelines* (CCREM 1987) and no fact sheet was prepared. The guidelines dated 1989 to 1997 were developed and initially published in CCREM 1987 as appendixes on the date indicated. They are published as fact sheets in this document. Other guidelines dated 1997 and those dated 1999 are published for the first time in this document.

[c] Interim guideline.

[d] No fact sheet created. For more information on this guideline, please refer to *Canadian Water Quality Guidelines* (CCREM 1987).

[e] This guideline (originally published in *Canadian Water Quality Guidelines* [CCREM 1987 + Appendixes] in 1987 or 1991 [PCBs in marine waters]) is no longer recommended and the value is withdrawn. A water quality guideline is not recommended. Environmental exposure is predominantly via sediment, soil, and/or tissue, therefore, the reader is referred to the respective guidelines for these media.

[f] This substance meets the criteria for Track 1 substances under the national CCME Policy for the Management of Toxic Substances (PMTS) (i.e., persistent, bioaccumulative, primarily the result of human activity, and CEPA-toxic or equivalent), and should be subject to virtual elimination strategies. Guidelines can serve as action levels or interim management objectives towards virtual elimination.

[g] Aluminium guideline= 5 $\mu g \cdot L^{-1}$ at pH <6.5
= 100 $\mu g \cdot L^{-1}$ at pH ≥6.5

[h] Ammonia guideline: Expressed as µg unionized ammonia·$L^{-1}$. This would be equivalent to 15.2 µg ammonia-nitrogen·$L^{-1}$. Guideline for total ammonia is temperature and pH dependent, please consult factsheet for more information.

[i] Guideline value slightly modified from CCREM 1987 + Appendixes due to re-evaluation of the significant figures.

[j] The technical document for the guideline is available from the Ontario Ministry of the Environment.

[k] Substance has been re-evaluated since CCREM 1987 + Appendixes. Either a new guideline has been derived or insufficient data existed to derive a new guideline.

[l]Cadmium guideline = $10^{\{0.86[\log(\text{hardness})] - 3.2\}}$.

[m]Copper guideline = 2 $\mu g \cdot L^{-1}$ at a water hardness of 0–120 $mg \cdot L^{-1}$ (soft to medium) as $CaCO_3$
= 3 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 4 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[n]Dissolved oxygen for warm-water biota: early life stages = 6000 $\mu g \cdot L^{-1}$
other life stages = 5500 $\mu g \cdot L^{-1}$
for cold-water biota: early life stages = 9500 $\mu g \cdot L^{-1}$
other life stages = 6500 $\mu g \cdot L^{-1}$

[o]Lead guideline = 1 $\mu g \cdot L^{-1}$ at a water harness of 0–60 $mg \cdot L^{-1}$ (soft) as $CaCO_3$
= 2 $\mu g \cdot L^{-1}$ at a water harness of 60–120 $mg \cdot L^{-1}$ (medium) as $CaCO_3$
= 4 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 7 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[p]Nickel guideline = 25 $\mu g \cdot L^{-1}$ at a water harness of 0–60 $mg \cdot L^{-1}$ (soft) as $CaCO_3$
= 65 $\mu g \cdot L^{-1}$ at a water harness of 60–120 $mg \cdot L^{-1}$ (medium) as $CaCO_3$
= 110 $\mu g \cdot L^{-1}$ at a water harness of 120–180 $mg \cdot L^{-1}$ (hard) as $CaCO_3$
= 150 $\mu g \cdot L^{-1}$ at a water harness >180 $mg \cdot L^{-1}$ (very hard) as $CaCO_3$

[q]The guideline of 4.0 $\mu g \cdot L^{-1}$ for phenoxy herbicides is based on data for ester formulations of 2,4-dichlorophenoxyacetic acid.

[r]The technical document for the guideline is available from British Columbia Ministry of Environment, Lands and Parks.

[s]Temperature: (for more information, see CCREM 1987)

Thermal Stratification: Thermal additions to receiving waters should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to the addition of heat from artificial origins.

Maximum Weekly Average Temperature: Thermal additions to receiving waters should be such that the maximum weekly average temperature is not exceeded.

Short-term Exposure to Extreme Temperature: Thermal additions to receiving waters should be such that the short-term exposures to maximum temperatures are not exceeded. Exposures should not be so lengthy or frequent as to adversely affect the important species.

[t]Expressed on a TEQ basis using NP TEFs, see Table 2 in factsheet.

[u]For protection from direct toxic effects; the guidelines do not consider indirect effects due to eutrophication.

[v]May not prevent accumulation of methylmercury in aquatic life, therefore, may not protect wildlife that consume aquatic life; see factsheet for details. Consult also the appropriate Canadian Tissue Residue Guideline for the Protection of Wildlife Consumers of Aquatic Biota.

[w]May not fully protect higher trophic level fish; see factsheet for details.

[x]Canadian Guidance Framework for Phosphorus is for developing phosphorus guidelines (does not provide guidance on other freshwater nutrients). It provides Trigger Ranges for Total Phosphorus (see Guidance Framework for Phosphorus factsheet):

ultra-oligotrophic <4 $\mu g \cdot L^{-1}$
oligotrophic 4-10 $\mu g \cdot L^{-1}$
mesotrophic 10-20 $\mu g \cdot L^{-1}$
meso-eutrophic 20-35 $\mu g \cdot L^{-1}$
eutrophic 35-100 $\mu g \cdot L^{-1}$
hyper-eutrophic >100 $\mu g \cdot L^{-1}$

[y]Guidelines are expressed in $\mu g$ nitrate$\cdot L^{-1}$. These values are equivalent to 2900 $\mu g$ nitrate-nitrogen$\cdot L^{-1}$, and 3600 $\mu g$ nitrate-nitrogen$\cdot L^{-1}$, for freshwater and marine respectively.

[z]Guideline is expressed as $\mu g$ nitrite-nitrogen$\cdot L^{-1}$. This value is equivalent to 197 $\mu g$ nitrite$\cdot L^{-1}$.

[aa]Supporting documents are available from the Canadian Council of Ministers of the Environment at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125

[bb]The Canadian Guidance Framework for the Management of Nearshore Marine Systems is for developing nutrient (phosphorus and nitrogen) guidelines for nearshore marine systems. Refer to factsheet for details

### Reference

CCREM (Canadian Council of Resource and Environment Ministers). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

### Reference listing:

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated September, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

For further scientific information, contact:

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For additional copies, contact:

CCME Documents
Toll Free: (800) 805-3025
www.ccme.ca

Aussi disponible en français


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# Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health

**SUMMARY TABLES**

**Update 7.0**
**September 2007**

**Table 1. Canadian Soil Quality Guidelines (mg·kg$^{-1}$).**

| Substance[y] | Year revised/ released[a] | Land Use and Soil Texture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural[*] | | Residential/ parkland[*] | | Commercial[*] | | Industrial[*] | |
| | | Coarse | Fine | Coarse | Fine | Coarse | Fine | Coarse | Fine |
| Arsenic (inorganic) | 1997 | 12[b] | | 12[b] | | 12[b] | | 12[b] | |
| Barium | 2003 | 750[c] | | 500[c] | | 2000[c] | | 2000[c] | |
| Benzene | | | | | | | | | |
| Surface[w] | 2004 | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] |
| Subsoil[w] | 2004 | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] |
| Surface[x] | 2004 | 0.0095[t,u] | 0.0068[t,u] | 0.0095[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] |
| Subsoil[x] | 2004 | 0.011[t,u] | 0.0068[t,u] | 0.011[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] | 0.030[t,u] | 0.0068[t,u] |
| Benzo*(a)*pyrene | 1997 | 0.1[e] | | 0.7[f] | | 0.7[f] | | 0.7[f] | |
| Cadmium | 1999 | 1.4[b] | | 10[g] | | 22[b] | | 22[b] | |
| Chromium | | | | | | | | | |
| Total chromium | 1997 | 64[b] | | 64[b] | | 87[b] | | 87[b] | |
| Hexavalent chromium (VI) | 1999 | 0.4[h] | | 0.4[h] | | 1.4[h] | | 1.4[h] | |
| Copper | 1999 | 63[b] | | 63[b] | | 91[b] | | 91[b] | |
| Cyanide (free) | 1997 | 0.9[b] | | 0.9[b] | | 8.0[b] | | 8.0[b] | |
| DDT (total) | 1999 | 0.7[i] | | 0.7[i] | | 12[i, j] | | 12[i, j] | |
| Diisopropanolamine (DIPA)[z] | 2006 | 180[b] | | 180[b] | | 180[b] | | 180[b] | |
| Ethylbenzene | | | | | | | | | |
| Surface | 2004 | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] |
| Subsoil | 2004 | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] | 0.082[t] | 0.018[t,u] |
| Ethylene glycol | 1999 | 960[k] | | 960[k] | | 960[k] | | 960[k] | |
| Lead | 1999 | 70[b] | | 140[b] | | 260[b] | | 600[b] | |
| Mercury (inorganic) | 1999 | 6.6[b] | | 6.6[b] | | 24[b] | | 50[b] | |
| Naphthalene | 1997 | 0.1[d] | | 0.6[h] | | 22[h] | | 22[h] | |
| Nickel | 1999 | 50[l] | | 50[l] | | 50[l] | | 50[l] | |
| Nonylphenol (and its ethyloxylates) | 2002 | 5.7[p] | | 5.7[p] | | 14[p] | | 14[p] | |
| Pentachlorophenol | 1997 | 7.6[b] | | 7.6[b] | | 7.6[b] | | 7.6[b] | |
| Phenol | 1997 | 3.8[b] | | 3.8[b] | | 3.8[b] | | 3.8[b] | |
| Polychlorinated biphenyls (PCBs) | 1999 | 0.5[m] | | 1.3[l] | | 33[j,l] | | 33[j,l] | |
| Polychlorinated dibenzo-*p*-dioxins/ dibenzofurans (PCDD/Fs) | 2002 | 4 ng TEQ·kg$^{-1}$ [q] | | 4 ng TEQ·kg$^{-1}$ [q] | | 4 ng TEQ·kg$^{-1}$ [r] | | 4 ng TEQ·kg$^{-1}$ [s] | |
| Propylene glycol | 2006 | Insufficient information[v] | | Insufficient information[v] | | Insufficient information[v] | | Insufficient information[v] | |
| Selenium | 2007 | 1[b] | | 1[b] | | 2.9[b] | | 2.9[b] | |

*Continued*

| Substance | Year revised/ released[a] | Land Use and Soil Texture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural* | | Residential/ parkland* | | Commercial* | | Industrial* | |
| | | Coarse | Fine | Coarse | Fine | Coarse | Fine | Coarse | Fine |
| Sulfolane[z] | 2006 | 0.8[b] | | 0.8[b] | | 0.8[b] | | 0.8[b] | |
| Tetrachloroethylene | 1997 | 0.1[e] | | 0.2[f] | | 0.5[f] | | 0.6[f] | |
| Thallium | 1999 | 1[n] | | 1[o] | | 1[o] | | 1[o] | |
| Toluene | | | | | | | | | |
| Surface | 2004 | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] |
| Subsoil | 2004 | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] | 0.37[t] | 0.08[t] |
| Trichloroethylene | 2006 | 0.01[b,u] | | 0.01[b,u] | | 0.01[b,u] | | 0.01[b,u] | |
| Uranium[z] | 2007 | 23[t] | | 23[t] | | 33[t] | | 300[t] | |
| Vanadium | 1997 | 130[l] | | 130[l] | | 130[i] | | 130[i] | |
| Xylenes | | | | | | | | | |
| Surface | 2004 | 11[t] | 2.4[t] | 11[t] | 2.4[t] | 11[t] | 2.4[t] | 11[t] | 2.4[t] |
| Subsoil | 2004 | 11[t] | 2.4[t] | 11[t] | 2.4[t] | 11[t] | 2.4[t] | 11[t] | 2.4[t] |
| Zinc | 1999 | 200[l] | | 200[l] | | 360[l] | | 360[l] | |

**Notes:** $SQG_E$ = soil quality guideline for environmental health; $SQG_{HH}$ = soil quality guideline for human health.

*For guidelines derived prior to 2004, differentiation between soil texture (coarse/fine) is not applicable.

[a]Guidelines released in 1997 were originally published in the working document entitled "Recommended Canadian Soil Quality Guidelines" (CCME 1997) and have been revised, edited, and reprinted here. Guidelines revised/released in 1999 are published here for the first time (see Table 2).

[b]Data are sufficient and adequate to calculate an $SQG_{HH}$ and an $SQG_E$. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use, derived in accordance with the soil protocol (CCME 1996; 2006). The corresponding interim soil quality criterion (CCME 1991) is superseded by the soil quality guideline.

[c]Data are insufficient/inadequate to calculate an $SQG_{EH}$, a provisional $SQG_{HH}$, an $SQG_E$, or a provisional $SQG_E$. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use (see table 2).

[d]Data are sufficient and adequate to calculate only a provisional $SQG_E$. It is greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[e]Data are sufficient and adequate to calculate an $SQG_{HH}$ and a provisional $SQG_E$. Both are greater than the corresponding interim soil quality criterion (CCME 1991). Therefore, in consideration of receptors and/or pathways not examined, the interim soil quality criterion is retained as the soil quality guideline for this land use.

[f]Data are sufficient and adequate to calculate an $SQG_{EH}$ and a provisional $SQG_E$. Both are less than corresponding interim soil quality criterion (CCME 1991). Therefore the soil quality guideline supersedes the interim soil quality criterion for this land use.

[g]The soil–plant–human pathway was not considered in the guideline derivation. If produce gardens are present or planned, a site-specific objective must be derived to take into account the bioaccumulation potential (e.g., adopt the agricultural guideline as objective). The off-site migration check should be recalculated accordingly.

[h]Data are sufficient and adequate to calculate only a provisional $SQG_E$, which is less than the existing interim soil quality criterion (CCME 1991). Therefore the provisional soil quality guideline supersedes the interim soil quality criterion for this land use.

[i]Data are sufficient and adequate to calculate only an $SQG_E$. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the $SQG_E$ becomes the soil quality guideline.

[j]In site-specific situations where the size and/or the location of commercial and industrial land uses may impact primary, secondary, or tertiary consumers, the soil and food ingestion guideline is recommended as the $SQG_E$.

[k]Data are sufficient and adequate to calculate only a provisional $SQG_E$.

[l]Data are sufficient and adequate to calculate only an $SQG_E$, which is less than the interim soil quality criterion (CCME 1991) for this land use. Therefore the $SQG_E$ becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[m]Data are sufficient and adequate to calculate only an $SQG_E$, which is greater than the interim soil quality criterion (CCME 1991) for this land use. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

[n]Data are sufficient and adequate to calculate a provisional $SQG_{HH}$ and an $SQG_E$. The provisional $SQG_{HH}$ is equal to the $SQG_E$ and to the existing interim soil quality criterion (CCME 1991) and thus becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[o]Data are sufficient and adequate to calculate a provisional $SQG_{HH}$ and an $SQG_E$. The provisional $SQG_{HH}$ is less than the $SQG_E$ and thus becomes the soil quality guideline for this land use.

[p]Data are sufficient and adequate to calculate only an $SQG_E$. An interim soil quality criterion (CCME 1991) was not established for these substances, therefore, the $SQG_E$ becomes the soil quality guideline.

[q]Data are sufficient and adequate to calculate only a provisional $SQG_{HH}$, which is less than the existing interim soil quality criterion (CCME 1991). Thus the provisional $SQG_{HH}$ becomes the soil quality guideline, which supersedes the interim soil quality criterion for this land use.

[r]Data are sufficient and adequate to calculate only a provisional $SQG_{HH}$. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the provisional $SQG_{HH}$ becomes the soil quality guideline.

[s]Data are sufficient and adequate to calculate only an $SQG_{HH}$. An interim soil quality criterion (CCME 1991) was not established for this land use, therefore the $SQG_{HH}$ becomes the soil quality guideline.

[t]Data are sufficient and adequate to calculate an $SQG_{HH}$ and an $SQG_E$. Therefore the soil quality guideline is the lower of the two and represents a fully integrated *de novo* guideline for this land use.

[u]This guideline value may be less than the common limit of detection in some jurisdictions. Contact jurisdictions for guidance.

[v]Data are sufficient and adequate to calculate only a preliminary $SQG_{FWAL}$ (Soil Quality Guideline for freshwater aquatic life). This value is 6,210 $mg \cdot kg^{-1}$. See accompanying factsheet for further information.

[w]$10^{-5}$ Incremental Risk

[x]$10^{-4}$ Incremental Risk

[y]Unless otherwise indicated, supporting documents are available from the National Guidelines and Standards Office, Environment Canada.

[z]Supporting documents are available from the Canadian Council of Ministers of the Environment at http://www.ccme.ca/publications/ceqg_rcqe.html?category_id=125

## References

CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

———. 1996. A protocol for the derivation of environmental and human health soil quality guidelines. CCME, Winnipeg. [A summary of the protocol appears in Canadian environmental quality guidelines, Chapter 7, Canadian Council of Ministers of the Environment, 1999, Winnipeg.]

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**Table 2. Interim remediation criteria for soil ($mg \cdot kg^{-1}$) that have not yet been replaced by Canadian Soil Quality Guidelines[1].**

| Parameter | Year released | Land use | | | |
|---|---|---|---|---|---|
| | | Agricultural | Residential/ parkland | Commercial | Industrial |
| **General Parameters** | | | | | |
| Conductivity [dS/m] | 1991 | 2 | 2 | 4 | 4 |
| pH | 1991 | 6 to 8 | 6 to 8 | 6 to 8 | 6 to 8 |
| Sodium adsorption ratio | 1991 | 5 | 5 | 12 | 12 |
| **Inorganic Parameters** | | | | | |
| Antimony | 1991 | 20 | 20 | 40 | 40 |
| Beryllium | 1991 | 4 | 4 | 8 | 8 |
| Boron (hot water soluble) | 1991 | 2 | | | |
| Cobalt | 1991 | 40 | 50 | 300 | 300 |
| Fluoride (total) | 1991 | 200 | 400 | 2000 | 2000 |
| Molybdenum | 1991 | 5 | 10 | 40 | 40 |
| Silver | 1991 | 20 | 20 | 40 | 40 |
| Sulphur (elemental) | 1991 | 500 | | | |
| Tin | 1991 | 5 | 50 | 300 | 300 |
| **Monocyclic Aromatic Hydrocarbons** | | | | | |
| Chlorobenzene | 1991 | 0.1 | 1 | 10 | 10 |
| 1,2-Dichlorobenzene | 1991 | 0.1 | 1 | 10 | 10 |
| 1,3-Dichlorobenzene | 1991 | 0.1 | 1 | 10 | 10 |
| 1,4-Dichlorobenzene | 1991 | 0.1 | 1 | 10 | 10 |
| Styrene | 1991 | 0.1 | 5 | 50 | 50 |
| **Phenolic Compounds** | | | | | |
| Chlorophenols[a] (each) | 1991 | 0.05 | 0.5 | 5 | 5 |
| Nonchlorinated[b] (each) | 1991 | 0.1 | 1 | 10 | 10 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | |
| Benzo*(a)*anthracene | 1991 | 0.1 | 1 | 10 | 10 |
| Benzo*(b)*fluoranthene | 1991 | 0.1 | 1 | 10 | 10 |
| Benzo*(k)*fluoranthene | 1991 | 0.1 | 1 | 10 | 10 |
| Dibenz*(a,h)*anthracene | 1991 | 0.1 | 1 | 10 | 10 |
| Indeno(1,2,3-c,d)pyrene | 1991 | 0.1 | 1 | 10 | 10 |
| Phenanthrene | 1991 | 0.1 | 5 | 50 | 50 |
| Pyrene | 1991 | 0.1 | 10 | 100 | 100 |
| **Chlorinated Hydrocarbons** | | | | | |
| Chlorinated aliphatics[c] (each) | 1991 | 0.1 | 5 | 50 | 50 |
| Chlorobenzenes[d] (each) | 1991 | 0.05 | 2 | 10 | 10 |
| Hexachlorobenzene | 1991 | 0.05 | 2 | 10 | 10 |
| Hexachlorocyclohexane | 1991 | 0.01 | — | — | — |
| **Miscellaneous Organic Parameters** | | | | | |
| Nonchlorinated aliphatics (each) | 1991 | 0.3 | — | — | — |
| Phthalic acid esters (each) | 1991 | 30 | | | |
| Quinoline | 1991 | 0.1 | | | |
| Thiophene | 1991 | 0.1 | | | |

[1]**Notes:**

All values are in $mg \cdot kg^{-1}$ unless otherwise stated.

Guidelines released in 1991 were published in "Interim Canadian Environmental Quality Criteria for Contaminated Sites" (CCME, 1991).

These interim remediation criteria are considered generally protective of human and environmental health and were based on experience and professional judgement.

These interim criteria (CCME, 1991) should only be used when soil quality guidelines based on the CCME soil protocol (CCME, 1996; 2006) have not yet been developed for a given chemical. Also, because the interim remediation criteria were not developed using the soil protocol and its integral checks, they cannot be modified through the site specific remediation objective procedure.

[a]Chlorophenols include
chlorophenol isomers (ortho, meta, para)
dichlorophenols (2,6- 2,5- 2,4- 3,5- 2,3- 3,4-)
trichlorophenols (2,4,6- 2,3,6- 2,4,5- 2,3,4- 3,4,5-)
tetrachlorophenols (2,3,5,6- 2,3,4,5- 2,3,4,6-)

[b]Nonchlorinated phenolic compounds include
2,4-dimethylphenol
2,4-dinitrophenol
2-methyl 4,6-dinitrophenol
nitrophenol (2-,4-)
phenol
cresol

[c]Aliphatic chlorinated hydrocarbons include
chloroform
dichloroethane (1,1- 1,2-), dichloroethene (1,1- 1,2-)
dichloromethane
1,2-dichloropropane, 1,2-dichloropropene (cis and trans)
1,1,2,2-tetrachloroethane, tetrachloroethene
carbon tetrachloride
trichloroethane (1,1,1- 1,1,2-), trichloroethene

[d]Chlorobenzenes include
all trichlorobenzene isomers
all tetrachlorobenzene isomers
pentachlorobenzene

### References

CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

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**Reference listing:**

Canadian Council of Ministers of the Environment. 2007. Canadian soil quality guidelines for the protection of environmental and human health: Summary tables. Updated September, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

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**Canadian Council of Ministers of the Environment**

# *CANADA-WIDE STANDARDS*

# *for*

# *PETROLEUM HYDROCARBONS (PHC) IN SOIL*

# *CANADA-WIDE STANDARDS for PETROLEUM HYDROCARBONS (PHC) IN SOIL*

These Canada-Wide Standards (CWS) for petroleum hydrocarbons in soil are established pursuant to the 1998 Canada-wide Accord on Environmental Harmonization of the Canadian Council of Ministers of the Environment (CCME) and its Canada-wide Environmental Standards Sub-Agreement.

The PHC CWS is a remedial standard for contaminated soil and subsoil occurring in four land use categories. The standard is grounded in the science of risk assessment and can be applied at any of three "Tiers": Tier 1 – generic numerical levels; Tier 2 – adjustments to Tier 1 levels based on site-specific information; Tier 3 – site-specific risk assessment. The same high level of environmental and human health protection is required at all three tiers.

Because the PHC CWS is tiered and risk-based there is necessarily some complexity in its development and application. Details regarding development and application of the standards are provided in a Technical Supplement.

The PHC CWS was developed with the input of four multistakeholder technical advisory groups and one dedicated working group involving the Canadian oil and gas industry, government and an academic chair. The PHC CWS represents a consensus view of the national Development Committee, developed with the assistance and input of the technical advisory groups.

## RATIONALE

Petroleum hydrocarbons (PHC) are used in nearly every facet of Canadian life. They provide energy to heat our homes and places of work, fuel our transportation systems, power manufacturing processes and tools, as well as providing a source for the numerous synthetic materials we take for granted in our lives. Used as intended, PHC provide great benefits to society. However, when released to the soil environment as raw feedstocks or refined fuels or lubricants, a number of problems can result. These include fire/explosion hazard, human and environmental toxicity, movement through soil to air or water, odour, and impairment of soil processes such as water retention and nutrient cycling.

About 60% of Canada's contaminated sites involve petroleum hydrocarbon (PHC) contamination that, left unaddressed, impairs the quality and uses of both land and water. Presently, management of these sites across Canada varies considerably and generally lacks an adequate scientific basis – resulting in over- and under-management. Where over-management occurs, land sale transactions and real estate redevelopment are limited by remediation costs. Under-managed sites continue to pose risks to human and environmental health. The PHC Canada-wide Standard will provide a consistent approach to managing PHC-contaminated sites across the country.

# DEFINITIONS

Petroleum hydrocarbons (PHC) is a general term used to describe mixtures of organic compounds found in or derived from geological substances such as oil, bitumen and coal. For the purposes of this CWS, PHC are considered to be comprised of 4 fractions as defined in Part 1. PHC exclude – for the purposes of this standard – known carcinogens such as benzene and benzo(a)pyrene, which are addressed as target compounds. Because of the relatively long history of managing toluene, ethylbenzene and xylenes ("TEX") as target compounds, these are also excluded from PHC.

# CONTEXT

Petroleum products released to the environment typically contain thousands of compounds, in varying proportions, composed predominantly of carbon and hydrogen, with minor amounts of nitrogen, sulphur and oxygen. The properties of PHC contamination in soils varies with the petroleum source, soil type, the composition, degree of processing (crude, blended or refined), and the extent of weathering caused by exposure to the environment.

The complexity of PHC, and the extreme variability of sources and site-specific circumstances, complicates assessment of the human and environmental health risks associated with PHC contamination in soil.

PHC contamination in soil is a concern for a number of reasons. First, the chemically reactive nature and volatility of PHC can pose a fire/explosion hazard, especially if vapours enter confined spaces. Second, most PHC constituents are toxic to some degree. Third, lighter hydrocarbons (i.e. those of lower molecular weights) are mobile and can become a problem at considerable distances from their point of release due to transport in ground, water or air. Fourth, larger and branched-chain hydrocarbons are persistent in the environment. Fifth, PHC may create aesthetic problems such as offensive odour, taste or appearance in environmental media. Finally, under some conditions, PHC can degrade soil quality by interfering with water retention and transmission, and with nutrient supplies.

Canadian regulatory agencies have responded to these concerns with assessment and remediation requirements where PHC contaminate soils and groundwater. A blend of generic guidelines and site-specific, risk-based approaches has emerged across Canada, but there is very little consistency across jurisdictions in the rationale for guidelines, numerical values provided, or application to land uses.

The CWS is founded on documented and scientifically defensible risk-based methodology, namely the *CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* and the American Society for Testing & Materials (ASTM) *Risk-based Corrective Action (RBCA)* - and additions/improvements thereon, including the Atlantic *Partners in RBCA Implementation (PIRI)* (see Technical Supplement, section 1). Consequently, the derivation of the CWS involves explicitly listed receptors - both human and ecological, and the levels of protection accorded. It also involves defined exposure scenarios, and documented underlying assumptions, equations and policies (see Technical Supplement, sections 1 and 2).

Moreover, a vast array of analytical chemistry options exists for quantifying hydrocarbons in soil. Various methods have been developed to measure most or part of the hydrocarbons present in a sample based on different sampling, storage, extraction, purification, quantification, and data treatment approaches. Lack of measurement standardization has led to high variability in results and confusion for users of the data. The PHC CWS includes an analytical reference method to promote consistency in PHC-in-soil measurement practices and to ensure comparability of data nationally (see Technical Supplement, section 4).

The CWS Tier-1 levels have been selected despite gaps and uncertainties in some of the information used to support them. Nevertheless, the information available is sufficient to conclude that implementing the CWS will protect the environment and is technically and economically feasible. In this regard, jurisdictions will have considerable flexibility in the detailed design of jurisdictional plans and an opportunity to reduce information gaps and uncertainties.

## PART 1:

## NUMERICAL TARGETS and TIMEFRAMES

The PHC CWS is a remedial standard. The standard does not specify timelines that jurisdictions must follow in remediating PHC contaminated sites. Rather, it specifies consistent methods and outcomes for assessment and management of such sites. The CWS requires jurisdictions to commit to timelines for implementation of this consistent assessment and management approach, however.

The PHC CWS is based on the assessment and consistent management of risks posed to human, plants, animals and environmental processes under four common uses of land – agricultural, residential/parkland, commercial, and industrial. The standard is laid out in three tiers, which incorporate different amounts of site-specific information. Environmental and human health protection goals do not change between the tiers. Additional site-specific information available at Tiers 2 and 3 is used to manage risks through more precise knowledge of actual or potential exposure.

The environmental and human health protection goals of the PHC CWS are stated in the Tier 1 levels. A summary of Tier 1 levels is provided in Table 1. Additional Tier 1 levels are provided in the Technical Supplement along with Tier 2 and Tier 3 guidance. To develop these levels, the Development Committee identified -- in consultation with stakeholders -- for each land use: (1) the receptors and resources to be protected, (2) the pathways by which each could be exposed, and (3) the tolerable exposure along all applicable receptor/exposure pathway combinations. These tolerable exposures acknowledge that people may experience PHC exposures unrelated to contaminated soil and adjustments for known or expected exposures are made. Under Tier 1 and many Tier-2 approaches, exposures are managed below the tolerable level through reduction of PHC concentrations in the soil. Some Tier-2 and Tier-3 approaches achieve the same result by reducing exposures through engineered and/or institutional controls. The former approach is preferred; however, the latter is needed in some cases as indicated by socio-economic considerations. Irrespective of the approach chosen, the same high level of environmental and human health protection is required at each Tier.

Tier-1 levels are used when the proponent accepts the base assumptions and parameters in the Tier-1 exposure scenario. Tier-2 levels may be generated and used when site conditions exist that significantly modify the exposure and risk scenarios. Tier-3 levels are based on site-specific assessment and management of risks.

The PHC CWS implementation differs from other CWS. The trigger for remedial action is usually the need to act on a site-by-site basis to accommodate a new or intensified land use, and thus avoid human and ecological exposure to PHC during the modified land use. In such cases, the timeframe for achieving target cleanup levels at a particular site will depend largely upon the timeframe associated with the proposed land use for the site. The CWS will also find application in the cleanup and restoration phases of responses to pollution emergencies involving petroleum products and crude oils.

One of the guiding principles of the *CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* is that impairment of relatively clean soil up to guideline levels is not advocated. Consistent with the principle, the PHC CWS target levels are not intended to be used as 'pollute-up-to levels' for uncontaminated land.

## Tier 1: Numerical Levels for Different Land Uses

Tier-1 numerical levels are summarized in Table 1, where:

- "Fraction" refers to the equivalent normal straight-chain hydrocarbon (nC) boiling point ranges (Fraction #1: nC6 to nC10; Fraction #2: >nC10 to nC16; Fraction #3: >nC16 to nC34; and, Fraction #4: nC35+).
- "Coarse" means coarse-textured soil having a median grain size of >75 µm as defined by the American Society for Testing and Materials.

- "Fine" means fine-textured soil having a median grain size of ≤75 µm as defined by the American Society for Testing and Materials. .
- Levels without parentheses do not include consideration of the soil-to-groundwater contamination pathway.
- Levels within parentheses do include protection of groundwater.

**Table 1. Summary of Tier 1 Levels (mg/kg) for surface soil.***

| Land Use | Soil Texture | Fraction 1 | Fraction 2 | Fraction 3 | Fraction 4 |
|---|---|---|---|---|---|
| Agricultural | Coarse-grained soil | 30[b] | 150 | 300 | 2800 |
| | Fine-grained soil | 210 (170[a]) | 150 | 1300 | 5600 |
| Residential/ Parkland | Coarse-grained soil | 30[b] | 150 | 300 | 2800 |
| | Fine-grained soil | 210 (170[a]) | 150 | 1300 | 5600 |
| Commercial | Coarse-grained soil | 320 (240[a]) | 260 | 1700 | 3300 |
| | Fine-grained soil | 320 (170[a]) | 260 (230[a]) | 2500 | 6600 |
| Industrial | Coarse-grained soil | 320 (240[a]) | 260 | 1700 | 3300 |
| | Fine-grained soil | 320 (170[a]) | 260 (230[a]) | 2500 | 6600 |

* Additional Tier 1 levels are presented in Technical Supplement.
a= Where applicable, for protection of potable groundwater.
b= assumes contamination near residence

## Tier 2: Site-specific Adjustments to Tier-1 Levels

Tier-2 levels may be generated and used when site-specific information indicates that site conditions exist that modify human or ecological exposure to PHC contamination and, thereby, alter risks significantly, relative to the generic conditions used to derive Tier-1 levels.

Thus, Tier-2 levels are derived on a site-by-site basis using site-specific parameters where necessary; the potentially adjustable parameters and corresponding calculation protocols are summarized and referenced in the Technical Supplement (section 2).

## Tier 3: Site-specific Risk Assessment and Management

The process of developing site-specific cleanup levels and related management options requires the appropriate use of both general and site-specific information. Background information and guiding principles have been established to direct and focus this process, and are documented in the *Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada* (CCME 1996). The use of these guiding principles in developing Tier 3 standards is outlined in the Technical Supplement.

Additional guidance in this connection is also available in *A Framework for Ecological Risk Assessment: General Guidance* (CCME, 1995) and *Risk Assessment Guidance for Superfund Vol I (USEPA 1989).* Other appropriate guidance may also be available from the appropriate jurisdictional authority.

# PART 2:

# IMPLEMENTATION

Because environmental issues related to PHC release to soil are principally limited to intra-jurisdictional effects, Clause 6.1 of the CWS Sub-agreement applies for this CWS. This means that specific measures undertaken by each government to meet this CWS will be at the discretion of each jurisdiction.

Jurisdictions agree to review current programs and tools and, as required, develop and activate jurisdictional implementation plans to integrate the CWS or ensure equal or better protection.

# REVIEW

The CWS will be reviewed as follows:

By the end of year 2003, review of additional scientific, technical and economic analysis to reduce information gaps and uncertainties and allow revision of the PHC CWS in the year 2005 as appropriate.

# REPORTING on PROGRESS

Progress towards meeting the above provisions will be reported as follows:

(a) to the respective publics of each jurisdiction on a regular basis, the timing and scope of reporting to be determined by each jurisdiction; and,

(b) to Ministers, with comprehensive reports at five-year intervals beginning in year 2003.

# ADMINISTRATION

Jurisdictions will review and renew Part 2 and the Annexes five years from coming into effect.

Any party may withdraw from these Canada-wide Standards upon three month's notice.

These Canada-wide Standards come into effect for each jurisdiction on the date of signature by the jurisdiction.

## Canada-wide Standards for Petroleum Hydrocarbons (PHC) in Soil

Signed by:

| | |
|---|---|
| British Columbia | Honourable Ian Waddell |
| Alberta | Honourable Lorne Taylor |
| Saskatchewan | Honourable Buckley Belanger |
| Manitoba | Honourable Oscar Lathlin |
| Ontario | Honourable Elizabeth Witmer |
| Environment Canada | Honourable David Anderson |
| New Brunswick | Honourable Kim Jardine |
| Nova Scotia | Honourable David Morse |
| Prince Edward Island | Honourable Chester Gillan |
| Newfoundland and Labrador | Honourable Ralph Wiseman |
| | Honourable Tom Lush |
| Yukon | Honourable Dale Eftoda |
| Northwest Territories | Honourable Joseph Handley |
| Nunavut | Honourable Olayuk Akesuk |

Note. Québec has not endorsed the Canada-wide Accord on Environmental Harmonization or the Canada-wide Environmental Standards Sub-agreement.