

Nuclear Power Demonstration Closure Project

EIS SUPPLEMENTARY DOCUMENTATION TECHNICAL SUPPORTING DOCUMENT

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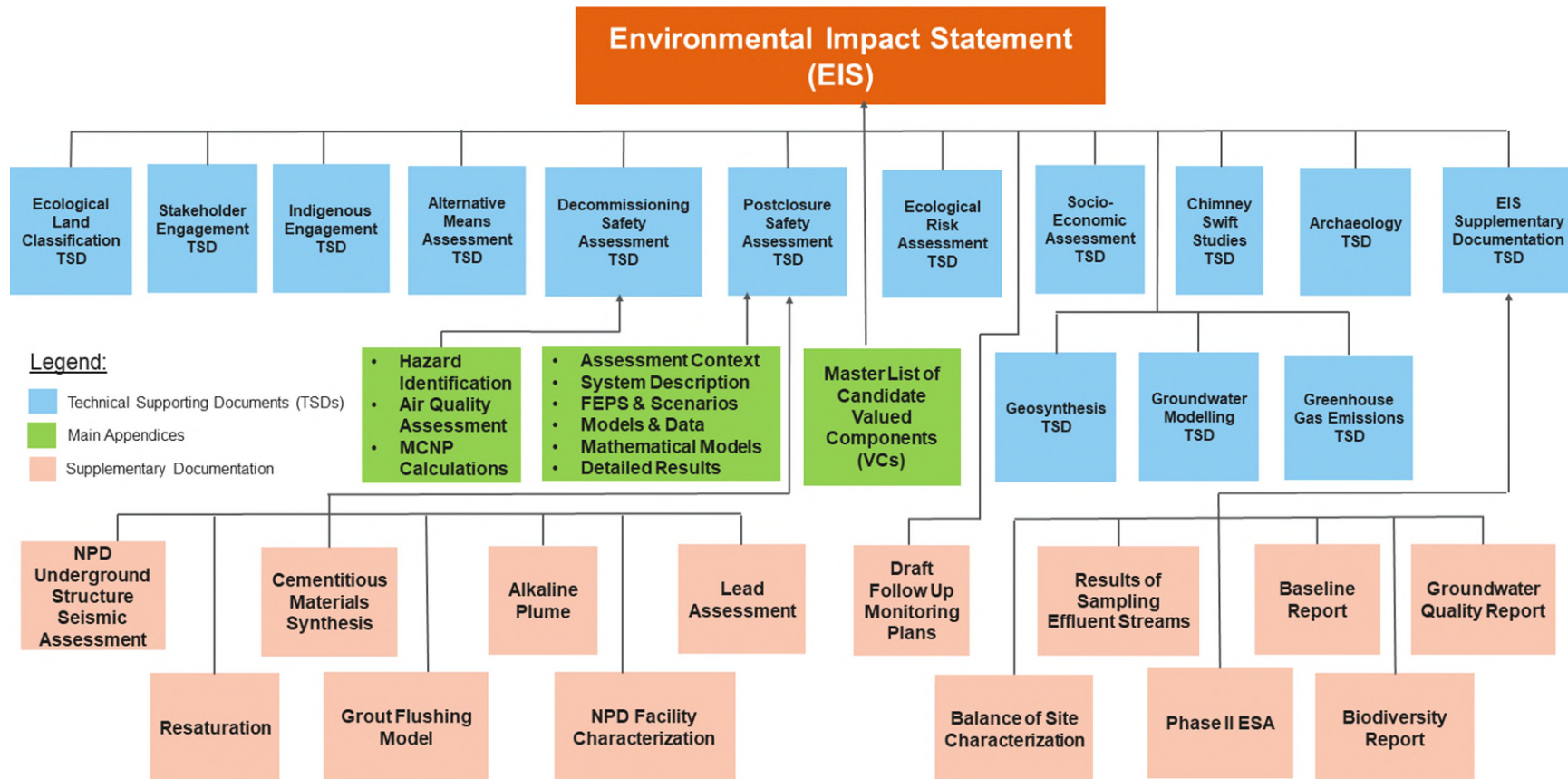
Revision 2

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This Technical Supporting Document (TSD) has been prepared in support of the Nuclear Power Demonstration (NPD) Closure Project. The project qualifies as a Designated Project under the *Canadian Environmental Assessment Act (2012)*, and therefore, an Environmental Impact Statement (EIS) is being prepared as part of the Environmental Assessment process. This TSD is comprised of six individual reports.

The findings of this TSD have been summarized in the NPD Closure Project EIS (CNL Doc #64-509410-ENA-004 Rev 1). The following figure shows the various documents associated with the EIS, and their relationships.





Environmental Assessment

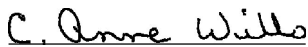
NUCLEAR POWER DEMONSTRATION SITE: A DESCRIPTION OF THE ENVIRONMENTAL BASELINE FOR DECOMMISSIONING

NPD DECOMMISSIONING

64-509200-ENA-001

Revision 1

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Environmental Assessment

Nuclear Power Demonstration
Site: A Description of the
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NPD Decommissioning

64-509200-ENA-001
Revision 1

2013 February

février 2013

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ACRONYMS

AECL	Atomic Energy Canada Limited
asl	above sea level
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
DRL	Derived release limit
EA	Environmental Assessment
ETB	Environmental Technologies Branch
HTO	Tritiated water
L1	former Landfill 1
L2	former Landfill 2
MH	Man Hole
MAC	Maximum Acceptable Concentration
NA	Data not available
ND	Not detected
NPD	Nuclear Power Demonstration
OBT	Organically bound tritium
PCB	Polychlorinated biphenyl
PHC	Petroleum hydrocarbons
SPT	Service Pipe Trench
TLD	Thermoluminescent dosimeter
TPH	Total petroleum hydrocarbons
WAS	Wells Area Sump

1. INTRODUCTION

The Nuclear Power Demonstration (NPD) Waste Management Site contains the decommissioned Generating Station. The facility was operated by Ontario Hydro from 1962 to 1987 as a prototype CANDU nuclear power generating station and a training school for nuclear generating station operating staff. It was decommissioned by Ontario Hydro, with assistance from Atomic Energy Canada Limited (AECL), to a “Static State” interim storage condition. Control of the NPD Waste Management Facility was turned over to AECL in 1988. This document summarizes the radiological and non-radiological environmental information reported between 1988 and 2008.

1.1 Purpose

The purpose of the document is to provide a common reference for the eventual preparation of an Environmental Assessment (EA) for the decommissioning of the NPD site [1]. This EA will be required to obtain a Canadian Nuclear Safety Commission (CNSC) licence.

1.2 Scope

This report compiles the existing radiological and non-radiological information available on air, water, sediments, aquatic biota, soil and vegetation. It presents the current monitoring being conducted at NPD and summarizes the findings of specific non-routine sampling campaigns.

This document includes information regarding historical regional and site setting. A preliminary field survey of the NPD site was also conducted as part of this work. This survey helped with the preparation of up to date maps. It also contributed to verifying infrastructures locations, sampling site locations and provided information regarding the ecological features present both on the site and along the adjacent shoreline of the Ottawa River.

In addition to this report, an electronic database was produced making it easier to retrieve information relevant to the NPD site when needed. (The database can be found in Vault 64, document number [64-509200-055-000-0001](#) in TRAK).

2. GEOGRAPHIC SETTING

2.1 Location

The NPD facility is located in the town of Laurentian Hills (Renfrew County, Ontario) 200 km northwest of Ottawa. It is situated on the southern shore of the Ottawa River (Figure 2-1). The facility is in a remote area, with relatively low population density. The town of Laurentian Hills has a population of approximately 2800 distributed over an area of 640 km² and contains the former village of Chalk River and the former hamlets of Point Alexander, and Rolphton. The nearest population centres are Rapides des Joachims (population roughly 170, 3 km northwest) and Deep River (population roughly 4200, 17 km southeast). To the west of NPD is the Township of Head, Clara, and Maria (population roughly 230, area 730 km²) [2]. Individual residents of Laurentian Hills live within 1 km of the facility boundary. The closest resident property is at Point Stewart on the Ottawa River 1 km downstream of NPD [3].

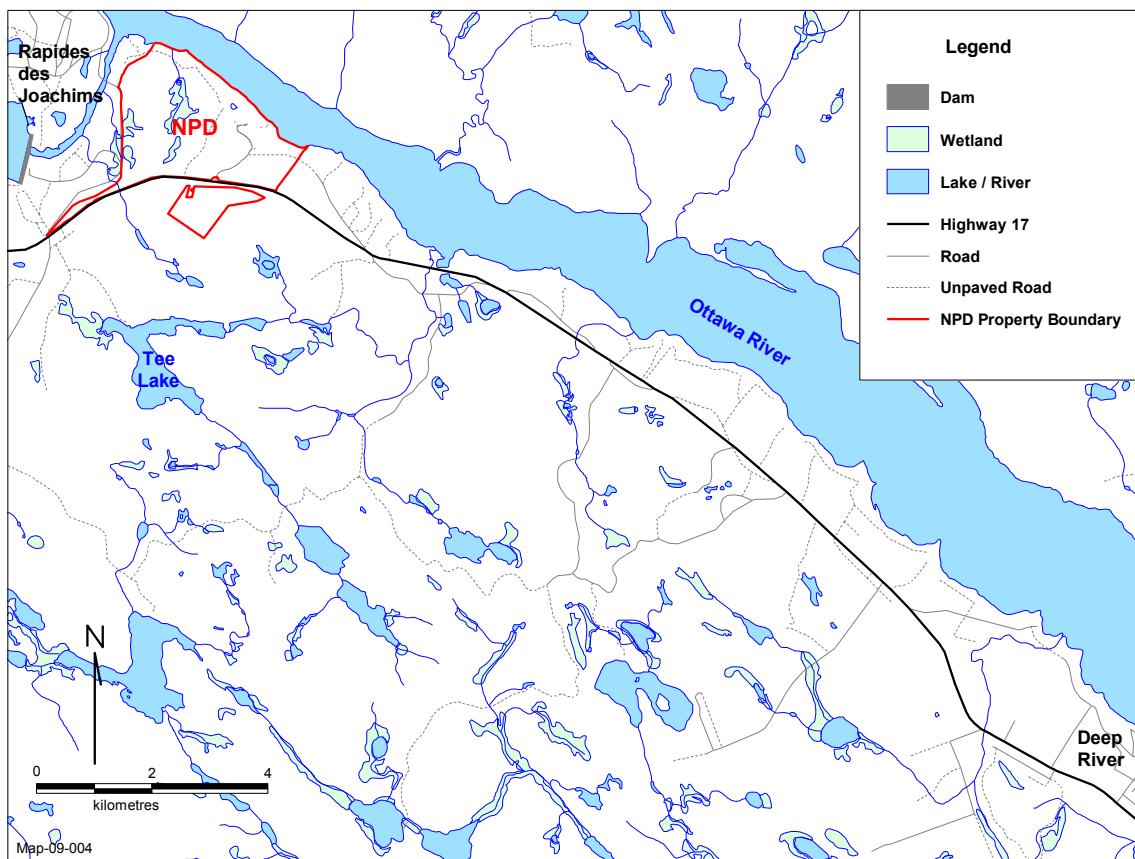


Figure 2-1 Location of the NPD Site

The surrounding land is primarily used for recreational activities. Agricultural activities in the area are limited to garden plots managed by residents. Sport fishing is carried out in lakes outside the NPD property, as well as in the Ottawa River, but there is no commercial fishing in the area.

2.2 Description of the site and vicinity

The NDP site contains the decommissioned Nuclear Power Demonstration (NPD) Nuclear Generating Station (Figure 2-2). NPD was constructed between 1956 and 1961 and was operated by Ontario Hydro from 1962 until 1987. Ontario Hydro maintained a training school for CANDU nuclear generating station operating staff at the site. In 1987, it was shut down and decommissioned to a “Static State” interim storage condition. In this state, the facility has been categorized as a waste management facility. After “Static State” was achieved, Ontario Hydro turned over ownership of the facility to AECL in September 1988 [3].

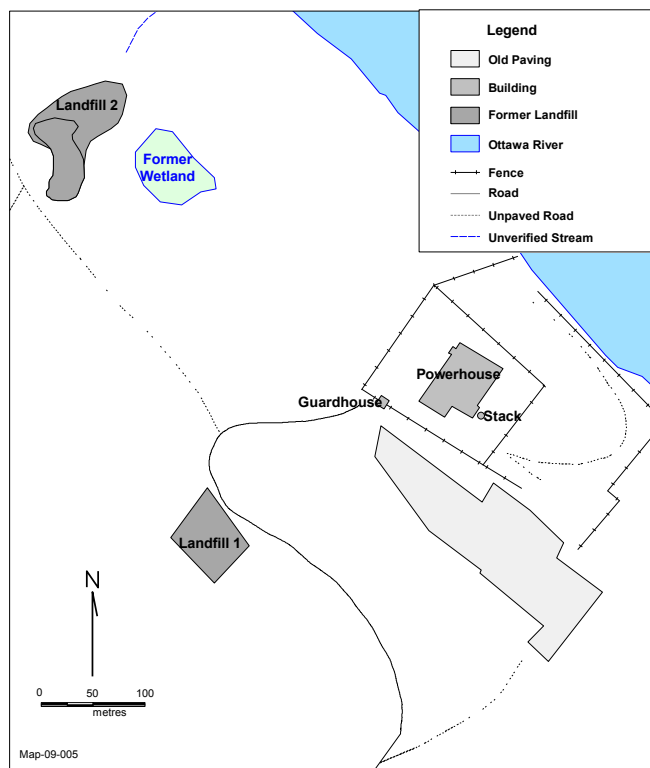


Figure 2-2 Plan of NPD Site (2008)

In its current “Static State”, all fuel and most removable equipment and hazardous material have been removed to Chalk River Laboratories (CRL) for storage and disposal. Full scale decommissioning consisting of the removal of the remaining powerhouse equipment, dismantling and disposition of the calandria and associated radioactive equipment, and demolition of some of the structures has not been completed. At present, the former power

station consists of the former powerhouse with its associated air effluent stack. The guardhouse is also still present. The power station is located on a 2.4 hectare parcel of land (roughly 140 m wide by 180 m deep) surrounded by a 380 hectare exclusion zone. Access to the site is restricted to authorized AECL personnel and approved visitors [3].

2.3 Meteorology and climate

The meteorology and climate is considered to be similar to the conditions prevailing at Chalk River Laboratories (CRL) located near the former village of Chalk River 26 km to the southeast along the Ottawa River.

2.3.1 The climate

The climate of the area is classified as humid continental, with warm summers, cold winters, and no distinct dry season [4].

2.3.2 Temperatures

At CRL, the daily mean air temperature ranges from -12°C in January to 19°C in July, with historic minima and maxima of -39°C and 39°C [4].

2.3.3 Precipitations

At CRL, annual precipitation has ranged from 560 mm to 1080 mm of water equivalent, with an average of 839 mm over the period 1963 to 2006. Over this period, monthly precipitation has averaged 45 mm in February to approximately 85 mm per month during June to September, inclusive. On average 23% of the annual precipitation falls as snow [4].

2.3.4 Wind speed and wind direction

At CRL, the distribution of winds and directions show little seasonal or annual variability. The winds at CRL are predominately northwest and southeast (parallel to the Ottawa River). Figure 2-3, Figure 2-4, and Figure 2-5 present recent wind rose diagrams.

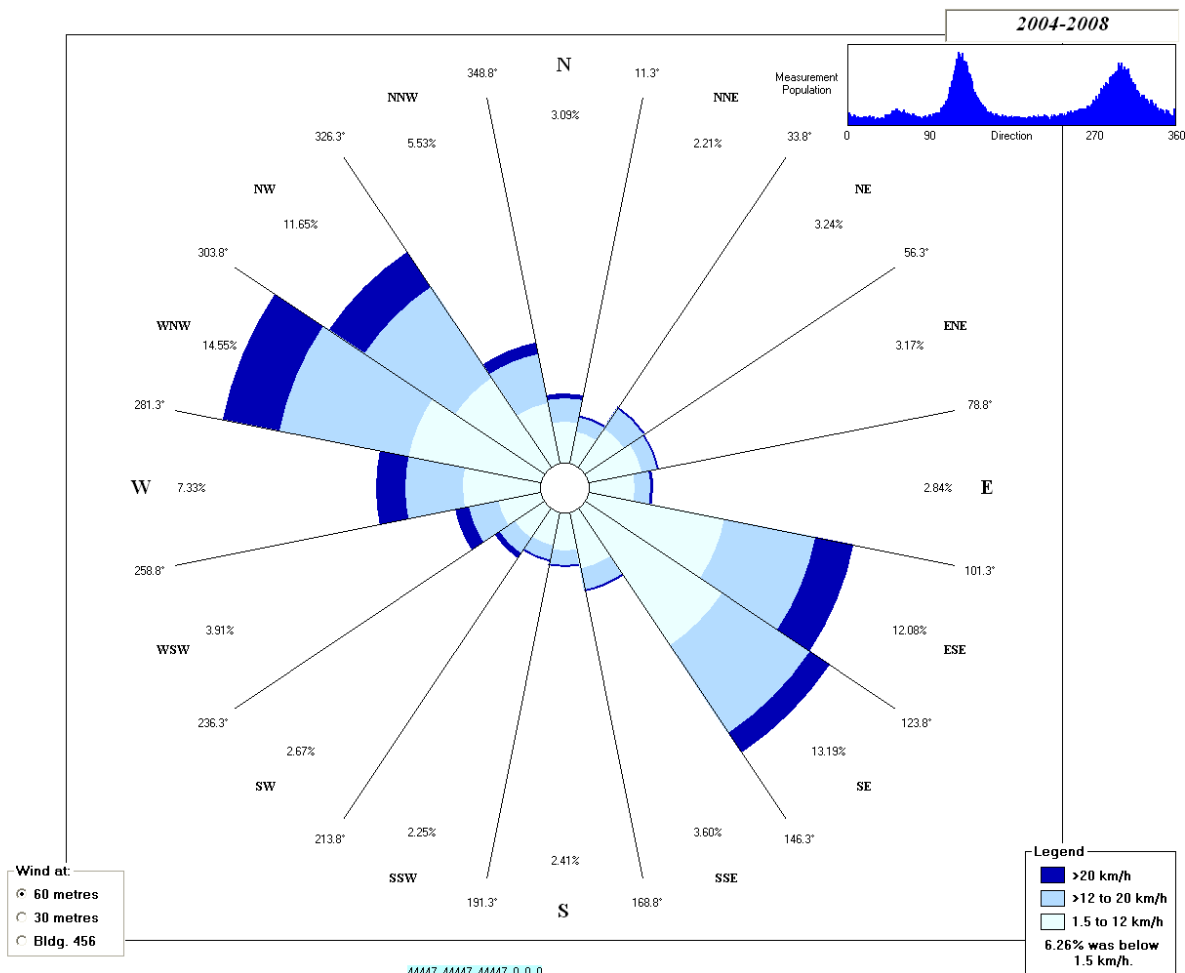


Figure 2-3 Wind Rose Diagram – Perch Lake at CRL 60 m (2004-2008)

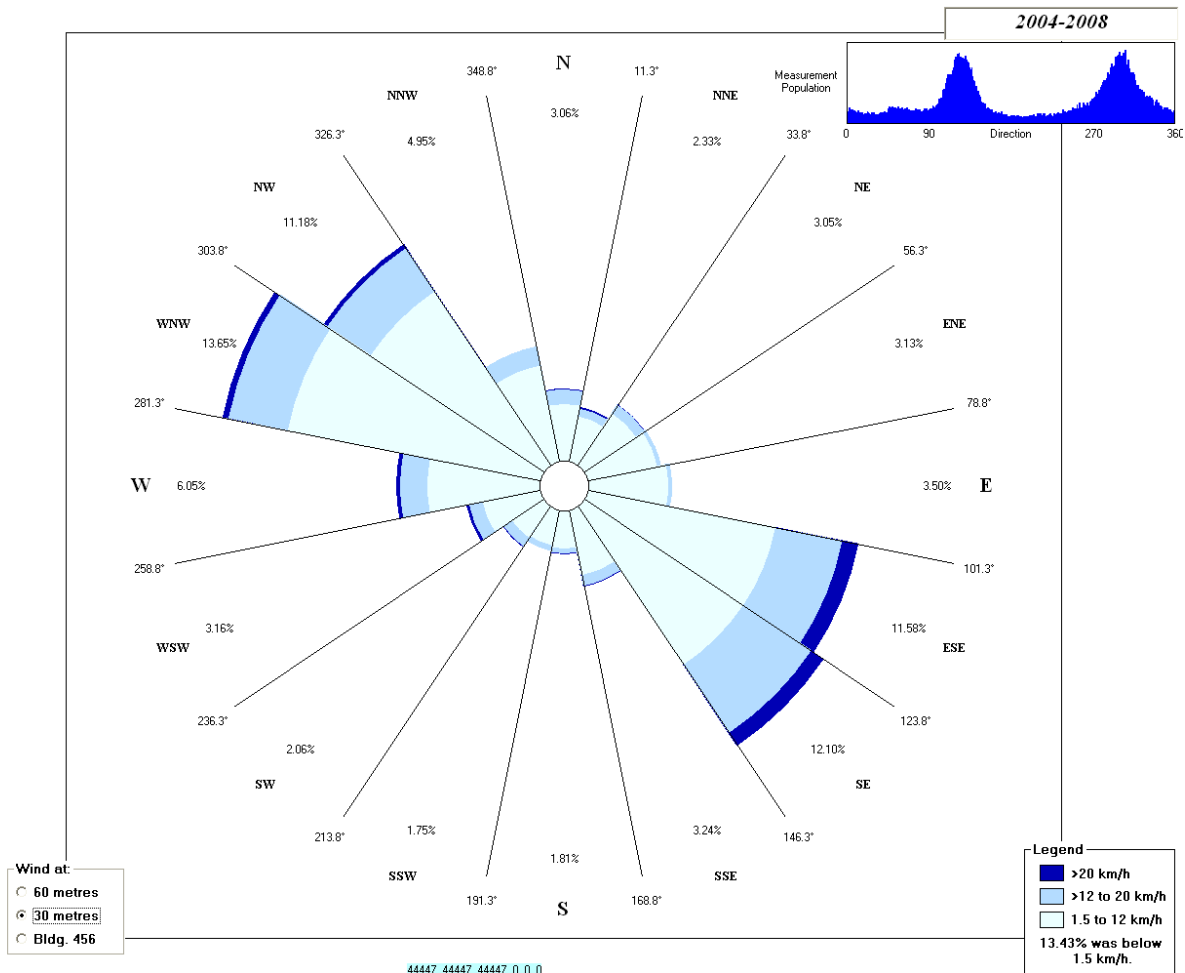


Figure 2-4 Wind Rose Diagram – Perch Lake at CRL 30 m (2004-2008)

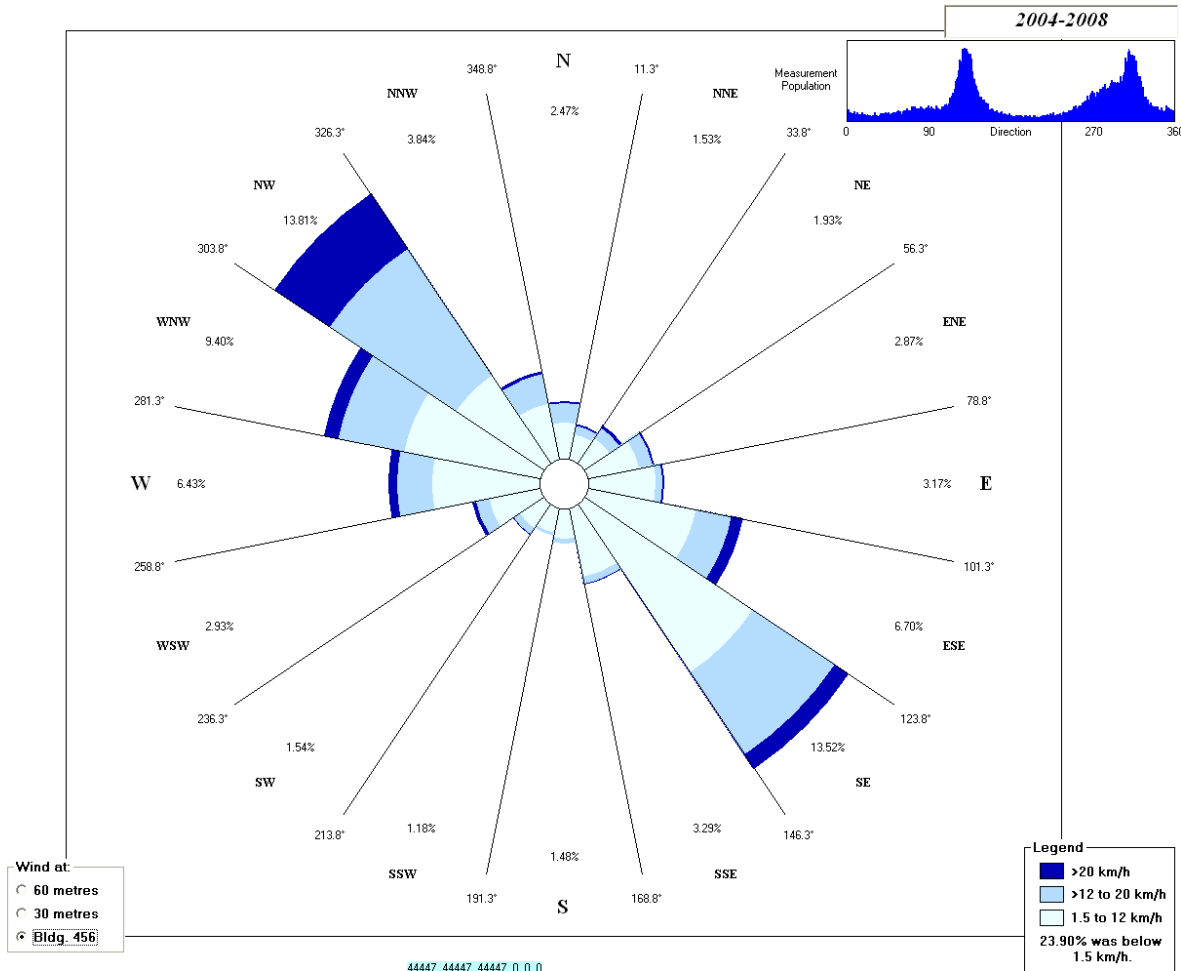


Figure 2-5 Wind Rose Diagram – Building 456 at CRL (2004-2008)

2.4 Physiography and topography

The surrounding terrain, except for the Laurentian Hills directly north and east across the river, consists of gently rolling hills, interspaced with many small lakes. The Ottawa River flows northwest to southeast [3].

2.5 Geology and hydrology

The NPD site is situated on the Ottawa River, at an elevation of approximately 125 m asl (above sea level). The site is situated on a regionally relatively flat area, dipping from a topographic high beginning on the north side of Tee Lake (approximately 225 m asl), to highway 17, which has an approximate elevation of 160 m asl, continuing to the Ottawa River which has an average elevation of 111 m asl [5].

During the construction of the generating station, numerous man-made terraces and steep interconnecting benches were created for construction and security purposes. This activity has resulted in a highly modified landscape at NPD site [5].

The surface of the NPD site is covered by a boulder pavement which, in most areas have been left as a result of water scouring the area and removing the finer fraction of the riverain sediments. The site is underlain by the Monteagle soil series and the crystalline pink and grey granitic gneisses of the Grenville Province of the Precambrian Shield [5].

The general geology of the region is the Precambrian shield with an old folding and faulting of the metamorphic rocks (gneiss). At the site itself, the base rock is quartz and granite gneiss with some overburden (1.5 to 7.5 m) of alluvial sand and gravel. The small amount of overburden and relatively steep incline of the base rocks makes ground and subsurface water run off very quickly to the river. Most of the containment area within the powerhouse is located below grade, well into the bedrock [3]. Surface ditches and underground collection pipes intercept water flow from areas adjacent to the powerhouse and direct it to the Ottawa River.

From the surficial geology map created by Gadd [6], about half of the NPD site is covered by sand and gravel deposits (Figure 2-6). The western part of the site is shown as Precambrian bedrock, which Gadd describes as often including rock outcrops but having large areas where the bedrock is thinly veneered by glacial till, gravel or other glacially derived material. Two regions of organic soil are noted, the westernmost one corresponding to current wetlands that are visible from the road to Rapides des Joachims.

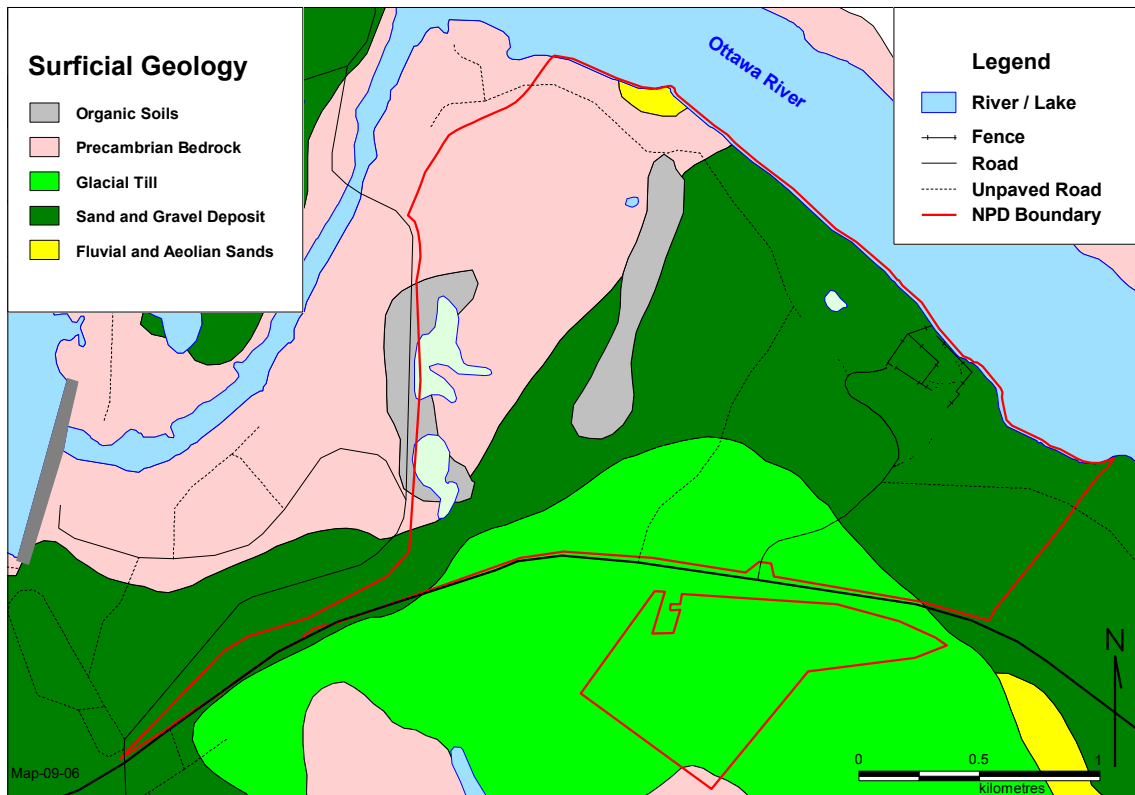


Figure 2-6 Surficial Geology (Digitized from [6])

2.5.1 Geology and hydrology near the former Landfill 1

The NPD Landfill 1 (L1) was located in a former sand and gravel extraction pit situated along the main access road to the station approximately 250 m southwest of the guardhouse (Figure 2-2). The geology around L1 consists of very bouldery sand and gravel at surface uphill (southwest) of the former landfill, overlying a unit of medium to coarse sand. This sand lies directly below the NPD station access road northwest of the location of the former landfill, and appears to be the host material for L1 itself. A second sand and gravel coarse sand unit, less bouldery and frequently containing some silt, underlies the coarse sand unit and overlies glacially-deposited stony silty sand till. The water table lies just above or below the contact between the coarse sand and the underlying sand and gravel [7].

For the most part, groundwater flow velocities are a few 10's of meter per year. Groundwater flow is approximately perpendicular to the water table contours (from the vicinity of Highway 17 towards the Ottawa River). Water passing beneath L1 may discharge to the tile drain system near the powerhouse [7].

2.5.2 Geology and hydrology near the former Landfill 2

The NPD Landfill 2 (L2) was located northeast of the powerhouse along the Old Mattawa Road (Figure 2-2) in a sand and gravel pit. From highway 17 the land slopes down towards the Ottawa River through the NPD site. This slope is interrupted by a nearly level bench or terrace (at elevation between 135 and 140 m asl) that is used by the Old Mattawa Road and that also hosts the former sand and gravel pit which is the location of L2. Surficial geology (mapped by [6], see also Figure 2-6), shows L2 to be covered by river-lain sands and gravels, possibly overlaying glacial till, in turn overlying granitic bedrock. Most of the surface in the region is covered by a boulder pavement, a lag concentrate of subrounded rocks up to 2 m in diameter left by water scouring and removal of the finer-grained fraction of the sediments. Extensive areas of bedrock outcrop are found approximately 0.5 km west of L2 at similar elevations, and thin overburden encountered during construction of NPD, suggest that unconsolidated sediments around L2 may be relatively thin. No well-defined drainage features were identified, in keeping with the high-permeability character of clean sands and gravels. However, north of the gravel pit, a small spring stream rises on the final slope to the Ottawa River (probably at the contact between the sand and gravel and underlying till). The most anomalous feature in the region of the former landfill is a small wetland immediately southeast. Although surface exposure around the wetland are not visibly different from undisturbed terrain adjacent to the gravel pit, the wetland's presence is a clear indication of substantially lower permeabilities in the subsurface, at least to the northeast [8].

2.6 Terrestrial Ecology

2.6.1 Vegetation

The NPD site supports a diverse mix upland areas with some wetland areas scattered throughout. Coniferous and mixed shade-intolerant (eg., pine, oak, poplar) forests, which are consistent with surrounding forests, predominate because of the warm microclimate found in the area [9].

Human disturbance, including logging of white pine in the 1800s and 1900s, and forest fires, has also influenced the current vegetation cover.

Vegetation communities are described qualitatively based on dominant plant species for tree, shrub, and ground cover as well as canopy conditions, relative age, soil wetness and disturbance. The NPD property is mainly wooded with the exception of open wetland areas. Wooded uplands generally range from 40-80 years old.

Three common vegetation community classes present are as follows.

- **Wetland Communities – Swamp:** Wetland areas on the NPD site are mainly found on the western half of the property. Three main deciduous swamp communities exist, one smaller community immediately south-east of L2. Two larger communities exist to the northwest of L2, the most notable being visible from Swisha Road.
- **Forested Upland Communities:** Forests within NPD are largely mixed or deciduous, dominated by white pine, red maple, poplar, and red pine. Natural coniferous forest, characterized by pine and cedar species is more prevalent on downward slopes approaching the river.
- **Cultural Communities:** Cultural meadows are unforested areas that are heavily influenced by human activities. These include roadsides, utility corridors, and abandoned or reclaimed land from decommissioned structures. Cultural plantations of white pine, red pine, and white spruce are planted along the main road into the built up area.

No nationally or provincially endangered or threatened species of vascular plants have been identified or recorded on the NPD site. No formal survey has been conducted for such species and would be a component of a formal EA.

Cover around L1 consists predominantly of white pine plantation, presumably planted after the landfill was decommissioned. Around L2, vegetation cover is dominated by mixed stands of pine, poplar and birch.

2.6.2 Wildlife

It is expected that since there is no human activity on the NPD site, other than travel from the front gate to the built up area and back, that wildlife species found on the site should be relatively typical for a boreal region in Ontario. No formal survey has been conducted to determine species specific to this site. A formal EA would include a Species at Risk study that would include surveys for both plant and wildlife species of concern.

2.7 Aquatic ecology

NPD is located in the reach of the Ottawa River extending approximately 90 km between La Passe and the Des Joachims Dam. Specifically, the property is directly adjacent to the Joachims Dam. This reach of the river consists of several “lakes” separated by short rapids and supports diverse warmwater and coolwater fish communities consisting of at least 55 documented species [10]. The provincially-rare fish species in the Ottawa River is the river redhorse [11]. Typical catches from the river include walleye, northern pike, channel catfish, smallmouth bass, and lake sturgeon.

3. PAST AND EXISTING INSTALLATIONS

3.1 Present installations

On the NPD site, only two buildings remain. There is the guardhouse and there is part of the powerhouse (a section of it was removed in 1992). Beside the building (on the east side), the vent stack is still present.

In addition, a network of subsurface drains with the purpose of collecting and removing groundwater from around and under the powerhouse structures (to reduce the risk of groundwater infiltration into the underground structures) is present. The system consists of 3 separate collector pipes with feeders, one covering the west and south side, one on the east side and one draining the pressure relief duct and pit as shown in Figure 3-1. Pipes, which previously channelled rainwater from the roof to the subsurface drains have either been removed or are capped.

Drain 1 contains two Man Holes (MH) that act as vents, observation stations, cleanouts and sample points. MH-1 is in collector pipe 1 on the south side and MH-2 is in the same collector pipe on the west side. Drain 1 discharges into the Ottawa River about 6 feet from the shore. There is one MH in Drain 2--MH-3 on the east side. The exact discharge location of Drain 2 has yet to be determined. Samples are taken yearly from the three MHs and gross beta and tritium values are reported (see Section 4.2).

The Wells Area Sump (WAS) collects the liquids from the active drainage system inside the powerhouse. Foundation leakage is directed by gravity to the Service Pipe Trench (SPT) and when sufficient water has accumulated in the WAS in the lowest part of the building it is sampled, analyzed for gross beta and tritium, verified below the derived release limits (DRL), and then pumped to the Ottawa River. The water is discharged through the Process Drain (see Figure 3-1) about 60 feet from the riverbank and 150 feet downstream from the former pump house. Water from the Internal Unrestricted Area floor drains is also directed by gravity to the Ottawa River through this route [12], [3], [13].

Old pavement is still present at the site of the former Training Centre. Other structures include the power lines, the main road and a network of gravel roads (some portions are no longer usable). The location of the former Landfill 1 is accessible from the main road, however, the former Landfill 2 is no longer accessible by road. Fences are also present on the site (Figure 2-2).

In addition to the installations, a number of boreholes and monitoring wells (Table 3-1, Figure 3-2) have been installed at various times on the NPD site [5], [7], [8], [14], [15]. Water levels measured in wells at some of the boreholes are provided in Table 3-2 and Table 3-3; [5] [8] [7] [14] [16], [17], [15], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]. During the drilling bedrock was encountered at 121.9 m asl at MT-2 and at 112.9 m asl at MT-8 [5]. Tests to determine hydraulic conductivity were done using sediments from NPD-1, NPD-4, NPD-5-I and NPD-7 [8]. The results gave a value of 0.0007 cm/s at NPT-1 in sand and gravel, >0.004 cm/s at NPD-4 in coarse sand, 8.2×10^{-6} cm/s at NPD-5-I in glacial till, and 6×10^{-5} cm/s at NPD-7 in silty sand and gravel.

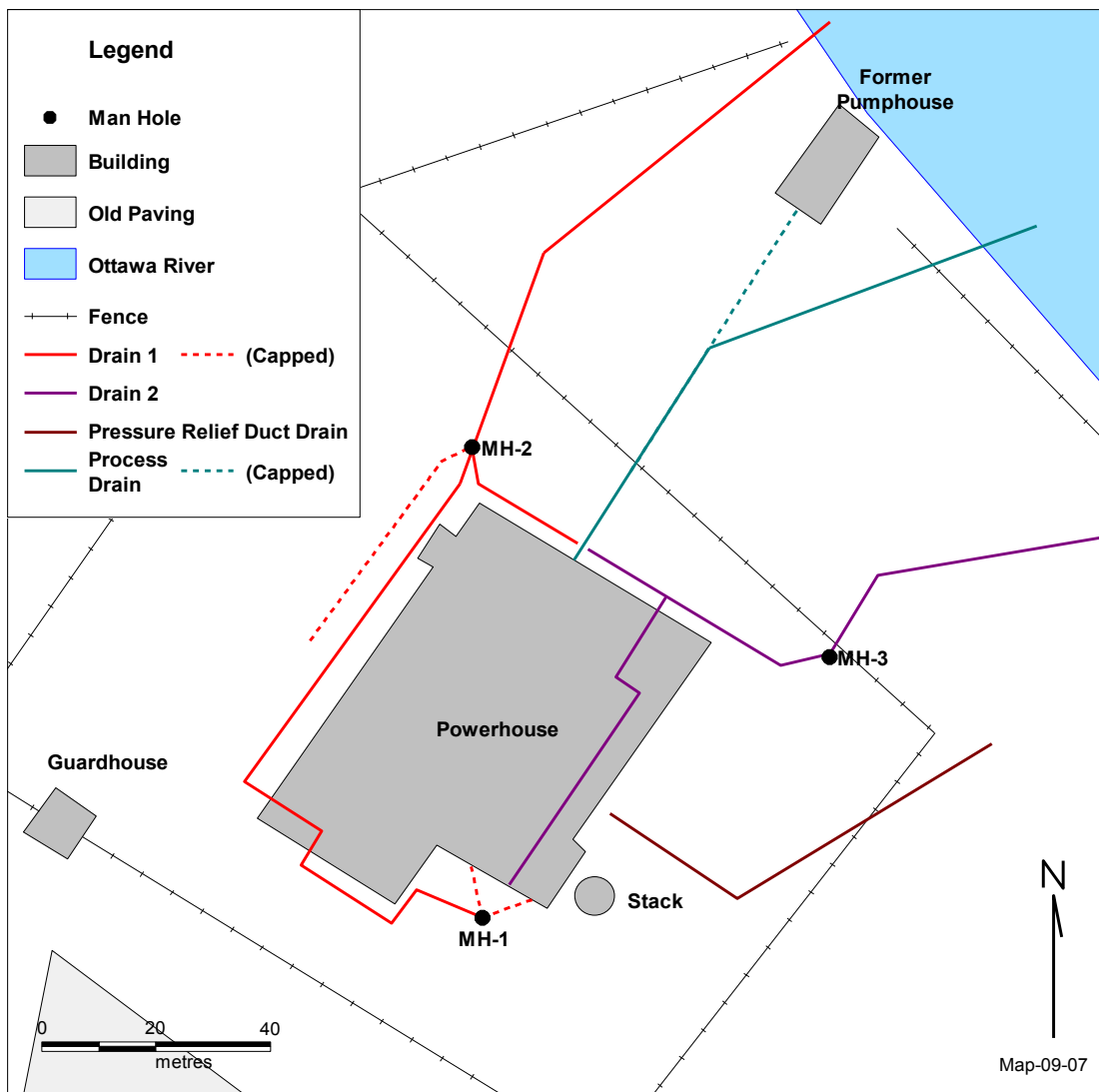


Figure 3-1 NPD Subsurface Drainage System

Some of the NPD boreholes shown in Figure 3-2 could still be used to conduct analyses particularly those that are used for the current monitoring program (BH-06-01 to BH-16-01, MT-5, MT-8, MT-9, RW-1, and RW-2) [30]. Others might be useable but may not have been sampled since the early 1990's. A number of test pits have been excavated in the past although all of them have been backfilled (Table 3-4) [5], [14].

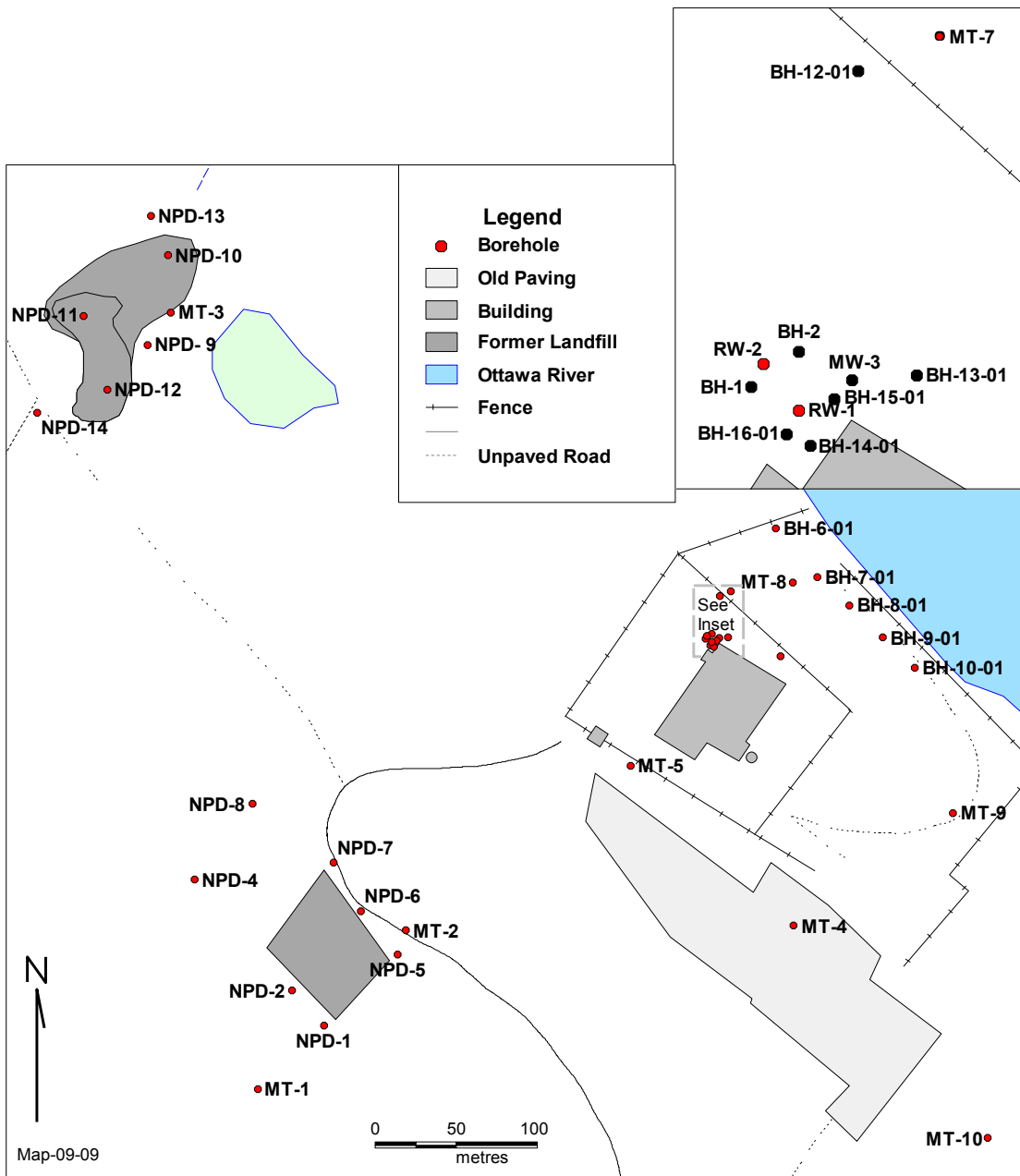


Figure 3-2 Boreholes and Monitoring Wells on the NPD Site

**Table 3-1
Borehole and Monitoring Well List with Information Known About Each Borehole that was Drilled on the NPD Site and Each Monitoring Well that was Installed.**

Location Code	Location Description	Installation Date	Elevation TOP	Surface Elevation	Length (m)	Well data	Screen data	Well Top (masl)	Well Bottom (masl)
BH-1	Underground fuel storage tank	18-Dec-92	NA	128.42	5.18	NA	NA	NA	NA
BH-2	Underground fuel storage tank	19-Dec-92	NA	128.32	5.36	NA	NA	NA	NA
BH-6-01	Underground fuel storage tank	12-Nov-01	NA	115.54	3.05	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-7-01	Underground fuel storage tank	12-Nov-01	NA	114.66	3.05	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-8-01	Underground fuel storage tank	12-Nov-01	NA	114.83	3.05	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-9-01	Underground fuel storage tank	12-Nov-01	NA	115.01	3.05	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-10-01	Underground fuel storage tank	12-Nov-01	NA	115.58	3.05	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-11-01	Underground fuel storage tank	14-Nov-01	NA	128.29	9.14	50 mm PVC pipe	slotted PVC screen	NA	NA
BH-12-01	Underground fuel storage tank	19-Nov-01	NA	127.88	10.06	50 mm PVC pipe	slotted PVC screen	NA	NA
BH-13-01	Underground fuel storage tank	19-Nov-01	NA	128.41	9.91	50 mm PVC pipe	slotted PVC screen	NA	NA
BH-14-01	Underground fuel storage tank	20-Nov-01	NA	128.27	4.57	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-15-01	Underground fuel storage tank	20-Nov-01	NA	128.5	7.01	32 mm PVC pipe	slotted PVC screen	NA	NA
BH-16-01	Underground fuel storage tank	20-Nov-01	NA	128.4	7.01	32 mm PVC pipe	slotted PVC screen	NA	NA
MT-1	South (upgradient) of L1	15-Dec-89	140.02	139.27	10.51	50mm PVC triloc	1.5m slot	130.3	128.8
MT-10	Southeast of Training Centre	19-Dec-89	135.58	134.99	7.62	50mm PVC triloc	1.5m slot	129.6	128.1
MT-2	North (downgradient) of L1	15-Dec-89	134.34	134.02	15.14	50mm PVC triloc	1.5m slot	120.4	118.9
MT-3	Northeast (downgradient) of L2	01-Dec-89	131.68	131.06	3.66	50mm PVC triloc	1.5m slot	129.7	128.2
MT-4	North of Training Centre	19-Dec-89	135.49	134.92	11.2	50mm PVC triloc	1.5m slot	125.5	124
MT-5	Southeast of Guard House	16-Dec-89	128.65	128.02	7.6	50mm PVC triloc	1.5m slot	122.2	120.7
MT-7	North of Reactor Building	18-Dec-89	128.63	127.85	7.62	50mm PVC triloc	1.5m slot	122	120.5
MT-8	West of Pump House	22-Dec-89	115.28	114.7	3.1	50mm PVC triloc	1.5m slot	113.2	111.7
MT-9	North of North Warehouse on Pump House Access Road	20-Dec-89	125.18	124.65	6.86	50mm PVC triloc	1.5m slot	122.1	120.6

Location Code	Location Description	Installation Date	Elevation TOP	Surface Elevation	Length (m)	Well data	Screen data	Well Top (masl)	Well Bottom (masl)
MW-3	Underground fuel storage tank	19-Dec-92	NA	128.4	7.77	NA	NA	NA	NA
NPD-1	L1*	12-May-88	142.609	141.81	11	3.2cm ID PVC pipe	Johnson 0.25mm slot	132.02	131.26
NPD-10	L2	31-Mar-89	134.26	133.43	3.1	3.2 cm ID PVC	0.25 mm slot size	131.94	130.42
NPD-11	L2	15-May-89	137.63	136.82	5.77	3.2 cm ID PVC	0.25 mm slot size	132.16	130.64
NPD-12	L2	31-Mar-89	135.85	134.95	4.5	3.2 cm ID PVC	0.25 mm slot size	132.17	130.65
NPD-13	L2	15-May-89	138.34	137.38	7.77	3.2 cm ID PVC	0.25 mm slot size	131.21	129.69
NPD-14	L2	31-Mar-89	137.92	136.99	6.4	3.2 cm ID PVC	0.25 mm slot size	132.21	130.69
NPD-2	L1*	18-May-88	142.392	141.46	10.1	3.2cm ID PVC pipe	Johnson 0.25mm slot	132.2	131.44
NPD-4	L1*	16-May-88	143.047	142.23	13.4	3.2cm ID PVC pipe	Johnson 0.25mm slot	130.6	129.84
NPD-5-I	L1*	09-May-88	137.54	136.77	12.2	3.2cm ID PVC pipe	Johnson 0.25mm slot	125.72	124.96
NPD-5-II	L1*	09-May-88	137.458	136.76	12.2	3.2cm ID PVC pipe	Johnson 0.25mm slot	128.11	127.35
NPD-6	L1*	10-May-88	137.078	136.09	10.4	3.2cm ID PVC pipe	Johnson 0.25mm slot	126.9	126.14
NPD-7	L1*	11-May-88	135.993	135	8.5	3.2cm ID PVC pipe	Johnson 0.25mm slot	127.69	126.93
NPD-8	L1*	17-May-88	145.264	144.41	16.8	3.2cm ID PVC pipe	Johnson 0.25mm slot	128.55	127.79
NPD-9	L2	15-May-89	135.14	134.33	4.5	3.2 cm ID PVC	0.25 mm slot size	131.92	130.4

* Local elevations converted to m asl using GPS elevation at NPD-7

Table 3-2
Water Levels (in m asl) on Installation of Boreholes and Wells Near L1 and L2

Borehole	05/16/88	05/18/88	05/19/88	05/24/88	05/25/88	05/27/88	03/31/89	05/15/89
NPD-1	132.89	132.92	132.94	132.99	132.99	133.00	NA	NA
NPD-2	NA	NA	132.22	132.29	132.31	N/A	NA	NA
NPD-4	130.75	130.81	130.83	130.90	131.01	N/A	NA	NA
NPD-5-I	127.78	127.81	127.85	127.96	127.97	N/A	NA	NA
NPD-5-II	NA	NA	127.54	127.68	127.69	N/A	NA	NA
NPD-6	127.74	128.08	127.83	127.96	127.98	128.15	NA	NA
NPD-7	127.90	127.92	127.95	127.99	127.69	NA	NA	NA
NPD-8	NA	128.23	128.26	128.43	128.45	NA	NA	NA
NPD-9	NA	NA	NA	NA	NA	NA	131.94	133.79
NPD-10	NA	NA	NA	NA	NA	NA	131.73	133.76
NPD-11	NA	NA	NA	NA	NA	NA	131.85	134.34
NPD-12	NA	NA	NA	NA	NA	NA	131.9	134.01
NPD-13	NA	NA	NA	NA	NA	NA	130.31	132.4
NPD-14	NA	NA	NA	NA	NA	NA	131.91	134.43

Table 3-3
Water Levels (in m asl) Measured on Installation of Boreholes and Periodically

Borehole	22-Dec-89	18-Jan-90	04-Jan-93	13-Nov-01	20-Nov-01	21-Nov-01	22-Sep-03	22-Apr-04	04-Oct-04	05-May-05	17-Oct-05	28-Apr-06	11-Oct-06	17-May-07	24-Oct-07	26-May-08	11-Nov-08
BH-6-01	NA	NA	NA	112.61	NA	NA	Dry	112.72	Dry	Dry	Dry	112.8	Dry	Dry	Dry	Dry	Dry
BH-7-01	NA	NA	NA	NA	112.39	NA	114.66	113.81	Dry	112.36	111.93	112.7	112.06	112.06	Dry	111.66	Dry
BH-8-01	NA	NA	NA	NA	112.29	NA	Dry	113.59	Dry	112.36	Dry	112.7	Dry	Dry	Dry	Dry	Dry
BH-9-01	NA	NA	NA	NA	113.24	NA	112.25	114.21	Dry	113.54	Dry	113.52	112.94	112.94	Dry	113.01	Dry
BH-10-01	NA	NA	NA	NA	112.76	NA	Dry	113.33	Dry	113.05	Dry	113.19	Dry	Dry	Dry	110.9	Dry
BH-11-01	NA	NA	NA	NA	NA	119.36	Dry	119.44	Dry	Dry	Dry	119.51	Dry	Dry	Dry	Dry	Dry
BH-12-01	NA	NA	NA	NA	NA	119.33	119.69	120.13	119.5	120.01	119.57	120.17	120.17	120.17	127.88	111.88	119.32
BH-13-01	NA	NA	NA	NA	NA	120.56	120.54	120.77	120.42	120.53	120.59	120.57	120.57	120.57	128.41	112.82	120.77
BH-14-01	NA	NA	NA	NA	NA	Dry	Dry	124.41	Dry	126.21	Dry	125.36	Dry	Dry	Dry	Dry	Dry
BH-15-01	NA	NA	NA	NA	NA	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
BH-16-01	NA	NA	NA	NA	NA	Dry	122.56	123.55	Dry	125.18	Dry	123.97	Dry	Dry	Dry	Dry	Dry
MT-1	130.81	130.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT-2	124.61	124.54	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT-3	Dry	Dry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT-4	127.98	127.69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT-5	123.94	123.71	NA	NA	NA	NA	NA	NA	NA	124.71	124.77	125.06	124.75	124.75	124.75	124.15	124.43
MT-7	Dry	Dry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MT-8	113.02	112.93	NA	NA	NA	NA	NA	NA	112.79	114.7	114.7	113.79	114.7	114.7	114.7	113.45	112.8
MT-9	121.48	Dry	NA	NA	NA	NA	NA	NA	NA	122.99	122.57	122.98	122.03	122.03	122.03	Dry	121.73
MT-10	129.11	128.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-3	NA	NA	121.92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

**Table 3-4
List of Test Pits**

Location Code	Location	Date	Length (m)
TP-0	L2	19-Jan-90	8
TP-3	Adjacent to Borehole MT-3	18-Jan-90	3
TP-4	Underground Storage Tank	04-Jan-93	7
TP-5	Underground Storage Tank	06-Dec-92	7
TP-6	Location of MT-6 Borehole (not drilled)	19-Jan-90	4
TP-8	Adjacent to Borehole MT-6	20-Jan-90	3
TP-9	Adjacent to Borehole MT-9	21-Jan-90	3
TP-10	Adjacent to Borehole MT-10	16-Jan-90	3
TP-A	Emergency vehicle garage	20-Jan-90	5
TP-B	Diesel UST	20-Jan-90	5
TP-C	Septic tank	20-Jan-90	4
TP-D	Waste oil tank	20-Jan-90	12
TP-E	Fuel UST and transformer tank	20-Jan-90	3.5
TP-F	Active waste tank	20-Jan-90	4
TP-G	North Warehouse	19-Jan-90	4
TP-H	North-South Warehouse storage pad	19-Jan-90	6
TP-I	UST in Training Centre	17-Jan-90	3.5
TP-J	Bermed storage area	16-Jan-90	4
TP-K	Concrete fire training pad	16-Jan-90	4
TP-L	Out-of service UST and sewer line	16-Jan-90	3.5
TP-M	UST	17-Jan-90	3.5
TP-N (A-C)	L1	17-Jan-90	18
TP-N (D)	L1	18-Jan-90	4

3.2 Past installations

When AECL took possession of the NPD site, a number of installations were present. They included a training center, the powerhouse building, two warehouses, an emergency vehicle garage, a pump house, two outbuildings, a garage, some storage sheds, a dousing water storage tank and the guardhouse (See Figure 3-3). The South Warehouse had been used first for construction stores and then to store hazardous chemicals. The North Warehouse was used to store large pieces of contaminated equipment pending disposal. In 1991, the outbuildings were sold by tender and removed. Other buildings, including the warehouses and the emergency vehicle garage, were also removed in 1991. In 1992, the administration wing and portable office buildings associated with the powerhouse building were demolished and removed. In addition, to this, the removal of underground fuel storage tanks took place that year. Two tanks were located close to the powerhouse building (one of which had been leaking). Others were located near the training centre. The pump house and dousing water storage tanks were demolished and removed in 1993. Finally, the training centre was demolished between 1994 and 1996.

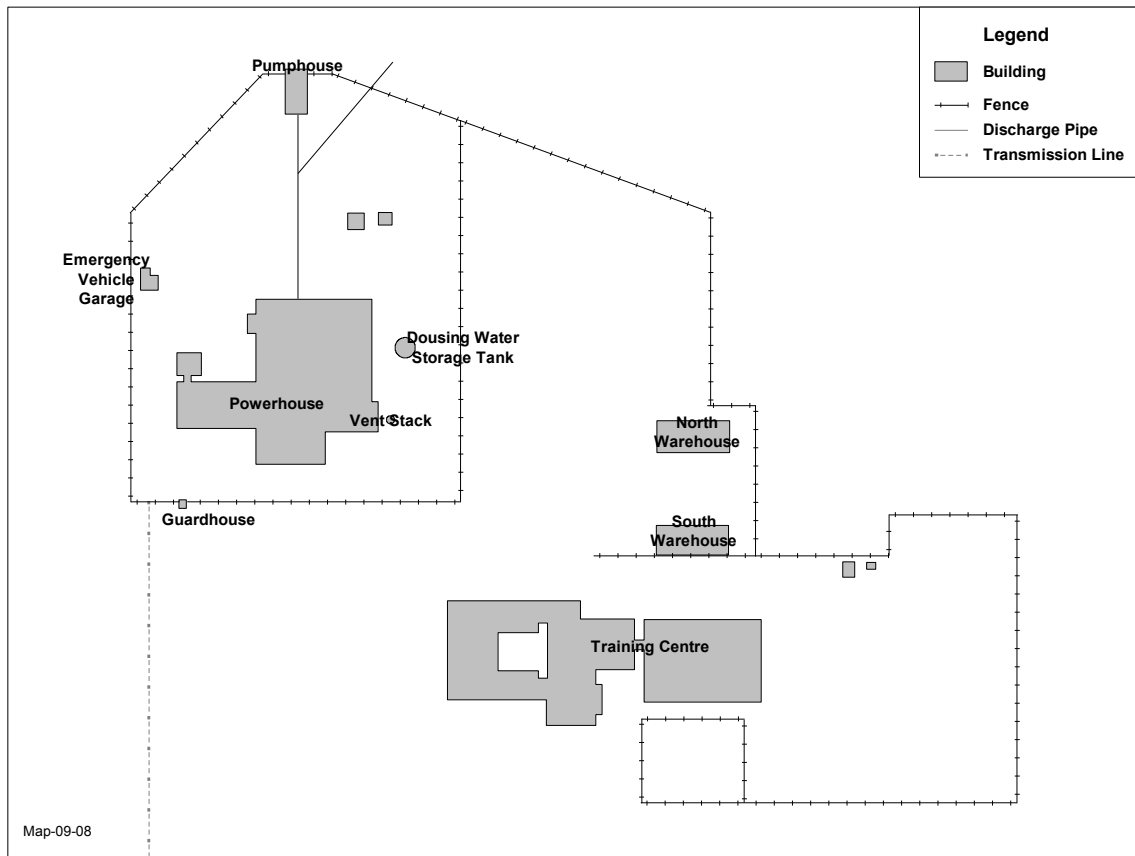


Figure 3-3 NPD Site 1988

4. MONITORING OF THE MAJOR SOURCES OF RADIOACTIVE EFFLUENTS

Airborne radioactive effluents are originating mainly from the vent stack. The ventilation system is operated on an as required basis. Liquid radioactive effluents from the active and inactive drainage systems located within the powerhouse are sampled, analyzed and then pumped into the Ottawa River on a controlled basis [3].

4.1 Airborne radioactive effluents monitoring (1989-present)

Radioactive airborne effluents are monitored by measuring gross beta, carbon-14 activity and tritium activity at the source (see Section 4.1.1). Section 5.1.1 of this report presents air environment monitoring data.

4.1.1 Measuring gross beta, carbon-14 activity and tritium activity at the source

Airborne radioactive effluents have been monitored since AECL took ownership of the NPD site. Reported values for 1988 September 16 to 1990 March 31 may be found in [31], [32], [33], [34], [35] but reports containing values from April 1990 to 1996 could not be located. The data associated with the monitoring of the vent stack radioactive releases from 1997 to the present are reported in Table 4-1. The data were taken from [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46].

The HEPA filtered ventilation system is operated only for short periods of time for example during entry of personnel to the facility or to purge the nuclear area for inspection and maintenance.

Table 4-1
Specific Values of Total Airborne Releases from the NPD Stack

Year	14C (GBq)	Gross Beta (kBq)	Tritium (GBq)
1997	NA	12	72
1998	NA	4.7	130
1999	NA	5.8	130
2000	NA	4.4	3
2001	NA	<26.0	76
2002	NA	<14.0	48
2003	NA	<30.0	100
2004	0.073	<14.9* / 225**	41
2005	0.19	240	32
2006	0.132	300	35
2007	0.0163	26	69

* Gross beta determined using Microspec--1 using Sr-90/Y-90 as a standard (November 2003 - June 2004)

** Gross beta determined using Canberra Packard Gross Alpha/Beta counter with ⁶⁰Co as a standard (June 2004 - November 2004)

4.2 Liquid radioactive effluents monitoring (1989-present)

Liquid radioactive effluents accumulate mainly in the WAS. When there is a need to release liquids that have accumulated in the WAS, samples are collected by facility operating personnel, analyzed, and verified below the DRL. Once this is completed, the liquids from the WAS are released to the Ottawa River. The date and the volume of each release are recorded. Additional liquid radioactive effluent monitoring is carried out by sampling the SPT and the Man Holes of the drain system.

Relevant information can be found in Sections 4.2.1 and 4.2.2. Data are available from 1988. Reported values for 1988 September 16 to 1990 March 31 may be found in [31], [32], [33], [34], [35]. Reports containing values obtained between April 1990 and 1996 were not looked at. Therefore, the references for these documents were not included in this report.

Section 5.1.2 of this report presents water environment monitoring data.

4.2.1 Measuring radioactive releases at the WAS

The data associated with the monitoring of the WAS radioactive releases are reported in Table 4-2. The information reported in the table includes the number of discharges, the total volume discharged and the total amount of various contaminants released. The data were taken from [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46].

**Table 4-2
WAS annual radioactive release**

Year	Number of Discharges	Total Volume (m ³)	¹³¹ I (MBq)	¹³⁷ Cs (MBq)	¹⁴⁴ Ce (MBq)	¹⁴ C (MBq)	⁶⁰ Co (MBq)	Unidentified Beta/Gamma (MBq) ^c	Gross Beta (MBq) ^d	Gross Gamma (MBq) ^e	Tritium (GBq)
1997	5	49.19	<0.024	2.04	<0.98	NA	0.01	0.97	NA	NA	502
1998	5	49.47	<0.016	2.55	<0.049	NA	0.07	1.37	NA	NA	501
1999	5	44.44	<0.014	2.52	<0.045	NA	0.16	0.96	NA	NA	775
2000	5	44.4	<0.012	3.06	<0.020	NA	0.09	0.55	NA	NA	109
2001	5	41.05	<0.012	1.77	<0.041	NA	0.05	0.62	NA	NA	892
2002	3	22.44	<0.0082	0.85	<0.031	NA	0.01	0.21	NA	NA	367
2003	3	28.8	<0.013	1.16	<0.047	NA	<0.0023	0.45	NA	NA	298
2004 ^a	3	24.8	NA	0.82	NA	9.54	0.01	0.31	NA	NA	145
2004 ^b			NA	NA	NA	4.23	NA	NA	2.16	2.53	102
2005	2	21.4	NA	NA	NA	8.60	NA	NA	4.10	1.90	200
2006	2	32.1	NA	NA	NA	6.71	NA	NA	2.48	1.24	122
2007	2	21.4	NA	NA	NA	7.23	NA	NA	2.73	1.44	127

^aMonitoring period 1 January to 29 July

^bMonitoring period 30 July to 16 November;

^cGross beta determined using Microspec--1 using Sr-90/Y-90 as a standard

^dResults determined using a Canberra Packard Gross Alpha/Beta counter and the activity is based on ⁶⁰Co

^eResults determined using a NaI gamma spectrometer and the activity is based on ⁰Co

4.2.2 Measuring gross beta and tritium values in samples obtained from subsurface drains

Water samples from subsurface drains located near the powerhouse are analyzed yearly for average gross beta and tritium values [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45],[46]. The data gathered are presented in Table 4-3 for Gross Beta and Table 4-4 for tritium.

**Table 4-3
Average Gross Beta Values (in Bq/L) for MH-1, MH-2, MH-3**

Year	MH-1	MH-2	MH-3
1993*	<17	<17	<17
1994*	83	<17	50
1995*	<220	<220	<220
1996*	6.4	2.7	4.5
1997*	300	<7.7	<2.9
1998*	<1.2	<2.7	<2.6
1999*	<4	<4.6	<4.1
2000*	<2.3	<4	<4.4
2001*	<2.2	<1.2	<1.2
2002*	<0.8	<0.8	<0.8
2003*	<0.8	<0.8	<0.41
2004**	<1.9	<1.9	2.3
2005**	1.9	<2	2.9
2006**	<2.5	4	<3.2
2007**	<1.8	<1.8	dry

* Gross beta determined using Canberra Packard Gross Alpha/Beta counter with ^{60}Co as a standard

** Gross beta determined using Canberra Packard Gross Alpha/Beta counter with ^{60}Co as a standard

Table 4-4
Average Tritium Values (in kBq/L) for MH-1, MH-2, MH-3

Year	MH-1	MH-2	MH-3
1993	<37.0	<37.0	<37.0
1994	<37.0	<37.0	<37.0
1995	31.0	20.0	22.0
1996	6.7	0.3	12.0
1997	140.0	0.2	2.3
1998	360.0	0.2	3.8
1999	290.0	0.2	3.0
2000	200.0	11.0	0.2
2001	230.0	0.1	16.0
2002	170.0	0.2	4.7
2003	240.0	0.5	6.9
2004	197.0	0.1	9.9
2005	140.0	0.6	3.9
2006	176.0	0.4	8.0
2007	175.0	0.3	dry

5. ENVIRONMENTAL MONITORING (1989-PRESENT)

5.1 Routine monitoring

5.1.1 Air

Ambient gamma radiation doses in air at TLD stations near NPD are part of the environmental monitoring program and are discussed in this Section. Refer to Section 4.1 for details regarding the stack vent effluent monitoring.

5.1.1.1 Ambient gamma radiation doses in air at TLD stations near NPD

During the 22 years since the NPD reactor was permanently shut down in 1987, there have been no anomalies in data on ambient radiation fields provided by the thermoluminescent dosimeters (TLDs) that are located near the NPD site. Operation of the TLD monitoring stations near NPD continues to be part of the monitoring program [47].

**Table 5-1
Location of the TLD Station Located Near NPD.**

Location	ETB Code	NPD Code	Easting (m)	Northing (m)
Des Joachims (Fraser's)	T28	T1	292354	5119264
NPD at Highway 17	T29	T2	294243	5117291
NPD Main Site (parking lot)	T30	T3	294859	5117896
Point Stewart, NPD, near Ottawa River	T31	T4	295603	5117594

Table 5-1 gives the locations of the TLDs. A map showing the location of them is shown in [47]. TLD-1 and TLD-4 lie in the prevailing wind directions from the NPD site. TLD-1 moved to current location at some time between 1994 and 1996 from a location in Des Joachims about half a kilometre away.

Ambient radiation fields were lowest during the first quarters, when snow cover provides partial shielding of radiation from the ground. There was a slight decrease in recorded ambient radiation fields between the start of the post-shutdown monitoring period and 1997. Variations since then have shown no clearly definable trends, and the radiation fields are characteristic of those observed in regions with similar surface soils that are unaffected by nuclear facilities [48].

The ambient radiation fields at TLD-2 (the junction of Highway 17 and the NPD access road) are consistently slightly lower than the other three locations; this is attributed to the wetland conditions around the station, with the water providing some shielding from the soil's natural radiation field [49].

The information presented in Table 5-2 was taken from [47], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64].

**Table 5-2
Ambient Gamma Radiation in Air at TLD Stations Near NPD**

Year	Quarter	Des Joachims ($\mu\text{R/hr}$)	NPD at Highway 17 ($\mu\text{R/hr}$)	NPD Car Park ($\mu\text{R/hr}$)	Point Stewart ($\mu\text{R/hr}$)
1972 - 1987	Average	9.3	6.9	NA	9.3
1988	4	6.5	3.0	5.6	NA
1989	1	7.8	4.9	6.9	NA
1989	2	5.8	2.4	4.3	7.0
1989	4	7.7	5.5	7.7	NA
1990	1	3.4	4.3	3.8	NA
1990	2	6.4	4.3	7.2	4.6
1990	3	4.6	1.6	6.0	NA
1990	4	6.8	3.0	6.4	NA
1991	1	5.5	6.0	6.0	NA
1991	2	7.4	5.0	6.5	NA
1991	3	7.2	4.7	6.4	6.0
1991	4	8.1	4.3	6.3	NA
1992	1	6.0	4.3	5.6	NA
1992	2	7.4	4.4	7.3	5.3
1992	3	5.7	4.3	6.7	NA
1992	4	7.1	4.9	6.8	NA
1993	1	8.0	4.5	7.2	NA
1993	2	7.4	3.3	5.8	4.9
1993	3	7.1	5.0	6.6	NA
1993	4	10.9	8.3	10.7	NA
1994	1	5.8	3.4	4.3	NA
1994	2	6.7	3.9	5.4	5.7
1994	3	6.7	5.2	5.7	5.2
1994	4	6.0	3.3	5.2	NA
1995	1	5.5	3.7	5.9	NA
1995	2	7.0	3.1	5.2	5.0
1995	3	6.8	5.2	7.1	8.8
1996	1	3.1	2.4	2.9	NA
1996	2	6.2	2.8	NA	2.9
1996	3	NA	4.4	NA	8.3
1996	4	NA	3.3	NA	NA
1997	1	4.2	0.3	2.5	5.2
1997	2	6.0	2.8	4.9	5.2
1997	3	4.9	2.1	3.7	6.0
1997	4	5.6	2.8	4.3	NA
1998	1	3.3	0.4	1.0	NA

Year	Quarter	Des Joachims ($\mu\text{R/hr}$)	NPD at Highway 17 ($\mu\text{R/hr}$)	NPD Car Park ($\mu\text{R/hr}$)	Point Stewart ($\mu\text{R/hr}$)
1998	2	6.3	3.6	5.6	5.9
1998	3	3.9	1.9	3.7	5.7
1998	4	5.7	3.1	4.9	NA
1999	1	4.6	0.0	2.1	NA
1999	2	6.0	3.3	5.1	1.8
1999	3	5.1	2.6	4.2	4.6
1999	4	6.1	4.0	5.7	NA
2000	1	3.3	0.1	1.4	NA
2000	2	6.0	3.9	5.7	4.9
2000	3	4.1	2.2	3.8	3.7
2001	1	2.7	1.0	1.6	NA
2001	2	5.6	3.6	5.6	1.8
2001	3	4.1	2.1	3.7	6.4
2001	4	6.8	4.0	5.8	NA
2002	1	2.8	-0.7	0.5	NA
2002	2	6.2	3.4	5.3	1.2
2002	3	4.7	2.9	4.7	6.7
2002	4	5.2	3.6	5.6	NA
2003	1	3.5	0.2	1.5	NA
2003	2	6.3	3.6	5.5	4.4
2003	3	5.1	4.4	4.5	6.4
2003	4	2.6	3.0	4.5	NA
2004	1	2.6	2.1	2.1	NA
2004	2	5.8	4.1	6.1	4.6
2004	3	5.9	4.5	5.2	6.7
2004	4	4.7	3.5	4.7	NA
2005	1	2.1	2.7	1.2	NA
2005	2	5.2	3.7	6.3	3.2
2005	3	5.1	4.6	4.1	5.4
2005	4	8.7	6.6	11.4	NA
2006	1	3.3	1.5	2.8	NA
2006	2	4.6	3.8	5.7	4.5
2006	3	5.5	4.1	5.3	5.0
2006	4	4.3	3.7	6.0	NA
2007	1	4.8	2.9	4.2	NA
2007	2	5.0	3.2	5.5	4.4
2007	3	5.1	3.6	5.2	6.1

5.1.2 Water

The ambient Ottawa River tritium, ^{137}Cs and ^{90}Sr concentrations upstream and downstream of NPD are monitored routinely. Refer to Section 4.2 for details on liquid effluent monitoring. In addition to the radiological sampling, twice yearly, sampling is carried out to analyze for petroleum products. The results of the petroleum products analysis are reported in Table 5-20 to Table 5-23 of this report.

5.1.2.1 Concentrations of tritium, ^{137}Cs and ^{90}Sr in the Ottawa River upstream and downstream of NPD

Water in the Ottawa River is sampled as part of the CRL Site Environmental Monitoring program. Samples collected at the former hamlet of Rolphton (near the Des Joachims dam) and Deep River are located upstream and downstream respectively of the NPD site. These locations are listed in Table 5-3 and a map showing the locations may be found in [47].

**Table 5-3
Ottawa River Upstream and Downstream Sampling Locations**

Name	Location	Location Code	UTM Easting (m)	UTM Northing (m)
Deep River	Ottawa River, Deep River Water Filtration Plant	ORD	307431	5109106
Des Jochims	Ottawa River, Rolphton (Des Jochims Generating Station)	ORR	291805	5117576

At both sampling stations, river concentrations are less than 0.00004% of the current Maximum Acceptable Concentration (MAC) of $7,000 \text{ Bq}\cdot\text{L}^{-1}$ of tritium in drinking water specified by Health Canada. Based on the data collected, there is no sign of any appreciable ^{137}Cs input to the river from the NPD site since there is no statistically significant differences between the two locations. For the most part the ^{90}Sr concentrations at the two locations are not significantly different [65].

Values for tritium, ^{137}Cs and ^{90}Sr from river water samples collected between 1988 and 2007 are presented in Table 5-4 and were taken from [31], [32], [33], [34], [35], [36], [37], [38], [39], [40] [41], [42], [43], [44], [45], [46], [69].

Table 5-4
Concentrations of Tritium, ¹³⁷Cs, and ⁹⁰Sr in the Ottawa River Upstream and Downstream of NPD

Year	Quarter	Tritium (Bq/L)		¹³⁷ Cs (mBq/L)		⁹⁰ Sr (mBq/L)	
		Deep River	Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims
1988	4	21.0	23.00	<2.0	<4.5	7.0	5.3
1989	1	19.0	14.0	<3.5	<2.1	7.4	8.5
1989	2	7.1	8.1	<3.0	<3.8	2.8	7.4
1989	4	6.2	8.9	<3.5	<0.9	7.4	14.9
1990	1	5.6	6.5	<1.5	<2.1	10.4	10.6
1990	2	7.8	6.6	<2.1	2.8	11.4	12.2
1990	3	5.5	4.3	<2.1	<1.5	15.5	11.9
1990	4	4.4	5.0	<2.2	<1.2	6.9	4.3
1991	1	6.8	6.1	<1.2	<2.3	9.0	6.9
1991	2	6.3	6.6	5.1	4.0	9.3	7.3
1991	3	5.5	5.5	2.7	<4.1	10.4	8.2
1991	4	0.5	4.9	1.8	<2.5	6.8	7.9
1992	1	6.6	4.6	<0.9	<5.7	6.7	9.8
1992	2	4.5	5.8	<4.3	<3.8	7.1	8.1
1992	3	5.2	3.8	3.1	<2.8	7.7	11.3
1992	4	3.9	3.4	<1.3	<2.2	3.1	3.6
1993	1	6.6	4.5	<7.7	5.4	3.9	5.6
1993	2	3.7	4.6	<2.2	<9.9	4.1	9.4
1993	3	9.6	5.4	4.9	<5	10.4	<2.8
1993	4	6.5	5.2	4.5	<3.4	8.7	6.4
1994	1	4.4	4.5	<2.4	2.6	10.3	4.8
1994	2	4.5	4.7	3.8	5.2	4.5	4.7
1994	3	4.8	3.4	<2.7	<2	7.3	6.6
1994	4	5.5	3.9	<3	<2.9	7.4	6.3
1995	1	4.1	2.9	<2.1	<1.4	7.4	7.1
1995	2	5.1	4.3	<2	<2.4	8.9	6.9
1995	3	4.0	2.5	3.6	<1.1	6.6	8
1995	4	4.1	4.5	2.7	2.7	3.5	4.3
1996	1	4.3	3.8	1.7	1.7	5.5	6.3
1996	2	4.6	3.5	2.2	3.8	3.7	5.7
1996	3	4.2	4.1	1.9	1.8	3.3	3.3
1996	4	6.0	5.2	1.9	3.5	4.8	5.1
1997	1	3.5	3.3	2.2	1.9	7.4	6.4
1997	2	3.3	2.2	1.2	2.8	6.4	7.8
1997	3	4.1	3.4	1.3	0.4	8.9	10.7
1997	4	3.8	5.4	1.1	2.8	9.1	11.1
1998	1	3.3	2.8	3.1	<1.62	11.4	7.9
1998	2	3.2	3.6	1.4	1.8	6	5.5

Year	Quarter	Tritium (Bq/L)		137Cs (mBq/L)		90Sr (mBq/L)	
		Deep River	Des Joachims	Deep River	Des Joachims	Deep River	Des Joachims
1998	3	3.9	5.3	1	2.7	2.1	4.3
1998	4	3.2	3.5	<1.26	<1.57	4	1.5
1999	1	3.3	3.4	1.1	3.8	5.7	<21.4
1999	2	3.7	3.6	1.4	2.1	5	<10.3
1999	3	4.4	2.8	5	1.9	3.1	5.5
1999	4	3.4	2.7	1.4	1.3	3.4	7.6
2000	1	3.8	2.8	<1.4	2.9	7.1	10.2
2000	2	3.8	3.4	1.6	5.1	2.3	7.4
2000	3	3.2	2.7	2.7	11.3	3.7	4.6
2000	4	3.7	3.9	<0.8	<1.6	2.6	5.5
2001	1	3.1	4.4	<0.9	<1.8	3.3	4.9
2001	2	3.8	4.0	<1	<2	3.6	4.0
2001	3	4.8	3.7	1.2	4.8	3.7	5.8
2001	4	4.6	5.3	0.8	3.0	3.3	3.7
2002	1	3.2	3.8	1.3	1.2	3.2	4.1
2002	2	3.5	3.6	1.7	1.5	4.7	3.9
2002	3	3.5	2.9	1.4	<1.3	2.5	4.0
2002	4	3.2	3.1	1.8	3.3	<2.4	<2.1
2003	1	3.1	2.9	1.3	0.9	2.8	3.0
2003	2	3.4	3.6	1.6	1.5	7.9	6.5
2003	3	3.1	3.0	1.3	0.7	4.4	5.3
2003	4	3.7	3.3	1.1	0.6	3.3	3.9
2004	1	3.0	2.3	<1.4	<1.1	4.5	3.0
2004	2	3.3	3.3	1.3	1.4	3.2	3.3
2004	3	2.8	2.4	0.9	0.9	4.4	5.7
2004	4	2.5	1.9	1.2	1.0	5.9	7.5
2005	1	3.1	2.8	0.9	0.7	7.7	4.9
2005	2	4.5	3.9	1.1	0.9	8.6	3.5
2005	3	3.2	2.5	0.6	1.3	5.2	3.8
2005	4	2.3	3.4	2.5	<0.6	14.3	6.1
2006	1	<2.5	<2.3	0.7	1.1	4.9	4.9
2006	2	<3.2	<3.3	<0.6	1.2	11	5.2
2006	3	<3.1	<3.0	0.8	1.1	<1.5	5.3
2006	4	<3.5	<3.5	0.8	<0.4	4.2	4.3
2007	1	<3.5	<3.8	<0.5	0.7	2.1	5.5
2007	2	3.7	<3.9	1.0	0.5	4.6	6.2
2007	3	<5.3	<5.2	0.6	0.6	5.4	3.6
2007	4	<5.5	<5.0	<0.3	0.4	2.9	4.2

5.1.3 Sediments

No routine monitoring is currently conducted on sediments. There was a sediment sampling campaign conducted between September 30th and October 2nd 2002 (see Section 5.2 for details).

5.1.4 Aquatic biota

No routine monitoring is currently conducted on aquatic biota. There are data available on aquatic biota ¹³⁷Cs and ¹⁴C measurements taken in fish between 1991 and 1994 (see Section 5.2 for details).

5.1.5 Soil

The ambient tritium concentrations (HTO) in soil samples collected near NPD are part of the monitoring program at NPD. The samples are collected at the same location every year. The off-site locations are shown in Figure 5-1 and the on-site locations in Figure 5-2. The locations are currently sampled once a year in September or October. In addition to measuring HTO, plans are being made to include organically bound tritium (OBT) measurements.

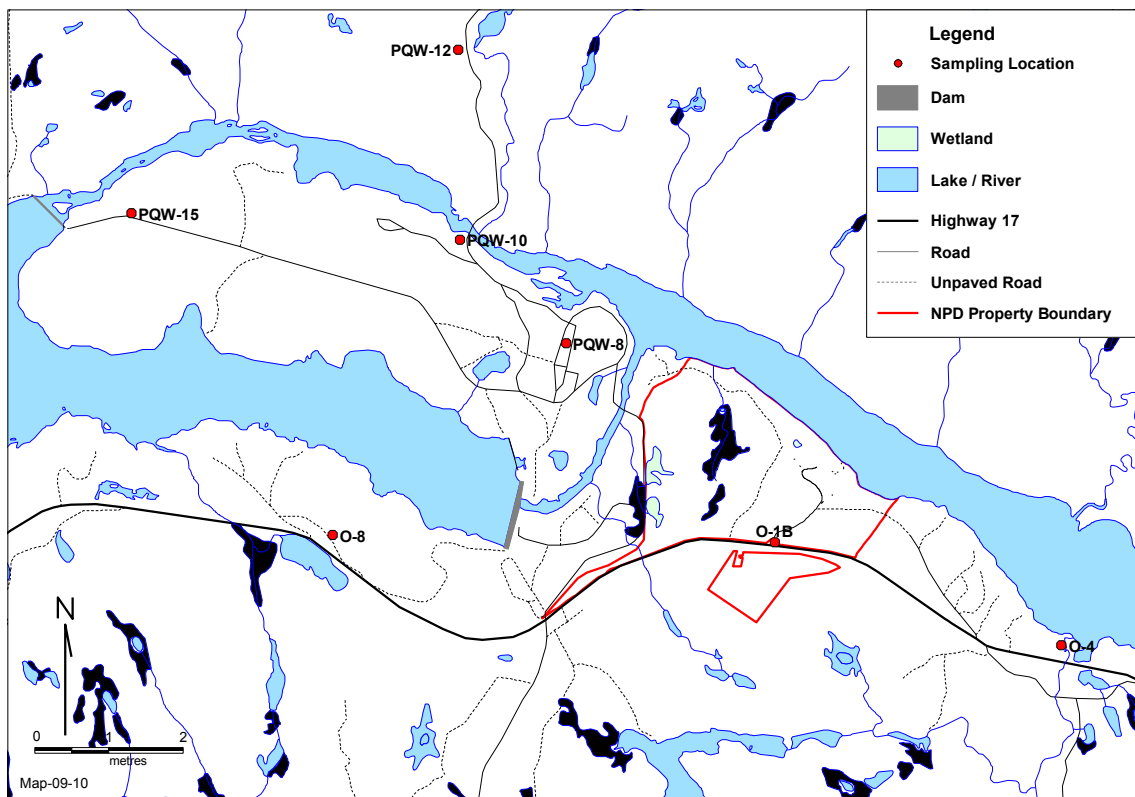


Figure 5-1 Off-site Soil and Vegetation Sampling Locations

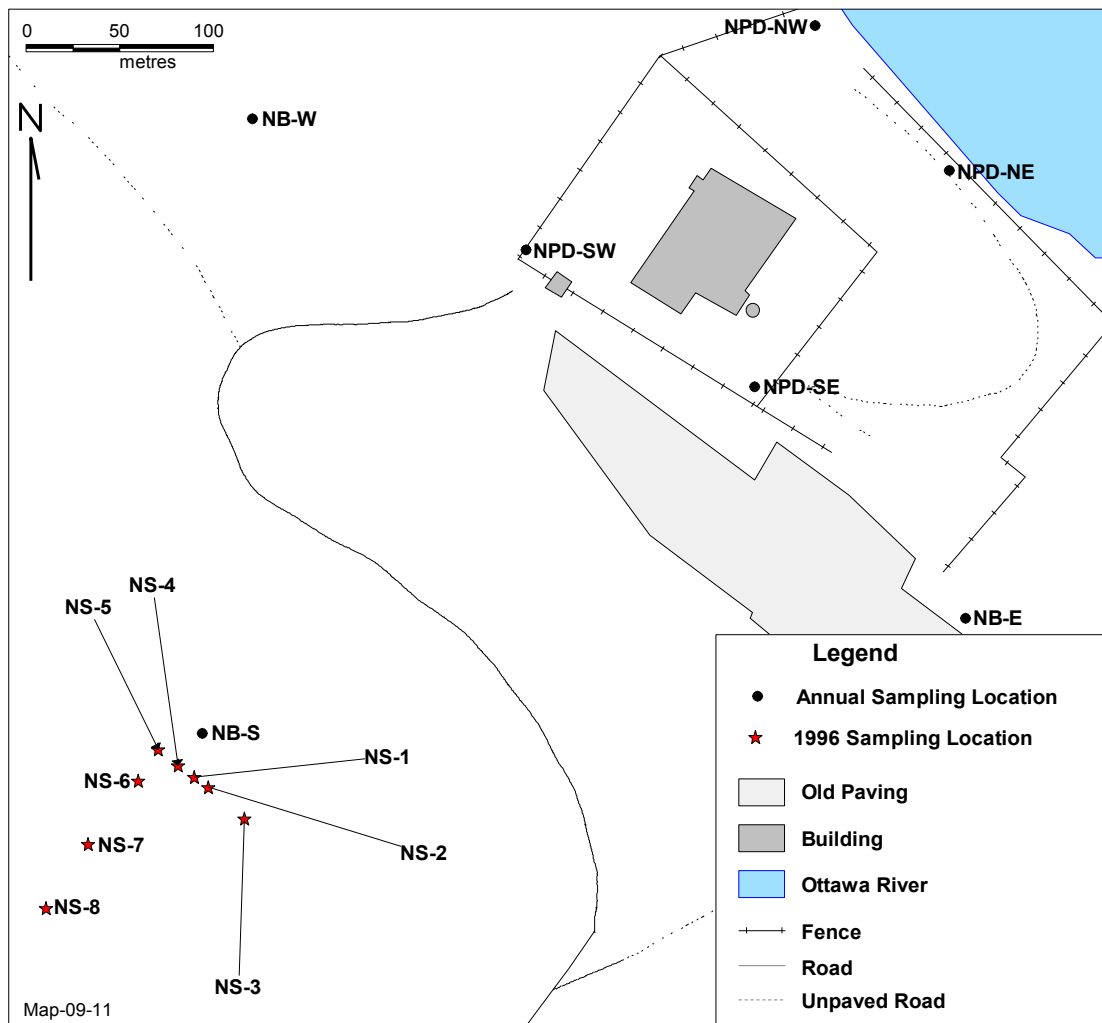


Figure 5-2 On-site Soil and Vegetation Sampling Locations

5.1.5.1 Concentrations of tritium (HTO) in surface soil samples near NPD

Surface soil samples are collected and analyzed annually. The information presented in Table 5-5 was taken from [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46]. The same areas are sampled every year. The same type of soils is, therefore, sampled but the composition can vary between samples. Changes in soil composition do not affect the HTO measurements (as HTO is measured in soil moisture) but could contribute to variations in OBT measurements.

**Table 5-5
Concentrations of Tritium (HTO) in Surface Soil Samples Near NPD (in Bq/L)**

Year	NB-E	NB-S	NB-W	NPD-NE	NPD-NW	NPD-SE	NPD-SW	O-1B	O-4	O-8	PQW-10	PQW-12	PQW-15	PQW-8
1988	NA	NA	NA	NA	NA	NA	NA	36	33	19	70	42	30	105
1990	NA	NA	NA	137	146	104	240	50	20	13	44	16	25	65
1991	NA	NA	NA	110	276	123	76	36	29	12	36	21	32	73
1992	NA	NA	NA	117	43	117	174	30	16	15	18	19	30	35
1993	NA	NA	NA	116	186	188	N/A	34	17	20	28	27	18	48
1994	NA	NA	NA	74	126	53	154	22	125	17	42	27	25	40
1995	NA	NA	NA	156	243	310	186	NA	45	20	N/A	21	15	26
1996	115	76	127	227	103	260	109	39	NA	NA	NA	NA	NA	NA
1997	98	63	121	250	131	96	114	34	NA	NA	NA	NA	NA	NA
1998	65	23	50	85	66	77	97	31	NA	NA	NA	NA	NA	NA
1999	91	61	74	173	200	136	140	39	NA	NA	NA	NA	NA	NA
2000	45	124	123	45	75	168	39	130	NA	NA	NA	NA	NA	NA
2001	34	25	50	103	87	63	63	25	21	NA	NA	NA	NA	NA
2002	58	21	39	59	73	157	49	32	NA	NA	NA	NA	NA	NA
2003	47	63	71	74	67	100	44	86	NA	NA	NA	NA	NA	NA
2004	71	63	87	81	99	84	72	37	NA	NA	NA	NA	NA	NA
2005	37	16	20	39	29	42	25	17	NA	NA	NA	NA	NA	NA
2006	33	26	32	25	34	41	26	16	NA	NA	NA	NA	NA	NA
2007	46	25	36	65	54	77	217	23	NA	NA	NA	NA	NA	NA

Part of the fence that surrounds the licensed area (the station itself) was moved in 1994, so that the NPD-NE and NPD-NW sampling stations are now outside the fence. Sampling was repeated at these locations rather than moving the sampling points to the new fence corners, however, in order to maintain continuity in the data sets. Three new sampling stations were established in 1996 on the west, south, and east sides of the possible new site property perimeter (locations NBW, NBS, and NBE, respectively) [65]. In 1996, the sampling of the far sites (PQW sites and the O-4 and O-8 sites) was discontinued when a reduced scale of off-site sampling was established.

5.1.6 Vegetation

The ambient tritium concentrations (HTO) and organically bound tritium (OBT) in vegetation samples near NPD are part of the monitoring program at NPD. The sampling is conducted at the same locations as for the soil HTO locations (Figure 5-1 and Figure 5-2). The locations are currently sampled once a year in September or October.

5.1.6.1 Concentrations of tritium (HTO) and organically bound tritium (OBT) in vegetation samples near NPD

The data presented in Table 5-6 are from [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46] and in Table 5-7 are from [48], [65], [75], [76], [77]. Care is taken for the type of vegetation to be the same, especially since 1996. As for the soil samples, the sampling takes place in September or October. Soil and vegetation are collected simultaneously.

**Table 5-6
Concentrations of Tritium (HTO) in Vegetation Samples Near NPD (in Bq/L)**

Sample Location & and Usual Species Collected														
Year	NB-E	NB-S	NB-W	NPD-NE	NPD-NW	NPD-SE	NPD-SW	O-1B	O-4	O-8	PQW-10	PQW-12	PQW-15	PQW-8
	Poplar	White Pine	White Birch	Grasses	Grasses	Grasses	Grasses	White Pine	White Pine	White Pine	White Pine	White Pine	White Pine	White Pine
1988	NA	NA	NA	NA	NA	NA	NA	215	68	182	253		51	
1989	NA	NA	NA	NA	NA	NA	NA	44	32	13	65	16	21	79
1990	NA	NA	NA	416	110	1380	266	29	40	9	34	18	16	41
1991	NA	NA	NA	784	309	961	577	70	86	26	67	56	44	90
1992	NA	NA	NA	363	321	2288	896	35	51	20	41	21	23	53
1993	NA	NA	NA	436	115	1779	NA	39	31	14	34	14	21	29
1994	NA	NA	NA	328	361	245	1009	49	51	22*	60	72	63**	58
1995	NA	NA	NA	548	174	796	252	N/A	28	9	N/A	16	20	21
1996	160	665	423	200	54	1117	656	16	NA	NA	NA	NA	NA	NA
1997	256	381	181	1066	207	779	181	54	NA	NA	NA	NA	NA	NA
1998	237	13	25	69	27	628	70	5	NA	NA	NA	NA	NA	NA
1999	63	73	79	444	167	581	191	36	NA	NA	NA	NA	NA	NA
2000	88	198	161	56	54	215	260	74	41	41	41	41	41	41
2001	52	32	99	456	49	52	188	30	66	NA	NA	NA	NA	NA
2002	274	14	27	260	194	260	37	25	NA	NA	NA	NA	NA	NA
2003	41	21	30	94	26	183	41	25	NA	NA	NA	NA	NA	NA
2004	78	109	194	119	106	288	380	77	NA	NA	NA	NA	NA	NA
2005	28	63	76	61	86	87	77	38	NA	NA	NA	NA	NA	NA
2006	23	18	25	27	29	155	55	11	NA	NA	NA	NA	NA	NA
2007	47	50	177	64	63	215	397	55	NA	NA	NA	NA	NA	NA

* Poplar

** Maple

**Table 5-7
Concentrations of Organically Bound Tritium (OBT) in Vegetation Samples Near NPD**

Year	NB-E	NB-S	NB-W	NPD-NE	NPD-NW	NPD-SE	NPD-SW	O-1B	O-4
2000	NA	NA	126	NA	NA	146	NA	NA	48
2001	73	37	111	78	67	129	98	52	43
2002	63	39	78	64	95	77	56	48	NA
2003	60	62	155	70	45	75	54	36	NA
2004	60	62	155	83	71	121	139	59	NA
2005	44	39	64	76	70	67	45	39	NA
2006	46	34	79	61	35	68	43	27	NA

5.2 Specific sampling campaigns (1989-present)

5.2.1 Air

No specific sampling campaigns were conducted during the specified time period.

5.2.2 Water

When AECL took ownership of the NPD site, a site assessment was conducted by MacLarentech Inc. Boreholes MT-1 to MT-10 that were not dry were analyzed for physical and inorganic parameters (Table 5-8), volatile organics (Table 5-9), radiological parameters (Table 5-10) and other contaminants (Table 5-11). Between 1989 and the present, water contamination surveys were conducted near the former Landfills 1 and 2. In addition, surveys were conducted following the leak of an underground fuel storage tank (which presumably occurred at some point between 1990 and 1992). The measurements associated with the surveys were mainly non-radiological.

5.2.2.1 MacLarentech water sampling

Table 5-8 to Table 5-11 summarize the findings of the MacLarentech water survey. Locations can be found on Figure 3-2. The data are from [5].

**Table 5-8
Physical Properties and Inorganic Parameters in Water Samples (MacLarentech Site
Assessment)**

Contaminant	Units	MT-1	MT-2	MT-4	MT-5	MT-8	MH-2
pH		5.8	6.4	7	5.8	6.3	5.7
Conductivity	mS/cm	122	185	273	122	276	188
DOC	mg/L	1.2	3.4	9.6	1.3	12.2	11.8
CN ⁻	mg/L	<0.01	<0.01	0.04	0.05	<0.01	<0.01
NO ₃ + NO ₂	mg/L	0.18	0.3	0.11	0.14	0.15	0.26
TKN	mg/L	0.6	0.22	0.62	0.2	0.07	0.11
Total P	mg/L	1.65	0.35	1.19	4.35	1	0.15
Cl ⁻	mg/L	24	5	33	15	21	37
Fl ⁻	mg/L	0.02	0.8	0.45	0.08	0.05	0.04
HCO ₃ ⁻	mg/L	37	98	94	49	107	61
(SO ₄) ²⁻	mg/L	11	24	28	3	40	14
Al	mg/L	<0.02	<0.02	<0.02	<0.02	0.08	<0.02
Ca	mg/L	4	10	23	9	21	12
Fe	mg/L	0.11	2.5	0.12	1.7	0.06	0.03
K	mg/L	1.6	7.2	4	2	3.3	2.1
Mg	mg/L	1	3	10	33	8	3
Mn	mg/L	0.02	0.08	0.05	0.07	1.2	<0.02
Na	mg/L	26	30	29	12	28	38
Si	mg/L	13	49	8.7	18	13	21
As	mg/L	<0.001	0.001	0.001	<0.001	<0.001	<0.001
Ba	mg/L	<0.02	0.06	<0.02	<0.02	<0.02	<0.02
Cd	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005
Cr	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cr (VI)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	mg/L	<0.02	0.07	<0.02	<0.02	0.02	<0.02
Hg	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mo	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ni	mg/L	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pb	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sb	mg/L	<0.002	<0.002	<0.002	<0.002	0.0042	<0.002
Sn	mg/L	<0.02	<0.02	<0.02		<0.02	<0.02
V	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zn	mg/L	<0.02	0.02	<0.02	<0.02	0.02	0.02

Table 5-9
Volatile Organics in Water Samples (MacLarentech Site Assessment)

Contaminant	Units	MT-1	MT-2	MT-4	MT-5	MT-8	MH-2
1,1,1-Trichloroethane	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
1,1-Dichloroethene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
1,2-Dichlorobenzene	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,3-Dichlorobenzene	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,4-Dichlorobenzene	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acrolein	µg/L	<1	<1	<1	<1	<1	<1
Acrylonitrile	µg/L	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Chlorobromomethane	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chlorodibromomethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroethane	µg/L	<1	<1	<1	<1	<1	<1
Dichloromethane	µg/L	<0.2	0.4	0.3	<0.2	<0.2	<0.2
Methyl Ethyl Ketone	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,2-Dichloroethene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
trans-1,3-Dichloropropene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
1,1,2,2-tetrachloroethane	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
1,1,2-Trichloroethane	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,1-dichloroethane	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dibromomethane	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichloroethane	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-Dichloropropane	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethane	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bromoform	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Bromomethane	µg/L	<1	<1	<1	<1	<1	<1
Carbon Tetrachloride	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chlorobenzene	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloroform	µg/L	<0.1	26	5.9	<0.1	<0.1	<0.1
Chloromethane	µg/L	<1	<1	<1	<1	<1	<1
Cis-1,3-Dichloropropylene	µg/L	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Tetrachloroethene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Trichlorofluoromethane	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vinyl Chloride	µg/L	<1	<1	<1	<1	<1	<1
Benzene	µg/L	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
m&p-Xylene	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o-Xylene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene	µg/L	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Toluene	µg/L	<0.3	0.3	9.5	<0.3	<0.3	<0.3

**Table 5-10
Radiological Parameters in Water Samples (MacLarentech Site Assessment)**

Contaminant	Units	MT-1	MT-4	MT-5	MT-8
Bi-214	Bq/L	<1	<1	<1	<1
K-40	Bq/L	<1	<1	<1	<1
Pb-210	Bq/L	<1	<1	<1	<1
Pb-214	Bq/L	<1	<1	<1	<1
Ra-226	Bq/L	<1	<1	<1	1.9
Th-230	Bq/L	<10	<10	<10	<10
Th-234	Bq/L	1.2	<1	<1	2

**Table 5-11
Other Contaminants in Water Samples (MacLarentech Site Assessment)**

Contaminant	Units	MT-1	MT-2	MT-4	MT-5	MT-8	MH-2
Phenols	µg/L	<1	<1	<1	12	<1	<1
PCBs	µg/L	0.02	ND	ND	ND	ND	ND
Oil and Grease	mg/L	4	2	3	3	1	2
TDS	mg/L	80	130	190	80	190	130

5.2.2.2 Contaminants in groundwater measured in the former Landfills1 and 2

With respect to L1 (see Figure 2-2), the groundwater flow is approximately from highway 17 to the Ottawa River and it is possible that some water passing under this former landfill discharge into the tile drain system around the powerhouse building. L1 is located in a former sand and gravel pit along the main access road to the NPD station (approximately 250 m southwest). Inactive waste produced by the station was placed in the pit and L1 was occasionally used as a burning dump. The pit was later covered with clean fill. Table 5-12 to Table 5-16 report the information collected from water collected from boreholes near L1. The elevated values of total alpha, total beta, and tritium (except for NPD-6 in 1988) were considered to be with the range of values measured at other sites around the reactor at the time. The elevated tritium concentration at NPD-6 was attributed to a possible release from L1 [7]. References [7] and [66] provide a good description of L1 and its history.

L2 is located in a sand and gravel pit northeast of the powerhouse building on the Old Mattawa Road. The pit may predate NPD and additional fill was removed during the construction of the station. Part of the pit was backfilled and may have been used for disposal of blasted rock from the NPD excavation and other miscellaneous construction debris. Table 5-17 reports the information regarding the radiological measurements and phenol measurement in water samples collected in boreholes near L2. Field parameters, anion, and cations are reported in Table 5-18. Information regarding other types of non-radiological contaminants can be found in Tables 5-14 to Table 5-16 [7], [67].

**Table 5-12
Radiological Contaminants and Phenol in Water Samples from L1**

Contaminant	Units	NPD-1	NPD-2		NPD-4	NPD-5-I		NPD-5-II	NPD-6		NPD-7		NPD-8
		27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	21/11/95	27/05/88
Phenol	µg/L	9	5.7	<2.4	4.5	5	<2.4	12.4	5.2	<2.4	7.1	<2.4	4
Total Alpha	Bq/L	0.013	0.017	NA	0.015	ND	NA	0.033	0.014	NA	0.017	NA	0.012
Total Beta	Bq/L	0.0385	ND	<0.005	0.18	0.231	<0.005	0.09	ND	0.006	0.154	<0.005	0.0385
Tritium	Bq/L	367	240	34	337	99	17	357	1030	290	188	33	314

**Table 5-13
Contaminants in Water Samples from L1, Field Parameters, Anions, Cations and Inorganic Parameters**

Contaminant	Units	NPD-1	NPD-2		NPD-4	NPD-5-I		NPD-5-II	NPD-6		NPD-7		NPD-8
		27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	21/11/95	27/05/88
Field Parameters													
pH		6.5	6.19	5.66	6.55	8.2	6.19	6.75	7.18	6.21	7.5	5.95	6.7
Eh	mV	NA	205	380	NA	200	NA	NA	22	NA	2	390	NA
EC	µS/cm	145	190	166	95	260	110	629	436	167	442	140	98
Temp	°C	6	6	3.6	6	6	5.3	6	6	1.4	6	5.5	6
Anions													
Cl	mg/L	24.1	44.8	53.7	11.7	8.3	2.59	45.5	43.8	41.5	73.5	45.6	15.1
F	mg/L	NA	NA	0.19	NA	NA	0.41	NA	NA	0.34	NA	0.19	NA
HCO ₃	mg/L	NA	8.6	25.4	NA	45.5	84.8	NA	69.8	59	59.7	26.6	NA
NO ₃	mg/L	0.75	1.24	1.99	0.75	<0.01	1.08	48.5	1.13	2.27	13	1.38	0.49
PO ₄	mg/L	NA	NA	<0.31	NA	NA	<0.31	NA	NA	0.79	NA	<0.31	NA
SO ₄	mg/L	16.7	9.8	5.84	15.3	33.4	11.4	81.6	42.6	39.9	41.2	11.3	14.9

Contaminant	Units	NPD-1	NPD-2		NPD-4	NPD-5-I		NPD-5-II	NPD-6		NPD-7		NPD-8
		27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	21/11/95	27/05/88
Cations													
Al	mg/L	NA	NA	0.02	NA	NA	0.021	NA	NA	1.34	NA	0.319	NA
Ca	mg/L	5.6	6.5	7.99	3.02	18	14.9	27	33	16.8	30	11.4	4.3
Fe	mg/L	NA	NA	0.065	NA	NA	0.1	NANA	NA	2.29	NA	0.8	NA
K	mg/L	3.1	1.98	1.97	2.6	8.22	6.74	6.25	6.58	4.52	8.12	2.9	2.21
Mg	mg/L	2.2	2.21	3.18	0.82	3.54	1.72	7.66	11.5	6.68	12.9	4.81	0.28
Mn	mg/L	0.1	<0.05	<0.01	<0.05	0.06	0.036	0.62	0.49	0.606	1.35	0.49	<0.05
Na	mg/L	14	22	28.3	12	23	16	78	27	19.9	28	19.6	9
Si	mg/L	NA	NA	4.98	NA	NA	7.36	NA	NA	7.2	NA	7	NA
Inorganics													
Ag	µg/L	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
As	µg/L	<0.1	5.8	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<1
B	µg/L	NA	NA	<10	NA	NA	<10	NA	NA	98	NA	<10	NA
Ba	µg/L	<1000	<1000	22	<1000	<1000	47	<1000	<1000	189	<1000	107	<1000
Be	µg/L	NA	NA	<5	NA	NA	<5	NA	NA	<5	NA	<5	NA
Bi	µg/L	NA	NA	<50	NA	NA	<50	NA	NA	<50	NA	<50	NA
Cd	µg/L	0.3	0.4	2.2	0.1	0.1	0.1	0.7	0.5	1.4	0.4	0.03	0.4
Co	µg/L	NA	NA	<10	NA	NA	<10	NA	NA	<10	NA	<10	NA
Cr	µg/L	<100	<100	<10	<100	<100	<10	<100	<100	<10	<100	<10	<100
Cu	µg/L	6	4	<10	10	2	<10	10	14	48	7	<10	5
Ga	µg/L	NA	NA	<50	NA	NA	<50	NA	NA	<50	NA	<50	NA
Hg	µg/L	NA	NA	<0.1	NA	NA	<0.1	NA	NA	<0.1	NA	<0.1	NA
Li	µg/L	NA	NA	<5	NA	NA	9	NA	NA	<5	NA	<5	NA
Mo	µg/L	NA	NA	<20	NA	NA	51	NA	NA	<20	NA	<20	NA
Nb	µg/L	NA	NA	<20	NA	NA	<20	NA	NA	<20	NA	<20	NA
Ni	µg/L	<50	<50	1.1	<50	<50	7.5	<50	<50	14.6	<50	27.2	<50
P	µg/L	NA	NA	<100	NA	NA	<100	NA	NA	257	NA	<100	NA

Contaminant	Units	NPD-1	NPD-2		NPD-4	NPD-5-I		NPD-5-II	NPD-6		NPD-7		NPD-8
		27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	27/05/88	21/11/95	27/05/88	21/11/95	27/05/88
Pb	µg/L	<2	<2	<100	<2	<2	<100	<2	<2	<100	<2	<100	<2
Sb	µg/L	NA	NA	<1	NA	NA	2	NA	NA	2	NA	2	NA
Se	µg/L	<1	<1	NA	<1	<1	NA	<1	<1	NA	<1	NA	<1
Sn	µg/L	NA	NA	<200	NA	NA	<200	NA	NA	<200	NA	<200	NA
Sr	µg/L	NA	NA	73	NA	NA	210	NA	NA	124	NA	84	NA
Ti	µg/L	NA	NA	<10	NA	NA	<10	NA	NA	78	NA	44	NA
U	µg/L	NA	NA	<1	NA	NA	<1	NA	NA	<1	NA	<1	NA
V	µg/L	NA	NA	<10	NA	NA	<10	NA	NA	<10	NA	<10	NA
W	µg/L	NA	NA	<50	NA	NA	<50	NA	NA	<50	NA	<50	NA
Y	µg/L	NA	NA	<5	NA	NA	<5	NA	NA	10	NA	<5	NA
Zn	µg/L	20	<20	21	40	60	<10	<20	<20	46	<20	<10	<20
Zr	µg/L	NA	NA	<10	NA	NA	<10	NA	NA	<10	NA	<10	NA

Table 5-14
Halogenated and Non-halogenated Volatile Organics in Water Samples L1 and L2

Contaminant	Units	NPD-2	NPD-5-I	NPD-6	NPD-7	NPD-9	NPD-14
		21/11/1995	21/11/1995	21/11/1995	21/11/1995	17/12/96	17/12/96
1,1,2,2-Tetrachloroethane	µg/L	<4.3	<4.3	<4.3	<4.3	<0.8	<0.8
1,1,2-Trichloroethane	µg/L	<0.6	<0.6	<0.6	<0.6	<0.7	<0.7
1,1-Dichloroethane	µg/L	<0.8	<0.8	<0.8	<0.8	<0.3	<0.3
1,1-Dichloroethylene	µg/L	<2.8	<2.8	<2.8	<2.8	<0.3	<0.3
1,2-Dibromomethane	µg/L	<1	<1	<1	<1	<0.2	<0.2
1,2-Dichloroethane	µg/L	<0.8	<0.8	<0.8	<0.8	<0.5	<0.5
1,2-Dichloropropane	µg/L	<0.9	<0.9	<0.9	<0.9	<0.5	<0.5

Contaminant	Units	NPD-2	NPD-5-I	NPD-6	NPD-7	NPD-9	NPD-14
		21/11/1995	21/11/1995	21/11/1995	21/11/1995	17/12/96	17/12/96
Bromodichloromethane	µg/L	<0.8	<0.8	<0.8	<0.8	<0.3	<0.3
Bromoform	µg/L	<3.7	<3.7	<3.7	<3.7	<0.4	<0.4
Bromomethane	µg/L	<3.7	<3.7	<3.7	<3.7	<0.4	<0.4
Carbon Tetrachloride	µg/L	<1.4	<1.4	<1.4	<1.4	<0.5	<0.5
Chlorobenzene	µg/L	<0.7	<0.7	<0.7	<0.7	<0.2	<0.2
Chloroform	µg/L	<0.7	<0.7	<0.7	<0.7	<0.4	<0.4
Chloromethane	µg/L	<3.7	<3.7	<3.7	<3.7	<0.7	<0.7
Cis-1,3-Dichloropropylene	µg/L	<1.4	<1.4	<1.4	<1.4	<0.5	<0.5
Dibromochloromethane	µg/L	<1.1	<1.1	<1.1	<1.1	<0.2	<0.2
m-Dichlorobenzene	µg/L	<1.1	<1.1	<1.1	<1.1	<0.4	<0.4
Methylene Chloride	µg/L	<1.3	<1.3	<1.3	<1.3	<0.4	<0.4
o-Dichlorobenzene	µg/L	<1.4	<1.4	<1.4	<1.4	<0.3	<0.3
p-Dichlorobenzene	µg/L	<1.7	<1.7	<1.7	<1.7	<0.5	<0.5
Tetrachloroethene	µg/L	<1.1	<1.1	<1.1	<1.1	<0.4	<0.4
Trans-1,2-Dichloroethylene	µg/L	<1.4	<1.4	<1.4	<1.4	<0.4	<0.4
Trans-1,3-Dichloropropylene	µg/L	<1.4	<1.4	<1.4	<1.4	<0.8	<0.8
Trichloroethene	µg/L	<1.9	<1.9	<1.9	<1.9	<0.3	<0.3
Trichlorofluoromethane	µg/L	<1	<1	<1	<1	<0.6	<0.6
Vinyl Chloride	µg/L	<4	<4	<4	<4	<0.6	<0.6
Benzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Ethylbenzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.3	<0.3
m&p-Xylene	µg/L	<1	<1	<1	<1	<0.4	<0.4
o-Xylene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Styrene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.3	<0.3
Toluene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.6	<0.6

Table 5-15
Base Neutral Extractable Organics in Water Samples from L1 and L2

Contaminant	Units	NPD-2	NPD-5-I	NPD-6	NPD-7	NPD-9	NPD-14
		21/11/1995	21/11/1995	21/11/1995	21/11/1995	17/12/1996	17/12/1996
1-Chloronaphthalene	µg/L	<2.5	<2.5	<2.5	<2.5	<1.4	<1.4
1-Methylnaphthalene	µg/L	<3.2	<3.2	<3.2	<3.2	<1.4	<1.4
2,4-Dinitrotoluene	µg/L	<0.8	<0.8	<0.8	<0.8	<0.6	<0.6
2,6-Dinitrotoluene	µg/L	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
2-Chloronaphthalene	µg/L	<1.7	<1.7	<1.7	<1.7	<0.8	<0.8
2-Methylnaphthalene	µg/L	<2.2	<2.2	<2.2	<2.2	<1.2	<1.2
4-Bromophenyl phenyl ether	µg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
4-Chlorophenyl phenyl ether	µg/L	<0.9	<0.9	<0.9	<0.9	<0.7	<0.7
5-Nitro acenaphthene	µg/L	<4.3	<4.3	<4.3	<4.3	<1.4	<1.4
Acenaphthene	µg/L	<1.3	<1.3	<1.3	<1.3	<1.2	<1.2
Acenaphthylene	µg/L	<1.4	<1.4	<1.4	<1.4	<1.3	<1.3
Anthracene	µg/L	<1.2	<1.2	<1.2	<1.2	<0.4	<0.4
Benzo(a)anthracene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.4	<0.4
Benzo(a)pyrene	µg/L	<0.6	<0.6	<0.6	<0.6	<0.4	<0.4
Benzo(b)fluoranthene	µg/L	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
Benzo(k)fluoranthene	µg/L	<0.7	<0.7	<0.7	<0.7	<1.0	<1.0
Benzo(g,h,l)perylene	µg/L	<0.7	<0.7	<0.7	<0.7	<0.4	<0.4
Benzyl butyl phthalate	µg/L	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Biphenyl	µg/L	<0.6	<0.6	<0.6	<0.6	<0.5	<0.5
Bis(2-chloroethoxy)methane	µg/L	<3.5	<3.5	<3.5	<3.5	<3.0	<3.0
Bis(2-chloroethyl)ether	µg/L	<4.4	<4.4	<4.4	<4.4	<0.6	<0.6
Bis(2-chloroisopropyl)ether	µg/L	<2.2	<2.2	<2.2	<2.2	<0.7	<0.7

Contaminant	Units	NPD-2	NPD-5-I	NPD-6	NPD-7	NPD-9	NPD-14
		21/11/1995	21/11/1995	21/11/1995	21/11/1995	17/12/1996	17/12/1996
Bis(2-ethylhexyl)phthalate	µg/L	<2.2	<2.2	<2.2	<2.2	<2.0	<2.0
Camphene	µg/L	<3.5	<3.5	<3.5	<3.5	<1.3	<1.3
Chrysene	µg/L	<0.3	<0.3	<0.3	<0.3	<0.4	<0.4
Dibenz(a,h)anthracene	µg/L	<1.3	<1.3	<1.3	<1.3	<0.3	<0.3
Di-n-butyl phthalate	µg/L	<3.8	<3.8	<3.8	<3.8	<3.0	<3.0
Di-n-octyloctylphalate	µg/L	<2	<2	<2	<2	NA	NA
Diphenyl ether	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Diphenylamine	µg/L	<14	<14	<14	<14	<4.0	<4.0
Fluoranthene	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Fluorene	µg/L	<1.4	<1.4	<1.4	<1.4	<0.8	<0.8
Indeno(1,2,3-c,d)pyrene	µg/L	<1.3	<1.3	<1.3	<1.3	<0.4	<0.4
Indole	µg/L	<1.9	<1.9	<1.9	<1.9	<1.4	<1.4
Naphthalene	µg/L	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
N-Nitroso-di-n-propylamine	µg/L	<3.1	<3.1	<3.1	<3.1	<3.0	<3.0
N-Nitrosodiphenylamine	µg/L	<14	<14	<14	<14	<3.0	<3.0
Perylene	µg/L	<1.5	<1.5	<1.5	<1.5	<0.5	<0.5
Phenanthrene	µg/L	<0.4	<0.4	<0.4	<0.4	<0.6	<0.6
Pyrene	µg/L	<0.4	<0.4	<0.4	<0.4	<0.6	<0.6

**Table 5-16
Acid Extractable Organics and PCBs in Water Samples from L1 and L2**

Contaminant	Units	NPD-2	NPD-5-I	NPD-6	NPD-7	NPD-9	NPD-14
		21/11/1995	21/11/1995	21/11/1995	21/11/1995	17/12/1996	17/12/1996
2,3,4,5-Tetrachlorophenol	µg/L	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
2,3,4,6-Tetrachlorophenol	µg/L	<2.6	<2.6	<2.6	<2.6	<3.0	<3.0
2,3,4-Trichlorophenol	µg/L	<0.6	<0.6	<0.6	<0.6	<0.4	<0.4
2,3,5,6-Tetrachlorophenol	µg/L	<1.6	<1.6	<1.6	<1.6	<0.7	<0.7
2,3,5-Trichlorophenol	µg/L	<1.3	<1.3	<1.3	<1.3	<1.1	<1.1
2,4,5-Trichlorophenol	µg/L	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
2,4,6-Trichlorophenol	µg/L	<1.3	<1.3	<1.3	<1.3	<0.6	<0.6
2,4-Dichlorophenol	µg/L	<1.7	<1.7	<1.7	<1.7	<1.2	<1.2
2,4-Dimethylphenol	µg/L	<7.3	<7.3	<7.3	<7.3	<3.0	<3.0
2,4-Dinitrophenol	µg/L	<42	<42	<42	<42	<4.0	<4.0
2,6-Dichlorophenol	µg/L	<2	<2	<2	<2	<1.4	<1.4
2-Chlorophenol	µg/L	<3.7	<3.7	<3.7	<3.7	<1.5	<1.5
4,6-Dnitro-o-cresol	µg/L	<24	<24	<24	<24	<2.0	<2.0
4-Chloro-3-cresol	µg/L	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
4-Nitrophenol	µg/L	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
m-Cresol	µg/L	<3.4	<3.4	<3.4	<3.4	<4.0	<4.0
o-Cresol	µg/L	<3.7	<3.7	<3.7	<3.7	<1.7	<1.7
p-Cresol	µg/L	<3.5	<3.5	<3.5	<3.5	<3.0	<3.0
Pentachlorophenol	µg/L	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Total PCBs	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Table 5-17
Radiological Contaminants and Phenol in Water Samples from L2

Contaminant	Units	NPD-9		NPD-10	NPD-11	NPD-12	NPD-13	NPD-14	
		12/04/1989	17/12/1996	12/04/1989	12/04/1989	12/04/1989	12/04/1989	12/04/1989	17/12/1996
Phenol	µg/L	NA	<0.9	NA	NA	NA	NA	NA	<0.9
Total Alpha	Bq/L	0.002	<0.032	<0.001	0.002	0.001	0.001	0.004	0.036
Total Beta	Bq/L	0.414	0.15	0.105	0.107	0.129	0.162	0.339	0.34
Tritium	Bq/L	845	NA	674	505	729	274	475	NA

Table 5-18
Field Parameters, Anions and Cations in Water Samples from L2

Contaminant	Units	NPD-9	NPD-10	NPD-11	NPD-12	NPD-13	NPD-14
		12/04/1989	12/04/1989	12/04/1989	12/04/1989	12/04/1989	12/04/1989
Field Parameters							
pH		6.65	6.2	6.7	6.35	6.75	6.95
EC	umhos		38	57	68	48	210
Eh	mV	210	530	490	385	560	200
Anions							
Cl	mg/L	7.6	2	2.9	2.7	2.7	22
HCO3	mg/L	64.9	23.7	40.2	46	32.2	139.4
NO3	mg/L	0.9	0.2	0	4.9	0.2	2.8
SO4	mg/L	19.9	10.9	13	13.3	10	12.1
Cations							
Ca	mg/L	16	6.6	10	11.4	7.9	21.7
Fe	mg/L	0.69	0.04	0.05	0.15	0.76	0.43
K	mg/L	3.2	1.4	2.7	2.8	2.7	9
Mg	mg/L	5	1.9	2.6	2.5	2.1	2.8
Mn	mg/L	0.24	0.19	0.16	0.72	0.28	0.89
Na	mg/L	11.52	2.34	4.86	5.67	2.07	27.9
DOC	mg/L	8	<1	2	2	1	17

5.2.2.3 Contamination related to the underground fuel storage facility leak

Following the leak of one of the underground fuel storage tanks, a number of measurements related to soil and water contaminations were obtained. It should be noted that no significant hydrocarbons were detected at this site by MacLarentech in 1990, suggesting that the leak appeared at some point between 1990 and the time of excavation (1992). Additional information about the preliminary site characterization and environmental assessment for the site of an underground fuel storage tank (maximum volume of 4500 litres of diesel fuel) adjacent to the reactor building is available. Most of the information presented here can be found in [14], [15].

Contaminated soils were encountered in 1992 at the base of the excavation during removal of the tank and the excavating company submitted soil samples for analysis (see Section 5.2 for information). The data obtained can be found in Table 5-32. As there was an existing drainage pipe running south to north located below the underside of the concrete base slab for the storage tank (~6 m below grade and 450 mm in diameter corrugated steel pipe) and because the pipe detours an underground spring fed stream away from the building with effluent fed directly into the Ottawa River, two water samples were taken and analyzed for phenols (Table 5-19) and petroleum products (Table 5-20 to Table 5-23).

Table 5-19
Phenol Measurements in Water (1993)

Location	Date	Concentration	Units
MW-3	02-Feb-93	<0.002	mg/L
Ottawa River Pump House	12-Jan-93	<0.002	mg/L

Regular groundwater monitoring by Paterson group (formerly John D. Paterson and Associates Limited) for petroleum products in boreholes, manholes, and two locations in the Ottawa River (One location called OR40 is approximately 40 m upstream and the other location called OR100 is approximately 100 m downstream of the former pump house) has continued from 1993 to the present [14], [16], [17], [15], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]. Results for 1993 to 1997 were reported for total petroleum hydrocarbons (TPH) and are shown in Table 5-20 along with the type of sample collected (purged or stagnant) for MT-8 and RW-1, the only locations for which this information was available. Results from 2000 to 2004 were reported for total petroleum hydrocarbons (TPH) separately in diesel and gasoline. TPH in gasoline was never detected, the detection limit being 100 µg/L until 2002 and 200 µg/L thereafter. Values for TPH in gasoline from 2000 to 2004 are shown in Table 5-21. Table 5-22 gives the locations examined and the type of sample collected (if water was available) for petroleum products from 2005 to the present. The results, reported as petroleum hydrocarbon (PHC) fractions F1 to F4, are given in Table 5-23 only for those samples where petroleum products were detectable. Petroleum products were not detectable in all other samples. The detection limit for F1 was 200 µg/L and for fractions F2 to F4 it was 100 µg/L.

**Table 5-20
Total Petroleum Hydrocarbons (µg/L) Measurements in Water (Monitoring 1993-1997)**

Date	TPH (µg/L)											
	WAS	MW-3	MT-8		Excavation Base	OR-40	OR-100	OR-DJ	OR-PH	RW-1		ST-6
05-Jan-93	NA	1940	NA		162	NA	NA	NA	NA	NA		NA
06-Jan-93	NA	NA	NA		NA	NA	NA	NA	110	NA		NA
19-Jan-93	2600	NA	200 <200	S P	NA	<200	<200	<200	NA	NA		NA
20-Apr-93	NA	NA	190 <50	S P	NA	NA	NA	NA	NA	110000	S	4180
27-Apr-94	NA	NA	200 <200	S P	NA	<200	<200	NA	NA	700	S	NA
21-Jun-95	NA	NA	<200 <200	P S	NA	<200	<200	NA	NA	96900	S	60700
07-Aug-95	NA	NA	NA		NA	NA	NA	NA	NA	37500 8800 8000	P+30 P+60 P+90	NA
26-Jun-96	NA	NA	<200 <200	P S	NA	<200	<200	NA	NA	6600 <200 <200	P+30 P+60 P+90	<200
05-Aug-97	NA	NA	<200 <200	P S	NA	<200	<200	NA	NA	2900 1200 <200	P+30 P+60 P+90	4400

P: purged

S: Stagnant

P+nn: number of minutes after purge

**Table 5-21
TPH in Diesel (µg/L) Measured in Water (Monitoring 2000-2004)**

Location Code	Sample Type	2000/06/15	2001/05/14	2001/11/13	2001/11/14	2001/11/19	2001/11/20	2001/11/21	2002/06/18	2003/05/27	2003/09/22	2004/04/22	2004/10/19
BH6-01	Purged	NA	NA	<100	NA	NA	NA	NA	100	Dry	Dry	<100	Dry
BH7-01	Purged	NA	NA	NA	NA	NA	<100	NA	<100	100	<100	<100	Dry
BH8-01	Purged	NA	NA	NA	NA	NA	<100	NA	<100	Dry	Dry	<100	Dry
BH9-01	Purged	NA	NA	NA	NA	NA	<100	NA	<100	<100	<100	<100	Dry
BH10-01	Purged	NA	NA	NA	NA	NA	300	NA	<100	Dry	Dry	<100	Dry
BH11-01	Purged	NA	NA	NA	NA	NA	NA	4400	<100	Dry	Dry	<100	Dry
BH12-01	Purged	NA	NA	NA	NA	NA	NA	<100	Dry	<100	<100	<100	<100
BH13-01	Purged	NA	NA	NA	NA	NA	NA	<100	<100	<100	<100	<100	<100
BH14-01	Purged	NA	NA	NA	NA	NA	NA	NA	Dry	<100	Dry	<100	Dry
BH15-01	Purged	NA	NA	NA	NA	NA	NA	NA	Dry	Dry	Dry	Dry	Dry
BH16-01	Purged	NA	NA	NA	NA	NA	NA	NA	10100	Dry	1300	<100	Dry
MH-2	NA	NA	NA	NA	NA	NA	NA	NA	<100	<100	NA	NA	NA
MH-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	<100	NA	NA	NA
MT-5	Purged	NA	NA	NA	NA	NA	NA	NA	<100	<100	<100	<100	<100
MT-8	Purged	<100	<100	NA	NA	NA	NA	NA	<100	<100	<100	<100	<100
MT-9	Purged	NA	NA	NA	NA	NA	NA	NA	<100	<100	500	<100	<100
OR-100	River	<100	<100	NA	NA	NA	NA	NA	<100	<100	<100	<100	<100
OR-40	River	<100	<100	NA	NA	NA	NA	NA	<100	<100	<100	<100	<100
RW-1	Purged	3600 ^a	6400 ^s	1400	6200	1100	800	600	1200	<100	300 ^b	400 ^s	Dry
RW-2	Stagnant	NA	NA	NA	NA	NA	NA	NA	<100	<100	<100	<100	400
ST-6	Stagnant	5400	23000	NA	NA	NA	NA	NA	6500	NA	NA	NA	NA

^s Stagnant sample

^a 3300 µg/L 30 minutes after purge and 1500 µg/L 60 minutes after purge

^b table value is 30 minutes after purge; 300 µg/L 65 minutes after purge and 200 µg/L 95 minutes after purge

Table 5-22
Water Samples Collected and Analysed for Petroleum Products (Monitoring 2005-Present)

Grey cells indicate samples with detectable petroleum products (values in Table 5-23).

Location Code	2005/05/06	2005/10/17	2006/04/28	2006/10/11	2007/05/17	2007/10/24	2008/05/22	2008/10/16
BH10-01	Purged	Dry	Stagnant	Dry	Dry	Dry	Stagnant	Dry
BH11-01	Dry	Dry	Stagnant	Stagnant	Dry	Dry	Dry	Dry
BH12-01	Purged	Purged	Purged	Purged	Purged	Purged	Purged	Purged
BH13-01	Purged	Purged	Purged	Purged	Purged	Purged	Purged	Purged
BH14-01	Stagnant	Dry	Purged	Dry	Dry	Dry	Dry	Dry
BH15-01	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
BH16-01	Stagnant	Dry	Stagnant	Stagnant	Dry	Dry	Dry	Dry
BH6-01	Dry	Dry	Stagnant	Dry	Dry	Dry	Dry	Dry
BH7-01	Purged	Stagnant	Purged	Purged	Stagnant	Dry	Purged	Dry
BH8-01	Purged	Dry	Purged	Purged	Dry	Dry	Purged	Dry
BH9-01	Purged	Dry	Purged	Purged	Purged	Dry	Purged	Dry
MT-5	Purged	Purged	Purged	Purged	Purged	Purged	Purged	Purged
MT-8	Purged	Purged	Purged	Purged	Purged	Purged	Purged	Purged
MT-9	Purged	Purged	Purged	Purged	Purged	Purged	Dry	Purged
OR-100	River	River	River	River	River	River	River	River
OR-40	River	River	River	River	River	River	River	River
RW-1	Stagnant	Stagnant	Stagnant	Stagnant	Stagnant*	Dry	Purged	Stagnant
RW-2	Stagnant	Stagnant	Stagnant	Stagnant	Stagnant	Dry	Purged	Stagnant

* little water available so only F1 analysis performed

Coloured cells indicate petroleum products detected

Table 5-23
Results for Samples with Detectable Petroleum Products in Water (Monitoring 2005-Present)

Location Code	Date	Sample Type	F1 PHCs (C6-C10) (µg/L)	F2 PHCs (C10-C16) (µg/L)	F3 PHCs (C16-C34) (µg/L)	F4 PHCs (C34-C50) (µg/L)
BH13-01	11-Oct-06	Purged	<200	<100	200	<100
MT-8	17-Oct-05	Purged	<200	<100	200	200
MT-9	28-Apr-06	Purged	<200	100	100	<100
RW-1	28-Apr-06	Stagnant	<200	<100	200	<100
RW-1	11-Oct-06	Stagnant	<200	200	300	<100
RW-2	11-Oct-06	Stagnant	<200	200	300	<100

5.2.2.4 CH2M HILL water sampling (2002)

Some work has been done on water samples in 2002. However, no report has been issued regarding this work. Some of the data obtained, taken from a draft report prepared for AECL by CH2M HILL in 2003, can be found in the database associated with this document. The data should be interpreted with caution.

5.2.3 Sediments

5.2.3.1 CH2M HILL sediment sampling (2002)

Some work has been done on sediment samples in 2002. However, no report has been issued regarding this work. Some of the data obtained, taken from a draft report prepared for AECL by CH2M HILL in 2003, can be found in the database associated with this document. The data should be interpreted with caution especially since the sampling technique used was not appropriate for the intent of the study.

5.2.4 Aquatic biota

5.2.4.1 Cs-137 and C-14 in Ottawa River fish after station shutdown

The fish sampling program was conducted between 1991 to 1994. The data presented were obtained from [69], [70], [71], [72], [73], [74]. No appreciable difference was found for fish collected up and down stream of NPD. The program review in 1995 concluded that fish sampling and analysis should be dropped from the routine monitoring program, but would be reinstated if other release or river water data indicated a need. Therefore, aquatic biota has not been sampled since 1994.

The data obtained for ^{137}Cs are presented in Table 5-24 and the data obtained for ^{14}C are presented in

Table 5-25.

Table 5-24
¹³⁷Cs in Ottawa River Fish After Station Shutdown

Year	Species	¹³⁷ Cs Concentration (Bq/kg wet weight)	
		Above Dam	NPD Outfall
1991	Sucker	NA	3.4
1991	Walleye	NA	46.2
1991	Whitefish	NA	5.5
1992	Bass	NA	12.3
1992	Bass/Perch	15.7	NA
1992	Perch	NA	12.8
1992	Pike	8.9	22
1993	Bass/Perch	26.3	NA
1993	Walleye	37	25.5
1993	Whitefish	NA	17.2
1994	Pike	NA	15.3
1994	Walleye	14	21.9

Table 5-25
¹⁴C in Ottawa River Fish After Station Shutdown

Year	Species	¹⁴ C Concentration (Bq/kg wet weight)	
		Above Dam	NPD Outfall
1991	Sucker	NA	275
1991	Walleye	NA	230
1991	Whitefish	NA	255
1992	Bass	NA	220
1992	Bass/Perch	226	NA
1992	Perch	NA	234
1992	Pike	234	231
1993	Walleye	NA	256
1993	Whitefish	NA	261
1994	Pike	NA	255
1994	Walleye	NA	251

5.2.5 Soil

A few soil-sampling campaigns were conducted between 1989 and 2008. One of which was the initial site assessment that was conducted by MacLarentech Inc [5]. Another soil sampling campaign was conducted when the survey was done to establish a new perimeter to the NPD properties [53]. The leak of one of the underground fuel storage tanks (that likely happened

between 1990 and 1992) also warranted some analysis [14]. The data collected are summarized in this Section.

5.2.5.1 MacLarentech soil sampling

Soil samples collected from Boreholes MT-1 to MT-10 when they were drilled were analyzed for physical parameters, metals, oil and grease, and PCBs (Table 5-26), volatile organics (Table 5-27) and extractable organics (Table 5-28).

**Table 5-26
Physical Properties, Metals, Oil and Grease and PCBs (MacLarentech site assessment soil samples collected from boreholes about January 1990)**

Parameter	Units	MT-1	MT-10	MT-2	MT-3	MT-4	MT-5	MT-7	MT-9
pH		5.7	6.3	6.5	4.6	NA	7.7	7.7	6.6
Conductivity	mS/cm	0.068	0.175	0.051	0.121	NA	0.127	0.115	0.123
SAR		0.18	0.24	0.59	0.18	NA	0.36	0.6	1.2
TKN	%	0.18	0.24	0.59	0.18	NA	0.36	0.6	1.2
Ag	mg/kg	<2	<2	<2	<2	NA	<2	<2	<2
As	mg/kg	<0.1	<0.1	<0.1	2	NA	<0.1	0.3	<0.1
Ba	mg/kg	110	85	95	200	NA	70	200	150
Be	mg/kg	<1	<1	<1	<1	NA	<1	<1	<1
Cd	mg/kg	<1	<1	<1	<1	NA	<1	<1	<1
Co	mg/kg	4	7	6	10	NA	10	10	10
Cr	mg/kg	9	20	15	25	NA	9	30	25
Cr (VI)	mg/kg	<0.1	<0.1	<0.1	<0.1	NA	<0.1	<0.1	<0.1
Cu	mg/kg	15	50	25	25	NA	220	60	50
Hg	mg/kg	0.07	0.17	0.04	0.23	NA	0.07	0.04	0.08
Mo	mg/kg	3	3	NA	4	NA	NA	3	4
Ni	mg/kg	6	25	10	10	NA	20	20	20
Pb	mg/kg	<2	7	<2	30	NA	3	40	10
Sb	mg/kg	<1	<1	<1	<1	NA	<1	<1	<1
Se	mg/kg	<0.2	<0.2	<0.2	<0.2	NA	<0.2	<0.2	<0.2
V	mg/kg	60	30	20	50	NA	15	40	55
Zn	mg/kg	75	60	35	100	NA	170	110	70
Oil and Grease	%	0.107	0.119	0.09	0.142	NA	0.106	0.102	0.123
PCBs	mg/kg	NA	<0.005	<0.005	<0.005	<0.005	<0.005	NA	<0.005

Table 5-27
Volatile Organic Parameters

(MacLarentech site assessment samples collected from boreholes about January 1990)

Parameter	Units	MT-1	MT-10	MT-3	MT-4	MT-5	MT-9
		15/12/1989	19/12/1989	15/12/1989	19/12/1989	16/12/1989	20/12/1989
1,1,1-Trichloroethane	µg/kg	<8	<8	<8	<8	<8	<8
1,1-Dichloroethene	µg/kg	<8	<8	<8	<8	<8	<8
1,2-Dichlorobenzene	µg/kg	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	µg/kg	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	µg/kg	<5	<5	<5	<5	<5	<5
Acrolein	µg/kg	<25	<25	<25	<25	<25	<25
Acrylonitrile	µg/kg	<20	<20	<20	<20	<20	<20
Chlorobromomethane	µg/kg	<8	<8	<8	<8	<8	<8
Chlorodibromomethane	µg/kg	<10	<10	<10	<10	<10	<10
Chloroethane	µg/kg	<25	<25	<25	<25	<25	<25
Dichloromethane	µg/kg	50	50	120	100	110	80
Methyl Ethyl Ketone	µg/kg	<3	<3	<3	<3	<3	<3
trans-1,2-Dichloroethene	µg/kg	<8	<8	<8	<8	<8	<8
trans-1,3-Dichloropropene	µg/kg	<8	<8	<8	<8	<8	<8
1,1,2,2-tetrachloroethane	µg/kg	<8	<8	<8	<8	<8	<8
1,1,2-Trichloroethane	µg/kg	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	µg/kg	<3	<3	<3	<3	<3	<3
1,2-Dibromomethane	µg/kg	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	µg/kg	<5	<5	<5	<5	<5	<5
1,2-Dichloropropane	µg/kg	<3	<3	<3	<3	<3	<3
Bromodichloromethane	µg/kg	<8	<8	<8	<8	<8	<8
Bromoform	µg/kg	<8	<8	<8	<8	<8	<8
Bromomethane	µg/kg	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	µg/kg	<10	<10	<10	<10	<10	<10
Chlorobenzene	µg/kg	<5	<5	<5	<5	<5	<5
Chloroform	µg/kg	<3	<3	<3	<3	<3	<3
Chloromethane	µg/kg	<25	<25	<25	<25	<25	<25
Cis-1,3-Dichloropropylene	µg/kg	<20	<20	<20	<20	<20	<20
Tetrachloroethene	µg/kg	<10	<10	<10	<10	<10	<10
Trichloroethene	µg/kg	<8	<8	<8	<8	<8	<8
Trichlorofluoromethane	µg/kg	<5	<5	<5	<5	<5	<5
Vinyl Chloride	µg/kg	<25	<25	<25	<25	<25	<25

Parameter	Units	MT-1	MT-10	MT-3	MT-4	MT-5	MT-9
		15/12/1989	19/12/1989	15/12/1989	19/12/1989	16/12/1989	20/12/1989
Benzene	µg/kg	<3	<3	<3	<3	<3	<3
Ethylbenzene	µg/kg	<8	<8	<8	<8	<8	<8
m&p-Xylene	µg/kg	<5	<5	<5	<5	<5	<5
o-Xylene	µg/kg	<10	<10	<10	<10	<10	<10
Styrene	µg/kg	<20	<20	<20	<20	<20	<20
Toluene	µg/kg	<8	<8	<8	<8	<8	<8

Table 5-28
Extractable Organic Parameters (MacLarentech site assessment samples collected from boreholes about January 1990)

Parameter	Units	MT-1	MT-3	MT-4
		15/12/1989	15/12/1989	15/12/1989
2,3,4,5-Tetrachlorophenol	µg/g	<0.4	<0.4	<0.4
2,3,4,6-Tetrachlorophenol	µg/g	<1	<1	<1
2,3,4-Trichlorophenol	µg/g	<0.4	<0.4	<0.4
2,3,5,6-Tetrachlorophenol	µg/g	<2	<2	<2
2,3,5-Trichlorophenol	µg/g	<0.4	<0.4	<0.4
2,4,5-Trichlorophenol	µg/g	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol	µg/g	<0.5	<0.5	<0.5
2,4-Dichlorophenol	µg/g	<0.6	<0.6	<0.6
2,4-Dimethylphenol	µg/g	<0.6	<0.6	<0.6
2,4-Dinitrophenol	µg/g	<29	<29	<29
2,6-Dichlorophenol	µg/g	<0.5	<0.5	<0.5
2-Chlorophenol	µg/g	<0.6	<0.6	<0.6
4-Nitrophenol	µg/g	<0.5	<0.5	<0.5
m-Cresol	µg/g	<0.8	<0.8	<0.8
o-Cresol	µg/g	<1.2	<1.2	<1.2
p-Cresol	µg/g	<1.1	<1.1	<1.1
Pentachlorophenol	µg/g	<1.2	<1.2	<1.2
Phenols	µg/g	<0.6	<0.6	<0.6
2-Methyl-4,6-dinitrophenol	µg/g	<6	<6	<6
4-Chloro-3-methylphenol	µg/g	<0.6	<0.6	<0.6
Benzo(b)fluoranthene	µg/g	<0.6	<0.6	<0.6
Benzo(k)fluoranthene	µg/g	<0.5	<0.5	<0.5
1-Chloronaphthalene	µg/g	<0.5	<0.5	<0.5
1-methylnaphthalene	µg/g	<0.4	<0.4	<0.4

Parameter	Units	MT-1	MT-3	MT-4
		15/12/1989	15/12/1989	15/12/1989
2,4-Dinitrotoluene	µg/g	<0.4	<0.4	<0.4
2,6-Dinitrotoluene	µg/g	<0.3	<0.3	<0.3
2-Chloronaphthalene	µg/g	<0.4	<0.4	<0.4
2-methylnaphthalene	µg/g	<0.4	<0.4	<0.4
4-Bromophenyl phenyl ether	µg/g	<0.2	<0.2	<0.2
4-Chlorophenyl phenyl ether	µg/g	<0.4	<0.4	<0.4
5-Nitro acenaphthene	µg/g	<0.4	<0.4	<0.4
Acenaphthene	µg/g	<0.4	<0.4	<0.4
Acenaphthylene	µg/g	<0.4	<0.4	<0.4
Anthracene	µg/g	<0.5	<0.5	<0.5
Benzo(a)anthracene	µg/g	<0.3	<0.3	<0.3
Benzo(a)pyrene	µg/g	<0.6	<0.6	<0.6
Benzo(g,h,i)perylene	µg/g	<0.6	<0.6	<0.6
Benzyl butyl phthalate	µg/g	<0.6	<0.6	<0.6
Bis(2-Chloroethoxy)methane	µg/g	<0.4	<0.4	<0.4
Bis(2-chloroethyl)ether	µg/g	<0.4	<0.4	<0.4
Bis(2-chloroisopropyl)ether	µg/g	<0.4	<0.4	<0.4
Bis(2-Ethylhexyl)phthalate	µg/g	<1.5	1.9	<1.5
Camphene	µg/g	<0.3	<0.3	<0.3
Chrysene	µg/g	<0.3	<0.3	<0.3
Dibenz(a,h)anthracene	µg/g	<0.8	<0.8	<0.8
Di-n-butyl phthalate	µg/g	<2.9	<2.9	<2.9
Diphenylamine	µg/g	<1.3	<1.3	<1.3
Fluoranthene	µg/g	<0.2	<0.2	<0.2
Fluorene	µg/g	<0.4	<0.4	<0.4
Indeno(1,2,3-c,d)pyrene	µg/g	<0.7	<0.7	<0.7
Indole	µg/g	<1.5	<1.5	<1.5
Naphthalene	µg/g	<0.5	<0.5	<0.5
N-Nitroso-di-n-propylamine	µg/g	<0.4	<0.4	<0.4
N-Nitrosodiphenylamine	µg/g	<1.2	<1.2	<1.2
Perylene	µg/g	<1.1	<1.1	<1.1
Phenanthrene	µg/g	<0.4	<0.4	<0.4
Pyrene	µg/g	<0.3	<0.3	<0.3

In addition, soil samples were collected from the test pits to characterize shallow soil conditions in the vicinity of the structures, and former landfill sites that may have been subject to near or surface contamination through discharge, leakage, or burial (see also Table 3-4). Samples from selected depths of each pit were analyzed for physical and inorganic parameters, oil and grease, phenol and PCBs (Table 5-29) and volatile organics (Table 5-30). The test pits were backfilled after sampling. All locations are, therefore, approximate.

Table 5-29

Physical Properties, Metals, Oil and Grease, Phenol and PCBs (MacLarentech site assessment samples collected from test pits about January 1990)

Parameter	Units	TP-6 0-1'	TP-6 8-10'	TP-8 0-2'	TP-A 2-4'	TP-B 2'	TP-C 2-4'	TP-D 4-6'	TP-E 0-1'	TP-F 2-4'	TP-G 0-1'	TP-H 0-1'	TP-I 0-1'	TP-J 2-4'	TP-K 0-1'	TP-L 4-6'	TP-M 6-8'	TP-N 0-1'	TP-N 0-1'	TP-N 4-6'	TP-N 10-12'	TP-0 4-6'
pH		7.1	6.9	7.2	6.8	7.6	NA	6	7.2	7.9	6.6	5.9	5.8	8.1	6	6.2	NA	9.3	7.3	NA	8.4	8.3
Conductivity	mS/cm	0.002	0.004	0.004	0.06	0.213	NA	0.05	0.051	0.19	0.09	0.068	0.06	0.165	0	0.005	NA	0.015	0.08	NA	0.059	0.073
SAR		0.22	0.32	0.12	0.47	0.48	NA	0.41	0.68	0.19	0.66	0.54	0.06	1.44	0.03	0.35	NA	1.76	0.47	NA	2.04	0.59
TKN	%	ND	ND	ND	0.04	0.002	NA	0.02	0.013	0.02	0.01	0.007	0.04	0.014	ND	0.005	NA	0.02	0.01	NA	0.022	ND
Al	mg/kg	NA	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ag	mg/kg	<3	<3	<3	<3	<3	15	<3	<3	<3	<3	<3	<3	<3	<3	<3	NA	<3	<3	NA	3	<3
As	mg/kg	10.3	10.4	20.1	11.7	7.8	1.7	14.2	15.4	7.2	7.2	5	28.5	17.9	9.1	8.2	NA	13.6	14.5	NA	39.2	10.9
Ba	mg/kg	75	70	160	85	80		65	80	50	65	130	110	95	50	55	NA	140	80	NA	190	90
Be	mg/kg	<3	<3	<3	<3	<3	<1	<3	<3	<3	<3	<3	<3	<3	<3	<3	NA	<3	<3	NA	<3	<3
Cd	mg/kg	<1	<1	20	<1	<1	8	<1	<1	<1	1	<1	<1	<1	<1	<1	NA	7	<1	NA	3	<1
Co	mg/kg	9	10	15	10	8	15	10	10	8	10	10	15	15	8	9	NA	15	10	NA	25	15
Cr	mg/kg	3	<2	15	3	<2	230	8	10	3	3	4	9	10	4	<2	NA	15	10	NA	40	3
Cr (VI)	mg/kg	<1	<1	<1	<1	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NA	<1	<1	NA	<1	<1
Cu	mg/kg	35	30	55	35	25		35	40	20	35	20	40	55	25	20	NA	70	310	NA	200	35
Hg	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	0.5	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	0.36	0.15	NA	0.47	<0.01
Mo	mg/kg	<3	<3	<3	<3	<3	<2	<3	<3	<3	<3	<3	<3	<3	<3	<3	NA	<3	<3	NA	7	2
Ni	mg/kg	10	10	10	15	8	3	9	15	10	10	10	15	15	10	6	NA	25	15	NA	35	8
Pb	mg/kg	<5	30	55	30	6	130	50	40	15	25	25	20	15	35	20	NA	760	50	NA	150	10
Sb	mg/kg	<3	<3	<3	<3	<3	<1	<3	<3	<3	<3	<3	<3	<3	<3	<3	NA	4	<3	NA	<3	<3
Se	mg/kg	<1	<1	<1	<1	<1	<0.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NA	<1	<1	NA	<1	<1
Th	mg/kg	NA	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
V	mg/kg	25	25	55	40	25	<2	40	35	25	30	35	55	40	30	25	NA	50	30	NA	60	40
Zn	mg/kg	50	35	100	65	40	430	65	50	30	110	55	85	370	40	30	NA	570	200	NA	1100	65

Parameter	Units	TP-6 0-1'	TP-6 8-10'	TP-8 0-2'	TP-A 2-4'	TP-B 2'	TP-C 2-4'	TP-D 4-6'	TP-E 0-1'	TP-F 2-4'	TP-G 0-1'	TP-H 0-1'	TP-I 0-1'	TP-J 2-4'	TP-K 0-1'	TP-L 4-6'	TP-M 6-8'	TP-N 0-1'	TP-N 0-1'	TP-N 4-6'	TP-N 10-12'	TP-O 4-6'
Phenols	µg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8	NA	NA
PCBs	mg/kg	NA	NA	NA	NA	NA	NA	NA	<0.005	NA	NA	<0.005	NA	<0.005	NA	NA	<0.005	NA	NA	0.05	NA	<0.005
Oil & Grease	%	0.007	0.004	0.008	0.02	0.009	NA	0.01	0.004	0	0.02	0.035	0.02	0.003	0	0.004	NA	0.006	NA	NA	0.022	0.004

Table 5-30
Volatile Organics (MacLarentech site assessment samples collected from test pits about
January 1990)

Parameter	Units	TP-3 4-6'	TP-6 8-10'	TP-C 2-4'	TP-J 2-4'	TP-L 4-6'	TP-M 6-8'	TP-N 4-6'
1,1,1-Trichloroethane	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
1,1-Dichloroethene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
1,2-Dichlorobenzene	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
1,3-Dichlorobenzene	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	µg/kg dry wt	<5	<5	<5	<5	<5	<5	<5
Acrolein	µg/kg dry wt	<25	<25	<25	<25	<25	<25	<25
Acrylonitrile	µg/kg dry wt	<20	<20	<20	<20	<20	<20	<20
Chlorobromomethane	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
Chlorodibromomethane	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
Chloroethane	µg/kg dry wt	<25	<25	<25	<25	<25	<25	<25
Dichloromethane	µg/kg dry wt	30	30	50	50	20	30	50
Methyl Ethyl Ketone	µg/kg dry wt	<3	<3	180	<3	<3	<3	<3
trans-1,2-Dichloroethene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
trans-1,3-Dichloropropene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
1,1,2,2-tetrachloroethane	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
1,1,2-Trichloroethane	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
1,1-Dichloroethane	µg/kg dry wt	<3	<3	<3	<3	<3	<3	<3
1,2-Dibromomethane	µg/kg dry wt	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloroethane	µg/kg dry wt	<5	<5	<5	<5	<5	<5	<5
1,2-Dichloropropane	µg/kg dry wt	<3	<3	<3	<3	<3	<3	<3
Bromodichloromethane	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
Bromoform	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
Bromomethane	µg/kg dry wt	<25	<25	<25	<25	<25	<25	<25
Carbon Tetrachloride	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
Chlorobenzene	µg/kg dry wt	<5	<5	<5	<5	<5	<5	<5
Chloroform	µg/kg dry wt	<3	<3	<3	<3	<3	<3	<3
Chloromethane	µg/kg dry wt	<25	<25	<25	<25	<25	<25	<25
Cis-1,3-Dichloropropylene	µg/kg dry wt	<20	<20	<20	<20	<20	<20	<20
Tetrachloroethene	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
Trichloroethene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
Trichlorofluoromethane	µg/kg dry wt	<5	<5	<5	<5	<5	<5	<5
Vinyl Chloride	µg/kg dry wt	<25	<25	<25	<25	<25	<25	<25
Benzene	µg/kg dry wt	<3	<3	<3	<3	<3	<3	<3
Ethylbenzene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8
m&p-Xylene	µg/kg dry wt	<5	<5	50	<5	<5	<5	<5

Parameter	Units	TP-3 4-6'	TP-6 8-10'	TP-C 2-4'	TP-J 2-4'	TP-L 4-6'	TP-M 6-8'	TP-N 4-6'
o-Xylene	µg/kg dry wt	<10	<10	<10	<10	<10	<10	<10
Styrene	µg/kg dry wt	<20	<20	<20	<20	<20	<20	<20
Toluene	µg/kg dry wt	<8	<8	<8	<8	<8	<8	<8

5.2.5.2 Gamma-emitting radionuclide concentrations in surface soil samples November 1996

The data presented in Table 5-31 were obtained from [53]. Initially collected on cut lines cleared to survey a proposed new perimeter for the NPD property at the NB locations (Figure 5-2). The gamma spectra obtained were dominated by ⁴⁰K. One sampling location (NB – S) showed higher levels of ¹³⁷Cs. NB – S is located on the edge of a now overgrown trail leading to what was a sand and gravel pit at the time of the construction of NPD. Surface soil was sampled at the 8 NS locations, which are near NB – S. No high levels of ¹³⁷Cs were found at these 8 locations.

**Table 5-31
Gamma-emitting Radionuclide Concentrations (Bq/kg dry wt) in Surface Soil Samples
November 1996**

Location Code	Ac-228	Bi-212	Bi-214	Cs-137	Gross Alpha	Gross Beta	K-40	Pb-212	Pb-214	Ra-226	Th-228	Tl-208
NB - E	11.9	13.8	6.5	5.3	579	690	434	15.4	7.8	6.4	15	5
NB - S	24	28.7	26.3	84.8	503	812	915	38.1	29.6	27.3	29.5	9.8
NB - W	20.6	22.8	16.1	19.9	221	746	807	30.4	17.4	16	28	9.3
NS-1	14.8	NA	NA	5.4	NA	NA	434	NA	NA	6.9	16.1	NA
NS-2	13	NA	NA	3.5	NA	NA	455	NA	NA	3.1	13.2	NA
NS-3	9	NA	NA	8.1	NA	NA	387	NA	NA	6	8.6	NA
NS-4	13.6	NA	NA	3	NA	NA	379	NA	NA	8.5	14.2	NA
NS-5	13.8	NA	NA	3.1	NA	NA	381	NA	NA	13.2	14.2	NA
NS-6	10.3	NA	NA	2	NA	NA	354	NA	NA	9.9	10.6	NA
NS-7	8.3	NA	NA	5.6	NA	NA	393	NA	NA	8	8.2	NA
NS-8	8.4	NA	NA	4	NA	NA	456	NA	NA	4.9	8.6	NA

5.2.5.3 Contamination due to an underground fuel storage tank leak

Following the leak of one of the underground fuel storage tanks, a number of measurements related to soil and water contaminations were obtained. Contaminated soils were encountered at the base of the excavation during removal of the tank in 1992 and the excavating company (Beattie Construction) submitted soil samples for analysis. The data obtained can be found in Table 5-32. Petroleum hydrocarbon results from samples collected by John D. Paterson and Associates Limited (current name Paterson group) are reported in Table 5-33 [14].

Table 5-32
Soil Samples Submitted for Analysis by the Excavation Company (Beattie Construction)

Contaminant	Date	Concentration (µg/g)
Arsenic	15-Dec-92	<0.01
Barium	15-Dec-92	0.05
Boron	15-Dec-92	0.09
Cadmium	15-Dec-92	<0.004
Chromium	15-Dec-92	<0.01
Cyanide (free)	15-Dec-92	<0.02
Fluoride	15-Dec-92	<0.1
Lead	15-Dec-92	<0.04
Mercury	15-Dec-92	<0.001
Nitrite and Nitrate (N)	15-Dec-92	0.1
Selenium	15-Dec-92	<0.01
Silver	15-Dec-92	<0.01
PCBs	15-Dec-92	<0.001

Table 5-33
Further Soil Analysis Following the Underground Fuel Storage Tank Leak (1992-2001)

Location	Sample Date	Combustible Vapour Peak Reading (ppm)	F1 PHCs (C6-C10) (mg/g)	F2 PHCs (C10-C16) (mg/g)	F3 PHCs (C16-C34) (mg/g)	F4 PHCs (C34-C50) (mg/g)	TPH (mg/g)	TPH (diesel) (mg/g)	TPH (gasoline) (mg/g)
Excavation - Initial	15-Dec-92	NA	NA	NA	NA	NA	7.6	NA	NA
Excavation - Base	12-Jan-93	NA	NA	NA	NA	NA	2.1	NA	NA
Excavation - near building	12-Jan-93	NA	NA	NA	NA	NA	4.7	NA	NA
BH-2	19-Dec-92	45	NA	NA	NA	NA	NA	NA	NA
MW-3	19-Dec-92	25	NA	NA	NA	NA	NA	NA	NA
BH13-01 SS1	19-Nov-01	10	NA	NA	NA	NA	NA	NA	NA
BH13-01 SS3	19-Nov-01	10	NA	NA	NA	NA	NA	<10	<10
BH13-01 SS4	19-Nov-01	10	NA	NA	NA	NA	NA	NA	NA
BH13-01 SS5	19-Nov-01	5	NA	NA	NA	NA	NA	NA	NA
BH13-01 SS6	19-Nov-01	15	NA	NA	NA	NA	NA	<10	<10
BH13-01 SS7	19-Nov-01	5	NA	NA	NA	NA	NA	NA	NA
BH14-01 SS8	20-Nov-01	10	NA	NA	NA	NA	NA	<10	<10
BH14-01 SS9	20-Nov-01	5	NA	NA	NA	NA	NA	<10	<10
BH15-01 SS10	20-Nov-01	5	NA	NA	NA	NA	NA	NA	NA
BH15-01 SS12	20-Nov-01	5	NA	NA	NA	NA	NA	<10	<10

Location	Sample Date	Combustible Vapour Peak Reading (ppm)	F1 PHCs (C6-C10) (mg/g)	F2 PHCs (C10-C16) (mg/g)	F3 PHCs (C16-C34) (mg/g)	F4 PHCs (C34-C50) (mg/g)	TPH (mg/g)	TPH (diesel) (mg/g)	TPH (gasoline) (mg/g)
BH15-01 SS13	20-Nov-01	15	NA	NA	NA	NA	NA	<10	<10
BH15-01 SS14	20-Nov-01	10	NA	NA	NA	NA	NA	<10	<10
BH16-01 G20	20-Nov-01	15	<20	200	270	<10	NA	<10	450
BH16-01 SS16	20-Nov-01	10	NA	NA	NA	NA	NA	NA	NA
BH16-01 SS17	20-Nov-01	5	NA	NA	NA	NA	NA	NA	NA
BH16-01 SS18	20-Nov-01	10	NA	NA	NA	NA	NA	<10	<10
BH16-01 SS19	20-Nov-01	10	NA	NA	NA	NA	NA	NA	NA

5.2.6 Vegetation

5.2.6.1 Radioactivity in sawdust samples from trees on the proposed new perimeter for the NPD site November 1996

The data presented in Table 5-34 are from [53] at locations shown in Figure 5-2. The samples were collected on cut lines cleared to survey a proposed new perimeter for the NPD property. The vegetation samples for NB – E was from poplar, NB - S from white pine, NB – W from white birch. Like for the corresponding soil samples, the gamma spectra were dominated by ⁴⁰K. Small but detectable amounts of ¹³⁷Cs were obtained.

**Table 5-34
Radioactivity in Sawdust Samples (in Bq/kg dry weight) from Trees on the Proposed New Perimeter for the NPD Site November 1996**

Location Code	Ac-228	Bi-212	Bi-214	Cs-137	Gross Alpha	Gross Beta	K-40	Pb-212	Pb-214	Ra-226	Th-228	Tl-208
NB - E	5.8	3.5	2.1	<0.13	100	63.7	44	5.2	2.5	2.3	4.2	1.4
NB - S	1.9	<5.2	<0.9	0.5	21.9	127	102	1.2	0.6	<1.7	1.5	0.5
NB - W	2.8	1.9	1.4	0.6	72.2	62	20	2.9	2.1	1.6	2.1	0.7

6. SUMMARY

6.1 Routine monitoring

This section summarizes the conditions prevailing at NPD based on the routine monitoring.

6.1.1 Air

6.1.1.1 Gross beta

Derived release limit (DRL) for ^{137}Cs in air (the radionuclide in air with the most restrictive DRL for NPD) is $2.9\text{E}+11$ Bq/a. The maximum annual gross beta release in for the period 1997 to 2007 was $3\text{E}+5$ Bq, which is about 1.0×10^{-4} percent of the DRL [46].

6.1.1.2 Carbon-14

DRL for ^{14}C in air is $1.7\text{E}+15$ Bq/a. The maximum annual ^{14}C release in for the period 2004 to 2007 was 0.19 GBq, which is about 1.1×10^{-5} percent of the DRL [46].

6.1.1.3 Tritium

DRL for tritium in air is $2.3\text{E}+16$ Bq/a. The maximum annual tritium release in for the period 1997 to 2007 was 130 GBq, which is about 9.3×10^{-4} percent of the DRL [46].

6.1.1.4 Gamma (TLDs)

During the 18 years since the NPD reactor was permanently shut down in 1989, there have been no anomalies in data on ambient radiation fields provided by the thermoluminescent dosimeters (TLDs) that are located near the NPD site. Variations are showing no clearly definable trends, and the radiation fields are characteristic of those observed in regions with similar surface soils that are unaffected by nuclear facilities [48].

6.1.2 Water

6.1.2.1 WAS radioactive releases

DRL for tritium in water is $1.4\text{E}+16$ Bq/a. The maximum annual tritium release for the period 1997 to 2007 was 892 GBq, which is about 6.4×10^{-3} percent of the DRL [46].

DRL for ^{14}C in water is $4.1\text{E}+13$ Bq/a. The maximum annual ^{14}C release for the period 2004 to 2007 was 0.014 GBq, which is about 3.4×10^{-3} percent of the DRL [46].

DRL for ^{60}Co in water (the radionuclide in water with the most restrictive DRL for NPD) is $4.4\text{E}+11$ Bq/a. The maximum annual gross beta release in for the period 2004 to 2007 was $4.1\text{E}+6$ Bq, which is about 9.3×10^{-2} percent of the DRL [46].

DRL for gross gamma in water is $4.4\text{E}+11$ Bq/a. Maximum annual gross gamma release for the period 2004 to 2007 was $2.53\text{E}+6$ Bq, which is about 5.8×10^{-4} percent of the DRL [46].

6.1.2.2 Ottawa River tritium

At both the up and down stream sampling stations, river concentrations are less than 0.00004% of the current Maximum Acceptable Concentration (MAC) of 7000 Bq·L⁻¹ of tritium in drinking water specified by Health Canada [65].

6.1.2.3 Ottawa River Cesium-137

With no statistically significant differences between the two locations (up and down stream), there is no sign of any appreciable ¹³⁷Cs input to the river from the NPD site [65].

6.1.2.4 Ottawa River Strontium-90

Some higher values of ⁹⁰Sr have been noted at Deep River with respect to Rapides des Joachims especially in the third quarter but for the most part the concentrations at the two locations are not significantly different [65].

6.1.2.5 Petroleum products

Petroleum hydrocarbons (PHC) concentrations have not been detected in any of the water samples recovered from the Ottawa River since the beginning of the sampling program.

All petroleum hydrocarbon (PHC) test results obtained since 2004 have been in compliance with the remediation criteria of 1.0 mg/L for PHC F₁+F₂ and 1.0 mg/L for PHC F₃+F₄ [30].

6.1.3 Soil

6.1.3.1 Soil HTO

The levels are still above background although the plant has been decommissioned for a number of years [68].

6.1.4 Vegetation

6.1.4.1 Vegetation HTO

Consistent with what was noted in soil, the levels are still above background although the plant has been decommissioned for a number of years [68].

6.1.4.2 Vegetation OBT

The levels are still elevated. The values obtained are consistent with the HTO levels measured. [68]

6.2 Where to find the environmental monitoring information (1988-2008)

Table 6-1 summarizes where to find environmental monitoring information related to NPD (1988-2008).

**Table 6-1
Environmental Monitoring Information (1988-2008)**

Environmental compartment	Description	Section
Air	<p>Monitoring releases Stack vent gross beta Stack vent carbon-14 Stack vent tritium</p> <p>Environmental monitoring Ambient gamma radiation doses (TLDs)</p>	<p>Section 4.1.1 Section 4.1.1 Section 4.1.1</p> <p>Section 5.1.1.1</p>
Water	<p>Monitoring releases WAS and drain system radiological analysis</p> <p>Environmental monitoring Ottawa River tritium Ottawa River cesium-137 Ottawa River strontium-90</p> <p>Petroleum products</p> <p>Specific sampling campaigns Physical properties (MacLarentech site assessment, 1990) Inorganics (MacLarentech site assessment, 1990) Volatile organics (MacLarentech site assessment, 1990) Radiological contaminants (MacLarentech site assessment, 1990) Other contaminants (MacLarentech site assessment, 1990)</p> <p>Physical properties (L1, 1988 and 1995) Inorganics (L1, 1988 and 1995) Volatile organics (L1, 1995) Phenol (L1, 1988 and 1995) Extractable organics (L1, 1995) PCBs (L1, 1995) Radiological contaminants (L1, 1988 and 1995)</p> <p>Physical properties (L2, 1989) Inorganics (L2, 1989) Volatile organics (L2, 1996) Phenol (L1, 1989 and 1996)</p>	<p>Section 4.2</p> <p>Section 5.1.2.1 Section 5.1.2.1 Section 5.1.2.1</p> <p>Section 5.2.2.3</p> <p>Section 5.2.2.1 Section 5.2.2.1 Section 5.2.2.1 Section 5.2.2.1 Section 5.2.2.1</p> <p>Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2</p> <p>Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2</p>

Environmental compartment	Description	Section
	Extractable organics (L2, 1996) PCBs (L2, 1996) Radiological contaminants (L2, 1989 and 1996) Phenol (following underground fuel leak, 1993) CH2M HILL water sampling (2002): No reliable data available	Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.2 Section 5.2.2.3 Section 5.2.2.4
Sediment	Specific sampling campaigns CH2M HILL sediment sampling (2002): No reliable data available	Section 5.2.3.1
Aquatic biota	Specific sampling campaigns Fish cesium-137 (1991-1994) Fish carbon-14 (1991-1994)	Section 5.2.4.1 Section 5.2.4.1
Soil	Environmental monitoring Ambient tritium (HTO) Specific sampling campaigns Physical properties (MacLarentech site assessment, 1990) Metal (MacLarentech site assessment, 1990; Paterson, 1992) PHCs and TPH (Paterson 1992-2001) Oils/grease (MacLarentech site assessment, 1990) Volatile organics (MacLarentech site assessment, 1990) Extractable organics (MacLarentech site assessment, 1990) Phenol (MacLarentech site assessment, 1990) PCBs (MacLarentech site assessment, 1990) Other contaminants (MacLarentech site assessment, 1990) Gamma-emitting radionuclides (1996) Contaminant analysis (Beattie Construction, 1992) PHCs and TPH (following fuel storage tank leak, 1992-2001)	Section 5.1.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.1 Section 5.2.5.2 Section 5.2.5.3 Section 5.2.5.3
Terrestrial biota	Environmental monitoring Vegetation ambient tritium (HTO and OBT) Specific sampling campaigns Vegetation radioactivity (1996)	Section 5.1.6.1 Section 5.2.6.1

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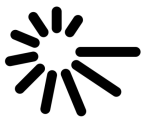
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Report, General

NPD BIODIVERSITY REPORT

NPD DECOMMISSIONING

64-509200-REPT-002

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Report, General

NPD Biodiversity Report

NPD Decommissioning

64-509200-REPT-002

Revision 0

2015 November

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EXECUTIVE SUMMARY

CNL is committed to the protection of the environment and the goal of sustainable development. Through the proactive management of its lands, habitats and species, CNL continues its effort to better understand the distribution and abundance of species at risk on its sites.

The purpose of this report is to provide a status on biodiversity features present at the Nuclear Power Demonstration (NPD) site in preparation for the site decommissioning and Environmental Effects Review (EER) required, at minimum, prior to active decommissioning.

A small sub-set of species were chosen for specific surveys in accordance to the area where activities are scheduled to take place.

Visual surveys were conducted for species where suitable habitat was identified. The species include:

- Bald eagle
- Bank swallow
- Barn swallow
- Red-shouldered hawk
- Monarch butterfly
- Map turtle
- Snapping turtle
- Eastern Milksnake

Targeted surveys were conducted in 2014 and 2015 to cover four different taxa (birds, reptiles, plants and mammals) and six different types of surveys as follows:

- Chimney Swift
- Nightjars
 - Common Nighthawk
 - Eastern Whip-poor-will
- Forest songbirds
 - Canada warbler
 - Cerulean warbler
 - Eastern wood pewee
 - Golden-winged warbler
 - Grasshopper sparrow
 - Kirtland's warbler
 - Loggerhead shrike

- Olive-sided flycatcher
- Red-headed woodpecker
- Wood thrush
- Mammals
 - Little brown myotis
 - Nothorn myotis
 - Tri-colored bat
 - Eastern small-footed myotis
- Plants
 - Ginseng
 - Butternut

Other sources of information from the Department of Fisheries and Oceans (DFO) to identify fish species were also consulted. Species potentially present include:

- Fish
 - Lake sturgeon
 - River redhorse
 - American eel
 - Northern brook lamprey

Eight species at risk have been identified on the NPD site and mitigation measures and recommendations have been provided in this report.

1. INTRODUCTION

The purpose of this report is to provide a status on biodiversity features present at the Nuclear Power Demonstration (NPD) site in preparation for the site decommissioning and Environmental Effects Review (EER) required prior to active decommissioning. This report includes a summary of the different surveys conducted on the site and highlights any potential species where mitigation measures might be required.

1.1 Acronyms

AECL	Atomic Energy of Canada Limited
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CNL	Canadian Nuclear Laboratories
DFO	Department of Fisheries and Oceans
EER	Environmental Effects Review
END	Endangered Species
EnvP	Environmental Protection
ESA	Endangered Species Act
Gd	<i>Geomyces destructans</i> , the fungus causing WNS
NLLP	Nuclear Legacy Liability Program
NPD	Nuclear Power Demonstration
NRCan	Natural Resources Canada
OMNRF	Ontario Ministry of Natural Resources and Forestry
Pd	<i>Pseudogymnoascus destructans</i>
PVA	Population Viability Analysis
SARA	Species at Risk Act
SARO	Species at Risk in Ontario List
SC	Special Concern
THR	Threatened Species
WNS	White-nose Syndrome

1.2 Background

As a Crown Corporation of the Government of Canada, Atomic Energy of Canada Limited (AECL), managed and operated by the Canadian Nuclear Laboratories (CNL), is committed to sustainable development. CNL includes the protection of the environment as an integral component of our decision-making in all phases of our business activities, including product development, planning and implementation, as well as operations and decommissioning.

CNL's Environment Policy [1] includes the following elements:

- We practice responsible environmental management.
- We are committed to pollution prevention¹.
- We set environmental objectives and targets to support continual improvement of our environmental performance.
- We comply with environmental laws, requirements, and recognized standards and guidelines applicable to our activities.
- We review the impacts of our activities, facilities, projects, services and products on the environment.
- We will seek to develop and improve technologies to advance environmental protection and clean air solutions.
- We promote public and employee awareness of this policy and our environmental performance.

As stated above, CNL operations must comply with all relevant environmental laws. One important legal requirement for the company is the Federal *Species at Risk Act, 2003* (SARA) [2].

1.3 Species at Risk Act

For a Crown Corporation, there are specific responsibilities and legal requirements in Canada under the SARA that apply to the sites under Atomic Energy of Canada Ltd's (AECL) ownership and managed by CNL. The objectives of the SARA are: i) to prevent wildlife species from being extirpated or becoming extinct, ii) to aid in the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity, and iii) to manage species of special concern to prevent them from becoming endangered or threatened.

In order to ensure compliance with sections 32 and 33 of the SARA, federal land managers shall 1) determine if species at risk under Schedule I of the SARA are present on their property, 2) take action to protect them, and 3) protect their residence and critical habitat. General prohibitions under the SARA are only applicable to endangered (END), threatened (THR) or

¹ Pollution prevention is defined as the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste and reduce the overall risk to the environment or human health

extirpated species listed under Schedule I, their residence and their critical habitat defined in a recovery strategy or action plan, if available. The management of species listed as special concern (SC) under Schedule I of the Act, shall be managed in accordance with the management plan posted on the public registry [3], if available. Table 1-1 below lists some definitions as listed in the SARA.

**Table 1-1
Definitions as Listed in the SARA**

Species at Risk	An extirpated, endangered or threatened species or a species of special concern.
Extirpated species	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
Endangered species	A wildlife species that is facing imminent extirpation or extinction.
Threatened species	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
Species of Special Concern	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Residence	A dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating.
Critical Habitat	The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' potential critical habitat in the recovery strategy or in an action plan for the species.

1.4 Biodiversity Survey Requirements

The NPD site has been identified for decommissioning under the Nuclear Legacy Liability Program (NLLP), program lead by Natural Resources Canada (NRCan). As part of this program, all infrastructures have been identified for decommissioning to a complete closure of the site to reduce Canada's radioactive waste and decommissioning liabilities, and ensure the long term safety and security of the public and the environment. Canada wishes to minimize continuous human intervention to the maximum extent possible or practical when the site moves to closure. In order to complete this work biodiversity surveys were required to ensure that CNL remains in compliance with the Species at Risk Act while undertaking the decommissioning

work. This report will support the development of mitigation measures in the Environmental Effects Review document.

1.5 Site Description and Study Area

The NPD site is a Nuclear Facility under a Waste Facility Decommissioning License issued to CNL [4]. The facility is located in Rolphton, Ontario approximately 200 km northwest of the city of Ottawa, along the Ottawa River (Figure 1-1). The NPD property is 375 hectares in size, 10 times smaller than the CRL site, with a very small portion of the site that is developed (approximately 35 hectares). The facility was operated by Ontario Hydro between 1962 and 1987 and primarily consisted of a prototype CANDU reactor. The site was also a training school for nuclear generating station operations staff. The NPD facility was shut down by Ontario Hydro, with assistance from CNL, and is currently in storage with surveillance phase.

The choice of the areas selected to conduct biodiversity surveys were based on the area where active decommissioning activities are scheduled. As described above, only a small portion of the NPD site has been developed and will require active decommissioning therefore, areas where CNL has not conducted operations and where decommissioning activities are not scheduled have been excluded from the survey. The Figure 1-2 below shows the area selected for surveys as well as an aerial view of the site. A general view of the built-up area is presented in Figure 1-3.

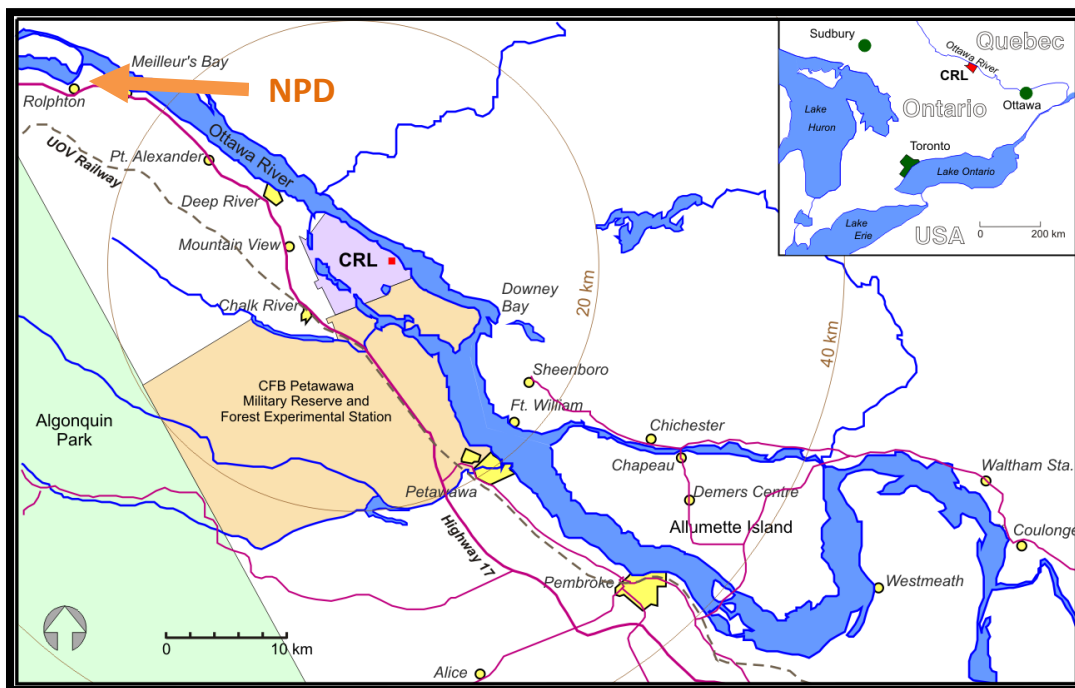
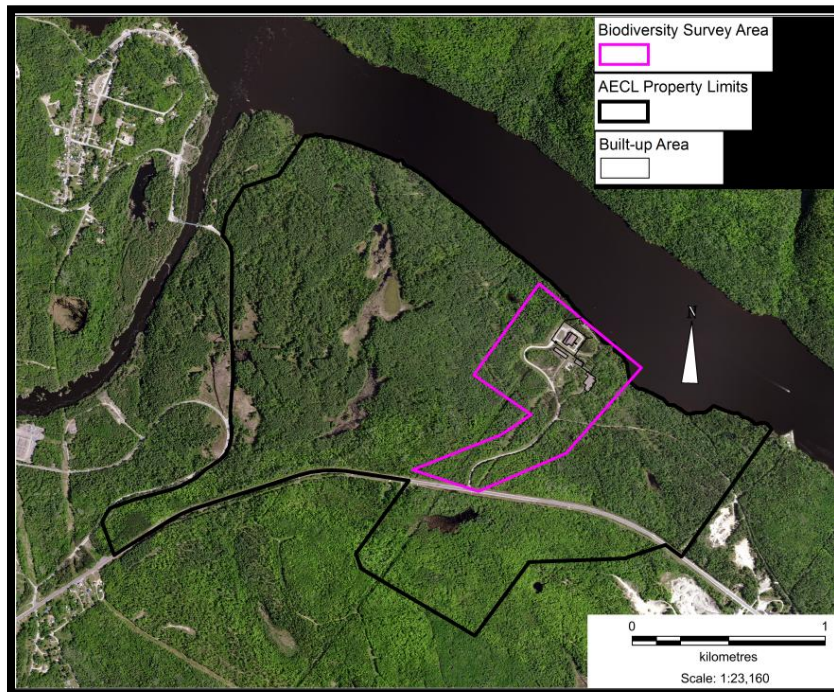


Figure 1-1 Location of the Nuclear Power Demonstration (NPD) site in Ontario



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Figure 1-2 Aerial view of the NPD site located in Rolphton, ON and delimitation of the biodiversity survey area



Figure 1-3 General view of the Nuclear Power Demonstration (NPD) site

2. BIODIVERSITY SURVEY

A complete list of species at risk present, potentially present, or known to be found in close proximity to the NPD site is presented in Table 2-1. From this list, nine species at risk have been confirmed on the NPD site. Table 2-1 also presents the Federal status of each species under the SARA [2], the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC), as well as the provincial status under the Species at Risk in Ontario List (SARO) [5], a regulation under the new provincial *Endangered Species Act* (ESA) [6] which, we strive to follow.

2.1 Justification

There is a potential for 50 different species at risk to be present at the NPD site. From this number, only a sub-set of species are known to be present in the area, therefore, targeted surveys were conducted only for those species. In addition, as described in section 1.5, approximately 10% of the site has been developed and scheduled for active decommissioning, a small sub-set of species were chosen for specific surveys in accordance to the area where activities are scheduled to take place and potential species habitat present. This method eliminated the need to survey for the entire suite of species at risk potentially present at NPD. The Table 2-1 below includes a justification for exclusion in the survey schedule.

**Table 2-1
Species at Risk Present and Potentially Present at NPD Sites
(status queried in July 2015)**

Species		Confirmed Sighting at NPD	Species Survey in 2014 and / or 2015	Status*	
Common Name	Scientific Name			SARA, 2003 (COSEWIC if different)	SARO - Ontario
BIRDS					
Bald Eagle	<i>Haliaeetus leucocephalus</i>	X	YES	No status (NAR)	SC
Bank Swallow	<i>Riparia riparia</i>		YES	No Status Yet (THR)	THR
Barn Swallow	<i>Hirundo rustica</i>		YES	No Status Yet (THR)	THR
Black Tern	<i>Chlidonias niger</i>		No habitat present in the selected area	No status (NAR)	SC
Bobolink	<i>Dolichonyx oryzivorus</i>		No habitat present in the selected area	No Status Yet (THR)	THR
Canada Warbler	<i>Cardellina canadensis</i>		YES	THR	SC
Cerulean Warbler	<i>Setophaga cerulea</i>		YES	SC (END)	THR
Chimney Swift	<i>Chaetura pelagica</i>	X	YES	THR	THR
Common Nighthawk	<i>Chordeiles minor</i>	X	YES	THR	SC
Eastern Meadowlark	<i>Sturnella magna</i>		No habitat present in the selected area	No Status Yet (THR)	THR
Eastern Whip-poor-will	<i>Antrostomus vociferus</i>		YES	THR	THR
Eastern Wood Pewee	<i>Contopus virens</i>	X	YES	No Status Yet (SC)	SC
Golden-winged Warbler	<i>Vermivora chrysoptera</i>		YES	THR	SC
Grasshopper Sparrow	<i>Ammodramus savannarum pratensis</i>		YES	No Status Yet (SC)	Not Listed
Kirtland's Warbler	<i>Setophaga kirtlandii</i>		YES	END	END
Least Bittern	<i>Ixobrychus exilis</i>		No habitat present in the selected area	THR	THR
Loggerhead Shrike Eastern subspecies	<i>Lanius ludovicianus migrans</i>		YES	No Status Yet (END)	END

Species		Confirmed Sighting at NPD	Species Survey in 2014 and / or 2015	Status*	
Common Name	Scientific Name			SARA, 2003 (COSEWIC if different)	SARO - Ontario
BIRDS					
Olive-sided Flycatcher	<i>Contopus cooperi</i>		YES	THR	SC
Peregrine Falcon	<i>Falco peregrinus anatum/tundrius</i>		No habitat present in the selected area	SC	SC
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>		YES	THR	SC
Red-Shouldered Hawk	<i>Buteo lineatus</i>		YES	SC (Schedule 3) (NAR)	Not Listed
Rusty Blackbird	<i>Euphagus carolinus</i>		No habitat present in the selected area	SC	Not Listed
Short-eared owl	<i>Asio flammeus</i>		No habitat present in the selected area	SC	SC
Wood Thrush	<i>Hylocichla mustelina</i>		YES	No Status Yet (THR)	SC
Yellow Rail	<i>Coturnicops noveboracensis</i>		No habitat present in the selected area	SC	SC
REPTILES					
Blanding's Turtle (GLStL population)	<i>Emydoidea blandingii</i>		No habitat present in the selected area	THR	THR
Eastern Musk Turtle (stinkpot)	<i>Sternotherus odoratus</i>		No habitat present in the selected area	THR (SC)	SC
Eastern Hog-nosed Snake	<i>Heterodon platirhinos</i>		YES	THR	THR
Eastern Ribbonsnake (GLStL population)	<i>Thamnophis sauritus</i>		YES	SC	SC
Eastern Milksnake	<i>Lampropeltis triangulum</i>	X	YES	SC	SC
Northern Map Turtle	<i>Graptemys geographica</i>		YES	SC	SC
Snapping Turtle	<i>Chelydra serpentina</i>		YES	SC	SC
Spiny Softshell Turtle	<i>Apalone spinifera</i>		No habitat present in the selected area	THR	THR
Wood turtle	<i>Glyptemys insculpta</i>		No habitat present in the selected area	THR	END
MAMMALS					
Eastern Cougar	<i>Felis concolor cougar</i>		No impact on habitat	Not Listed	END
Eastern Small-footed Myotis	<i>Myotis leibii</i>	X	YES	Not Listed	END

Species		Confirmed Sighting at NPD	Species Survey in 2014 and / or 2015	Status*	
Common Name	Scientific Name			SARA, 2003 (COSEWIC if different)	SARO - Ontario
Eastern Wolf	<i>Canis lupus lycaon</i>		No impact on habitat	SC (THR)	SC
Little Brown Myotis	<i>Myotis lucifugus</i>	X	YES	END	END
Northern Myotis	<i>Myotis septentrionalis</i>	X	YES	END	END
Tri-colored Bat	<i>Perimyotis subflavus</i>		YES	END	END
INSECTS					
Monarch Butterfly	<i>Danaus plexippus</i>	X	YES	SC	SC
Northern Barrens Tiger Beetle	<i>Cicidela patruela</i>		Habitat present	END	END
Rusty Patched Bumble Bee	<i>Bombus affinis</i>		Habitat present	END	END
PLANTS					
American Ginseng	<i>Panax quinquefolius</i>		YES	END	END
Butternut Tree	<i>Juglans cinera</i>		YES	END	END
FISH					
American Eel	<i>Anguilla rostrata</i>		In-water work may be required	No Status Yet (THR)	END
Lake Sturgeon (Great Lakes - Upper St. Lawrence populations)	<i>Acipenser fulvescens</i>		In-water work may be required	No Status Yet (THR)	THR
Northern Brook Lamprey (Great Lakes - Upper St. Lawrence populations)	<i>Ichthyomyzon fossor</i>		In-water work may be required	SC	SC
River Redhorse	<i>Moxostoma carinatum</i>		In-water work may be required	SC	SC

Species		Confirmed Sighting at NPD	Species Survey in 2014 and / or 2015	Status*	
Common Name	Scientific Name			SARA, 2003 (COSEWIC if different)	SARO - Ontario
BIRDS					
AMPHIBIANS					
Western Chorus Frog	<i>Pseudacris triseriata</i>		No habitat present in the selected area	THR	Not Listed
MOLLUSCS					
Hickorynut	<i>Obovaria olivaria</i>		In-water work may be required	No Status Yet (END)	END
* Status: NAR : Not at Risk; END : Endangered; THR : Threatened; SC : Special Concern; GLStL : Great Lakes St. Lawrence					

2.2 Methodology and Results

This section includes the methodology and results of the surveys conducted in the identified area for species identified in Table 2-1. Recommendations are provided at the end of each section and summarized in section 3 .

2.2.1 Visual Surveys

Visual surveys were conducted for species where suitable habitat was identified. The species include:

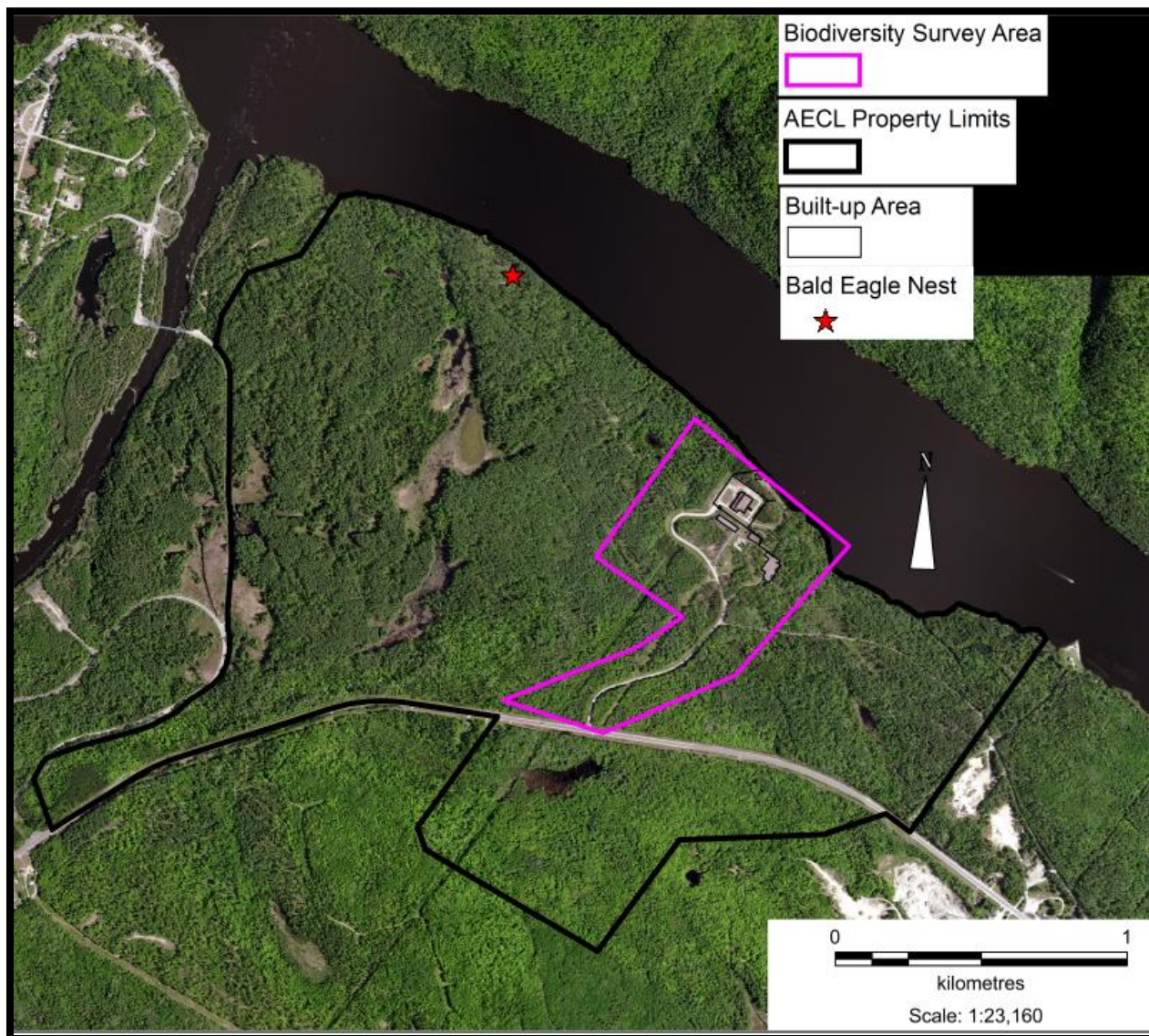
- Bald eagle
- Bank swallow
- Barn swallow
- Red-shouldered hawk
- Monarch butterfly
- Map turtle
- Snapping turtle
- Eastern Milksnake

A few Monarch butterfly individuals were identified on the site primarily in cleared areas. Several varieties of wildflowers are available as nectar sources on the site such as: Goldenrods (*Solidago* spp.), asters (*Aster* spp.) and milkweeds (*Asclepias* spp.).

An active bald eagle’s nest has been located on the NPD site which is known to have been in use for the second year in a row (pers. Comm., D. Ronan). Figure 2-1 below shows the location of the nest which is located 875 metres away from the construction zone. The exact location of the nest in UTM’s using the NAD83 projection is: E 294089; N 5119004.

Surveys conducted in 2014 for Milksnake using cover boards were not successful at identifying the species at the NPD site. But, in 2015 a juvenile Milksnake was witnessed within the building therefore, confirming the presence of the species at the site.

Finally, no other species were confirmed from the visual surveys conducted.



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Figure 2-1 Location of the active bald eagle nest on the NPD site by the Ottawa River -

2.2.1.1 Recommendations

Monarch

- No removal of nectaring plants outside of the construction area;

- No use of pesticides on the NPD site unless reviewed and approved by Environmental Protection (EnvP).

-

Bald eagle

- Directions published by the Ontario Ministry of Natural Resources and Forestry (OMNRF) Stand and Site Guide [7] propose to implement a 400-m buffer between forest operations and an active Bald Eagle's nest. Therefore, due to the distance between the nest and the construction area, no mitigation measures are required.
- Monitor nest occupancy every year.

Eastern Milksnake

- Always sweep the area for the presence of snakes in the work area especially between the months of August to October when juveniles are known to enter buildings.
- Release any snakes outside preferably outside the construction zone.

Potential for other species

- Include other potential species at risk listed above and habitat description in the awareness training package that will be provided to workers prior to the site decommissioning. Report sightings of any species to EnvP.

2.2.2 Targeted Surveys

Targeted surveys were conducted in 2014 and 2015 to cover four different taxa (birds, reptiles, plants and mammals) and six different types of survey as follows:

- Chimney Swift
- Nightjars
 - Common nighthawk
 - Eastern Whip-poor-will
- Forest songbirds
 - Canada warbler
 - Cerulean warbler
 - Eastern wood pewee
 - Golden-winged warbler
 - Grasshopper sparrow
 - Kirtland's warbler

- Loggerhead shrike
- Olive-sided flycatcher
- Red-headed woodpecker
- Wood thrush
- Mammals
 - Little brown myotis
 - Nothorn myotis
 - Tri-colored bat
 - Eastern small-footed
- Plants
 - Ginseng
 - Butternut

2.2.2.1 Chimney Swift Survey

Over the past 50 years, aerially foraging insectivorous birds in North America have shown sharp population declines [8]. Among this group, the Chimney Swift (*Chaetura pelagica*) has experienced a 95% population decline in the past 40 years and subsequently has been listed as threatened in both Ontario and Canada [9]. Although diet change has been shown to be a possible factor in this decline [10], Swifts also face the added pressure of habitat loss. Historically, caves and hollow trees of old growth forests supplied natural nesting and roosting habitat, but Swifts responded to the industrialization of North America by adopting man-made structures as both roosting and nesting sites [11]. Chimneys used for roosting are generally large masonry chimneys found on churches, schools, or industrial buildings and can house hundreds to thousands of birds during migration. However, chimneys are undergoing rapid modernization; they are now either unnecessary in many cases (e.g., gas or electric heat), or they are being capped or lined with metal, rendering them unusable to the birds. The fact that masonry chimneys are increasingly uncommon, may be limiting Chimney Swift populations, since little is known about why Swifts select certain roost sites or how they use them.

2.2.2.1.1 Protocol and Findings

Since 2010, evening roost counts have been conducted at the NPD site following the protocol published by Bird Studies Canada [12]. Observers arrived at the site 30 minutes prior to sunset and began counting down five-minute intervals. Counts included entrances, exits and birds flying within a 100 m radius. Observation ended 5 minutes after the last bird was seen entering the chimney or if no birds were observed on a given night, until 20 minutes after sunset. The information below was recorded:

- Site name;

- Observer name;
- Date;
- Time of sunset;
- Observation start time;
- Observation end time;
- Visit number;
- Estimated number of birds using the chimney;
- Precipitation;
- Cloud cover;
- Wind;
- Temperature (°C);
- Number of entrances of birds in the chimney;
- Number of exits of birds from the chimney;
- Number of birds flying within a 100m radius
- Common nighthawk observation;
- Additional comments.

Roost counts between 2010 and 2015 are presented below in Figure 2-2. Counts are presented in Julian days regardless of the year. The numbers of birds vary throughout the breeding season following the same pattern every year. Large peaks are present during the spring and fall migration and the period in between indicates the nesting period when birds are away from the roost busy incubating or feeding their offspring. The small numbers of birds left in the roost during the nesting period are the non-breeding juveniles and the member of the breeding pair that is not incubating.

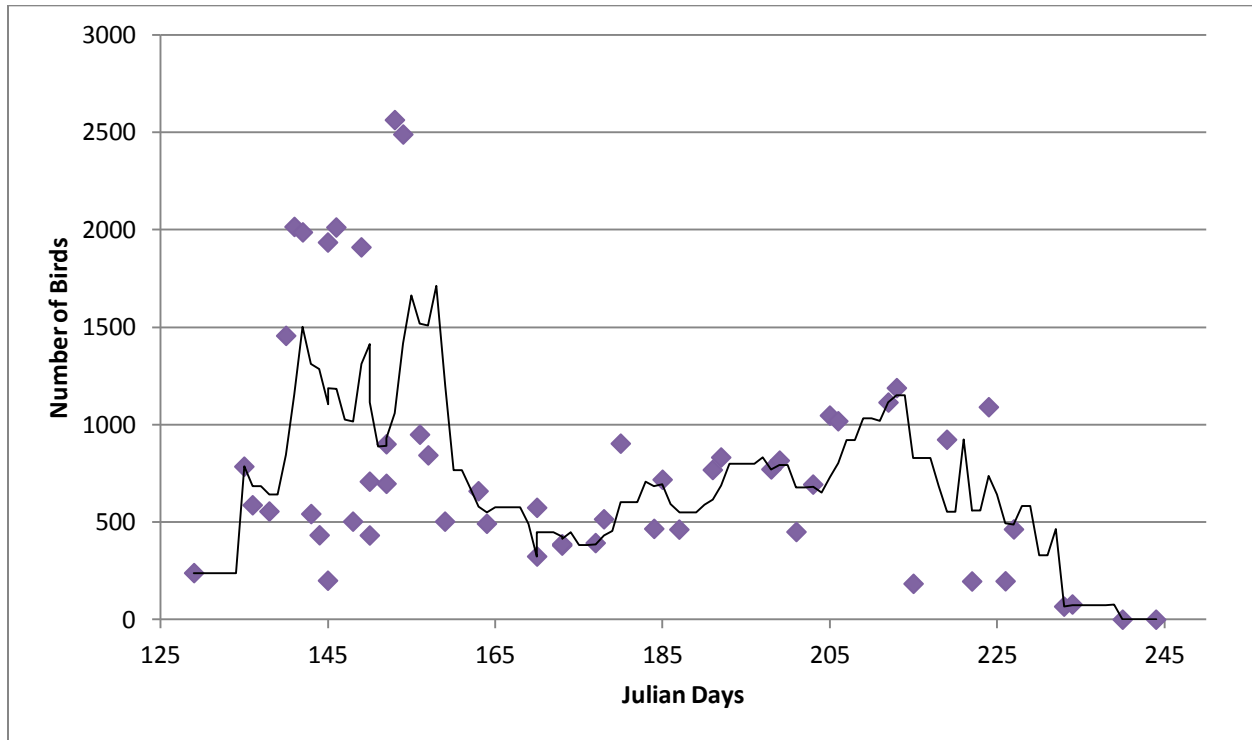


Figure 2-2 Number of Chimney Swift at the NPD stack for every roost counts conducted since 2010 presented in Julian days

2.2.2.1.2 Recommendations

The provincial ESA [6] and General regulations [13] prescribed specific guidance in case of activities that would result in the demolition of an existing structure that provides Chimney Swift habitat. The Regulations [13] dictate that replacement habitat must be created if the structure will no longer be suitable as habitat.

In spite of the recommendations, to our knowledge, very little work has been conducted on Chimney Swift roost sites replacement habitat and potential success. In 2012, CNL and Trent University initiated a project to study Chimney Swift behaviour within a large roost. This work provided CNL with some indication of the Chimney Swift behaviour within a roost and how they disposition themselves at night. This work is the first of its kind in Canada. The preliminary results of this work provided us some indication of characteristics that seem to attract Chimney Swift and confidence that a successful alternative habitat could be built. In addition, CNL has contracted out a literature review of the characteristics of the super roosts located in Ontario and Quebec as well as a review of the characteristics and success of the five alternative roost sites that have been built in the US (4 roosts) and in Canada (Qc) (1 roost). The report [14] provides a list of features common to the super roosts and a list of recommendations adapted to our climate to be included in the design of an alternative habitat.

CNL has explored several options to mitigate the removal of the NPD stack and habitat replacement is the preferred option.

2.2.2.2 Nightjars

The Eastern Whip-poor-will (*Antrostomus vociferous*) is a nocturnal aerial insectivore classified as a medium sized bird, with a well camouflaged plumage which consists of mostly grey, brown and small amounts of black. They have a small beak that opens to a massive mouth, lined with bristles they can use to sense bugs while in flight [15].

The species chooses its habitat based more upon forest structure rather than being attracted to certain tree species, but have also been associated with tree species such as pine, oak, aspen and birch. Mid-succession forests or coniferous plantations seem to be the most appealing habitats for nesting, however the Eastern Whip-poor-will has been reported to nest on rock or sand barrens. Feeding takes place around marshes with trees, and around power lines as these give them perches to 'sally' from to catch insects such as beetles, moths, ants and bees. Whip-poor-wills are also territorial and will establish areas of 3-11 ha (average of 5 ha) as a home range [16]. Site fidelity was noted in many of the breeding pairs that were monitored in a study in Kansas, providing reason to expect Eastern Whip-poor-wills to return to the previous nesting grounds [15].

The species has seen a drastic decline over the last 40 years. Estimates from Breeding Bird Studies have reported a 75% decrease in Whip-poor-will populations. As the population declines, studies have shown that the range of the animal has contracted significantly with most of the population extirpated from south-western Ontario [15].

The Common Nighthawk (*Chordeiles minor*) is also a nocturnal aerial insectivore. This species is considered a medium-sized bird (approximately 82 g), "characterized by long, slender, pointed wings, and by a long, slightly notched tail" [17]. Its colouration of brown, black and buff help it remain camouflaged while roosting in trees or nesting on the litter of the forest floor.

As stated above, many of the aerial insectivores are experiencing drastic declines in population and have been for decades. Currently, the population of Common Nighthawks that breeds in Canada is roughly 400,000 adults which, represents a 49.5% decline over the last 10 years [17].

The reasons for the Common Nighthawk population decline are still unknown. As they are an insectivorous species, decreases in insects due to large-scale pesticides are a possible cause for Common Nighthawk declines. As their required habitat includes open areas such as rock barrens, beaches, forest clearings and pastures, the Common Nighthawk took advantage of the European settlement when newly open habitats were created with extensive deforestation. Therefore, another possible reason for population decline can include loss of habitat due to forest fire suppression, reforestation, intensive use of agricultural land, and the replacements of gravels roofs with tar covered roofs.

2.2.2.2.1 Protocol and Findings

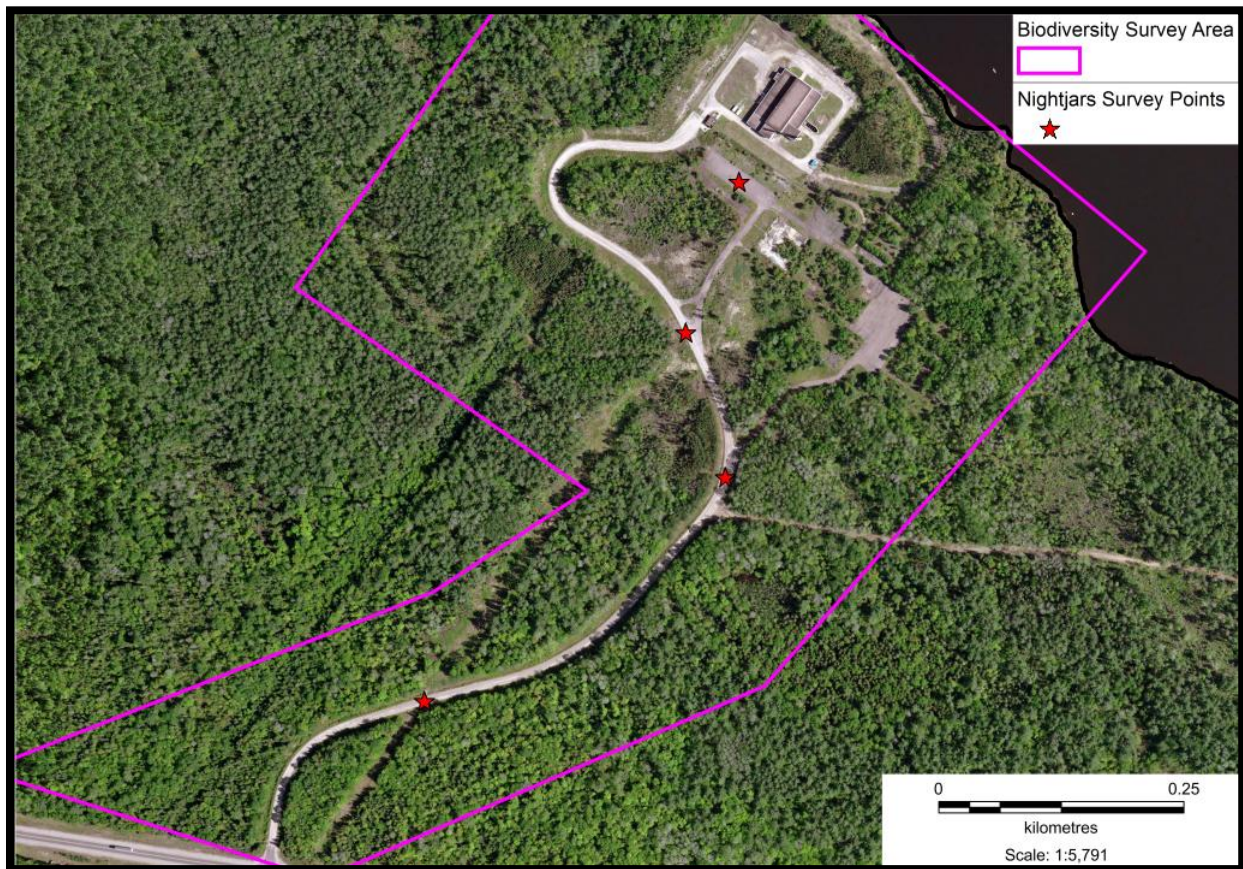
CNL conducted a screening survey at the NPD site for Nightjars (Whip-poor-wills and Common Nighthawk) in the summer of 2014. As Nightjars are nocturnal, the survey was completed on the night of June 10th during the breeding season. The survey protocol adopted by CNL was based on the Ontario Whip-poor-will Project: *'Where in the Square?' Whip-poor-will Pilot Project Participant's Guide* [18].

Selection of Survey Points

The NPD site covers a total of approximately 403 hectares. Several habitats are present such as:

- Recently harvested forests;
- Lakeshores, and river banks;
- Association of deciduous and pine species with large openings; and
- Semi-open forests or patchy forests with clearings (barrens);

The Survey points were selected on the night of the survey along the primary access road which is deemed sufficient to cover the entire work area identified for decommissioning (Figure 2-3).



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Figure 2-3 Nightjars Survey Points- aerial view.

Timing of the survey and environmental conditions

The seasonal window to conduct Nightjar surveys is between May 15th and July 31st. The optimal time to conduct surveys is on a calm, clear night during the eight day period between the first quarter and the full moon of June.

Surveys must start at least 30 minutes after sunset when the moon is above the horizon, and end no later than 30 minutes before sunrise. The sky must be clear of clouds; little to no wind, no precipitation and the temperature must be above 10°C [18].

Protocol

At each survey point the following information was recorded:

- Survey point number;
- Names of observers;
- Date and time of the survey;
- Sunset and moonrise time;
- Weather (temperature, wind, and sky conditions e.g., moon visibility);
- Stop information (physical description and GPS coordinates in UTM (Nad83));
- Vehicle Odometer reading;
- Survey start time at each stop;
- Traffic and noise level observed.

Once the information listed above was recorded, a three-minute period of Nightjar observations occurred followed immediately by a second three-minute period. During the second three-minute period, information was recorded on additional birds only. If the same bird keeps calling during the second three-minute period, it was noted. Information collected for each individual of the targeted species was as follows:

- Distance of the birds from the observers;
- Direction;
- Total number of birds calling.

Findings

During the Nightjars targeted surveys, no Whip-poor-will or Common Nighthawk were heard. In addition, at no time Whip-poor-will was heard during a Chimney Swift count over the past 6 years but a Common nighthawk was seen flying by. Therefore, we are confident that no Whip-poor-will are using habitat in close proximity to the decommissioning area identified, but Common nighthawk could be present, although we never heard one.

2.2.2.2.2 Recommendations

- Inspection of the roof of the main building prior to demolition work to ensure no Common nighthawk nest is present.

2.2.2.3 Forest songbirds

During May and June of 2014, the first forest songbird survey at the NPD site was conducted.

2.2.2.3.1 Protocol and Findings

Three locations were selected within forested areas at NPD using passive recorders where audio files were analyzed for the presence of forest songbird species. Recordings using an acoustic recorder (SM2+ Terrestrial Acoustic package, Wildlife Acoustics, Maynard, Massachusetts) were taken every hour for five minute lengths from 5:30 to 9:30 am, between May 12th and June 17th, 2014, for at least one day.

- 5 minutes at 5:30 (e.g June 16 from 5:30-5:35)
- 5 minutes at 6:30 (e.g June 16 from 6:30-6:35)
- 5 minutes at 7:30 (e.g June 16 from 7:30-7:35)
- 5 minutes at 8:30 (e.g June 16 from 8:30-8:35)
- 5 minutes at 9:30 (e.g June 16 from 9:30-9:35)

Recorder Placement

The recorders were placed in field locations that had the potential to record the highest number of different songbird species. The physical attributes of the locations where recorders were deployed were documented as follows:

- Location name/waypoint name;
- Ground cover description;
 - % Vegetation (e.g. plants);
 - % Other (e.g. rocks);
- Canopy cover
 - % Cover
- General description
 - Forest structure, distance to roads, etc.

The location name/waypoint name refers to the corresponding GPS point that was taken with a Garmin, Oregon 400t. A map of forest songbird audio recorder locations is shown in Figure 2-4.



Figure 2-4 Aerial view of the Forest songbird recorder locations

Audio Files Analysis

The audio files collected to date have been analyzed using the Cornell University’s Raven software [19]. This program helps the user identify species by viewing spectrograms of the audio file while listening to it. After importing a file into the software, the spectrograms created from the recordings can be compared against reference spectrograms of bird calls.

Audio file analysis included the identification of breeding evidence for the targeted species listed. Evidence of breeding was noted in accordance with the Guide of Participant of the Ontario Breeding Bird Atlas [20] as follows:

Observed

- Species heard in its breeding season (no evidence of breeding). Presumed migrants should not be recorded.

Possible Breeding

- Species heard in its breeding season in suitable nesting habitat;
- Singing male present, or breeding calls heard, in its breeding season in suitable nesting habitat;

Probable Breeding

- Pair heard in their breeding season in suitable nesting habitat;
- Permanent territory presumed through registration of territorial song on at least two days, a week or more apart, at the same place;
- Agitated behaviour or anxiety calls of an adult.
- Confirmed Breeding

Forest Songbird Data Results

The list of targeted Forest Songbird identified at the 3 surveyed sites is presented below.

Table 2-2 A list of the targeted Forest Songbirds identified at the 3 surveyed sites.

Survey Location	Species	Date(s) Recorded	Singing Territorial Calls
NPD-01 (E 294682 N 5118238)	Black-Throated Blue Warbler	May 14 th , 2014	Yes
		June 14 th , 2014	Yes
		June 15 th , 2014	Yes
		June 16 th , 2014	Yes
		June 17 th , 2014	Yes

Survey Location	Species	Date(s) Recorded	Singing Territorial Calls
	Black-Throated Green Warbler	May 13 th , 2014	Yes
		June 16 th , 2014	Yes
	Chestnut-Sided Warbler	May 13 th , 2014	Yes
		June 14 th , 2014	Yes
		June 16 th , 2014	Yes
		June 17 th , 2014	Yes
	Eastern Wood-Pewee	June 16 th , 2014	Yes
	Nashville Warbler	May 14 th , 2014	Yes
		June 15 th , 2014	Yes
	Veery	May 13 th , 2014	No
		May 14 th , 2014	Yes
			No
		June 16 th , 2014	Yes
	White-Throated Sparrow	May 13 th , 2014	Yes
		May 14 th , 2014	Yes
		June 14 th , 2014	Yes
		June 16 th , 2014	Yes
June 17 th , 2014		Yes	
NPD-02 (E 294812 N 5118328)	Black-Throated Blue Warbler	June 14 th , 2014	Yes
		June 15 th , 2014	Yes
		June 16 th , 2014	Yes
	Black-Throated Green Warbler	June 16 th , 2014	Yes

Survey Location	Species	Date(s) Recorded	Singing Territorial Calls
	Cape May Warbler	June 14 th , 2014	Yes
		June 15 th , 2014	Yes
		June 16 th , 2014	Yes
	Chestnut-sided Warbler	May 13 th , 2014	Yes
		June 14 th , 2014	Yes
		June 15 th , 2014	Yes
		June 16 th , 2014	Yes
	Common Yellowthroat	June 16 th , 2014	Yes
	Nashville Warbler	May 13 th , 2014	Yes
		June 16 th , 2014	Yes
	White-Throated Sparrow	May 13 th , 2014	Yes
		June 14 th , 2014	Yes
		June 15 th , 2014	Yes
		June 16 th , 2014	Yes
NPD-03 (E 295006 N 5118077)	Black-Throated Blue Warbler	May 14 th , 2014	Yes
	Black-Throated Green Warbler	May 14 th , 2014	Yes
	Cape May Warbler	May 14 th , 2014	Yes
	Chestnut-sided Warbler	May 14 th , 2014	Yes
	Nashville Warbler	May 14 th , 2014	Yes
	White-Throated Sparrow	May 14 th , 2014	Yes

2.2.2.3.2 Recommendations

Only the Eastern Wood-Pewee was heard at one of the survey point. We recommend the following mitigation measures for this species and all other migratory birds present.

- High risk activities, as identified by EnvP, requiring vegetation removal such as grass mowing (only if not maintained short at all times), brushing and tree cutting must be conducted outside of the migratory birds breeding season which extends between April 20th to August 20th.
- Low risk activities, as identified by EnvP, requiring vegetation removal can be carried out at any time but, if scheduled during the migratory birds breeding season, inspection of the job site to confirm the absence of nests must be conducted by a trained biologist, as defined by Environment Canada, and training must be offered to staff conducting the work for basic nest identification.
- If avoidance or rescheduling of the work outside the breeding season is not possible and nest removal is likely, permits can be issued by Environment Canada only for overabundant species or species causing damage or danger.

2.2.2.4 Mammals

Bats choose roost locations based on availability of foraging habitat and fresh water. Roosts are used to hibernate, rest and rear young. Different species have different roosts requirements and use multiple roost locations year-round to suit their seasonal needs. For example, little brown myotis (*Myotis lucifugus*) use buildings or hollow trees for maternity and summer roosts and hibernating roosts are often in caves, abandoned mines, and occasionally in buildings. Whereas the tri-coloured bat (*Perimyotis subflavus*) typically uses tree foliage for maternity roosts and caves or mines hibernation.

Small-bodied bat species that winter in caves or mines are dying from White-nose Syndrome (WNS), caused by the fungus *Pseudogymnoascus destructans* (*Pd*), (formerly known as *Geomyces destructans*). The fungus was first detected in North America in 2006 [21] and recent research provides evidences verifying that this fungus originated in Europe [22]. The fungus is psychrophilic (cold-loving), growing in humid, cold environments typical in caves where bats hibernate [23], [24]. Mortality typically occurs in the winter as the fungus causes dehydration resulting in increased frequency of arousal episodes during hibernation. The increase in activity depletes valuable fat stores, leading to starvation and death [24]. While their wings may remain damaged from the fungus, bats that survive through the winter are able to rid themselves of the fungus as their bodies warm up and become an unsuitable host for *Pd*.

While the fungus was introduced through anthropogenic activities, most of the spread throughout eastern North America has occurred via bat movement and migration. During hibernation bats form dense clusters to reduce heat and moisture loss. As a result of this close contact *Pd* is easily transferred from one bat to another. The fungus is then transported to summer roosts and subsequent hibernacula.

The populations of affected species are not expected to recover quickly because bats typically have slow population growth rates. Mortality is high in yearlings, while adults are long-lived and only produce one or two young annually [25]. Such a life-history strategy heightens the vulnerability of these bat species to high adult mortality rates. Therefore, hope for any recovery of the species is based on the likelihood that some small percentage of the population will be resistant to the effects of *Pd*. These survivors would pass on this resistance to their offspring and populations would increase. Through examination of bats in Europe which carry *Pd* a bacteria has been discovered which combats the fungus and may be used as a short-term solution to allow bats to combat infection. In the long term there is hope a vaccine can be produced to protect populations from contracting *Pd*, or that there will be a method of ridding hibernacula of the fungus that has established itself in those caves [26].

It is important to establish whether or not bat species are using NPD’s infrastructures as some bat species prefer to establish their maternity roost in buildings, and the NPD site offers suitable foraging habitat. The presence of bats in buildings scheduled for decommissioning will require additional precautions during the planning phase of projects and timing will be crucial for the protection of the species. Although habitat does not seem to be a limiting factor, destruction of good quality habitat is adding to the current main threat.

2.2.2.4.1 Protocol and Findings

A passive acoustic bat survey was conducted in 2015 in proximity of the NPD building (Figure 2-5). The recorders used were SM2-bat+ recorder with a SMX-U1 ultrasonic microphone and a SM3-bat recorder with a SMM-U1 ultrasonic microphone (Wildlife Acoustics, Maynard Massachusetts). Both units were programmed to record calls between 16khz and 192khz with a duration of 1.5 milli-second (ms) up to 50-ms. All recordings was done in full spectrum format. Recorders were set up during the day, and were set to record bat activity during the night from 21:00 until 6:00 and were left in the same positions for 2-10 nights.

Each species of bat produces a unique call signature which can be identified through visual analysis of sonograms from recorded ultrasonic (echolocation) calls. AnalookW (Titley Scientific, Columbia, Missouri) and Kaleidoscope Pro (Wildlife Acoustics, Maynard, Massachusetts) computer softwares were utilized to aid in the species identification and observations of bat activity at the NPD site. The analysis determined that the Little brown myotis, Northern myotis (*Myotis septentrionalis*) and Eastern small-footed myotis are present in proximity of the NPD building. Details of the survey results are presented in Table 2-3 below.

Table 2-3 Bat recorder (Wildlife Acoustics SM2) Locations.

Site Name	UTM (NAD83) 18T	Date 2015	Total recorder-hours	Species detected	% species at risk echolocation calls
(1) East Side of	E 294915 N 5118209	June 23 June 27	108	<u>Eastern small-footed myotis</u>	0.33

Site Name	UTM (NAD83) 18T	Date 2015	Total recorder-hours	Species detected	% species at risk echolocation calls
Building		July 7		<u>Little brown myotis</u> , <u>Northern myotis</u> , Big brown bat, Silver-haired bat, Hoary bat	
(2) North Side of Building	E 294886 N 5118258	June 23 June 26	39	Big brown bat, Silver-haired bat, Hoary bat	0.00
(3) West Side of Building	E 294829 N 5118244	June 30	13	Big brown bat, Silver-haired bat, Hoary bat	0.00
(4) South Side of Building	E 294846 N 5118183	July 7	27	<u>Little brown myotis</u> , <u>Northern myotis</u> , Big brown bat, Silver-haired bat, Hoary bat	0.048



Figure 2-5 Bat recorder locations-aerial view.

2.2.2.4.2 Recommendations

The surveys conducted detected the presence of bats flying in the open area around the building. There is currently no evidence of a roost located inside the building. Nevertheless, due to the presence of bat species at risk feeding in the area, it is recommended that:

- a visual inspection be completed inside the building to confirm that no roost are present in the building prior to decommissioning;
- all potential entry points around the building should be plugged; and
- any bat sighting inside the building be reported to EnvP;
- a follow-up study should be conducted in 2016 allowing for further acoustic monitoring both passively and actively.

Although habitat is not deemed as the most limiting factor for bat conservation, anthropogenic structures that contain maternity roosts are classified as a “residence” under SARA, and therefore protected. If a known roost must be removed as part of NPD operations, mitigation measures such as; the installation of artificial bat houses and planning work outside of the maternity roosting period will have to be implemented. There may be additional timing restrictions on decommissioning and operational activities within the building.

2.2.2.5 Plants

Terrestrial and shoreline vegetation characterization surveys were conducted in June and July of 2014 at the NPD site. The purpose of the surveys were to characterize land areas around the site where decommissioning operations will occur and identify any potential Butternut trees or American Ginseng.

2.2.2.5.1 Protocol and Findings

Below in Figure 2-6 is an aerial view of the NPD site where vegetation characterizations have been conducted.



Figure 2-6 Vegetation Characterization Site Locations-aerial view.

Terrestrial Survey

Terrestrial surveys occurred along the NPD main road. Every 200-m a location was surveyed 30 m into the forest on both sides of the road (Figure 2-6). At each point the following information was recorded in detail:

- location information;
- upper canopy;
- lower canopy;
- ground layer;
- ground surface;

- anthropogenic features;
- habitat features;
- forest type;
- wildlife present, and;
- weather conditions.

Detailed information for each location is presented in the Table below (Table 2-4).

Table 2-4
Terrestrial survey characterization details.

Date and Site Name	Easting	Northing	Ground description	Anthropogenic factors	Type of Forest	List of Vegetation Present
June 14, 2015 Songbird B	294682	5118238	Rock Fragments >5mm in diameter, leaf litter (3cm deep), downed woody debris and moss (polytrichum sp. & mniium sp.)	Close to NPD control area fence. Old landfill that has experienced succession.	Mixedwood forest	White birch, Trembling aspen, Spruce, Balsam fir, Red maple, Eastern White-cedar, Mayflower, Carex sp., Bush honey suckle, Fragrant bedstraw
June 17, 2014 Songbird A	294812	5118328	Leaf litter (3cm deep), downed woody debris and moss.	Near old Mattawa Road. Slightly disturbed with edge effects, some NPD waste.	Mixedwood forest	Red maple, Eastern White-cedar, Hemlock, White pine, Red pine, Balsam fir, Trembling aspen, Beech, Hazelnut, Red oak, Red maple, Lady fern, Wild salsaparilla, Bunch berry, Wintergreen, Mayflower, Pink lady's-slipper
June 17, 2014 Songbird C	295006	5118077	Rock Fragments >5mm in diameter, leaf litter (2cm deep)	Former training centre	Young mixedwood forest	Largetooth aspen, Red oak, Red maple, White birch, White pine, Hazelnut, Red pine, Wintergreen, Wild ginger, Sweet fern, Mayflower, Bracken fern

Date and Site Name	Easting	Northing	Ground description	Anthropogenic factors	Type of Forest	List of Vegetation Present
June 18-19, 2014 NPDVS4	294834	5117854	Litter (5cm deep), moss and lichen (coral moss), thin soil	Disturbed, previously excavated and backfilled	Young mixedwood forest	White pine, Balsam fir, Red maple, Hazelnut, Sweet fern, Wild ginger, Skunk currant, Cow vetch, Mayflower
June 19, 2014 NPDSV5	294711	5118036	Leaf litter (1cm deep), moss (pleurozium schreberi, haircap moss polytric)	None	Young mixedwood forest	White pine, Red maple, Red pine, Ironwood, Hazelnut, Balsam fir, White spruce, Wild sarsaparilla, Red osier dogwood, Wild ginger, Mayflower
June 19, 2014 NPDSV6	294776	5117875	Rock fragments >5mm (very few), leaf litter (2cm), moss (pleurozium schreberi, coral lichen, cladine douce, dicranum polysetum)	Plantation	Mixedwood forest	Redpine, Jack pine, White birch, Sweet fern, Red maple
June 19, 2014 NPDVS7	294852	5117850	Leaf litter (2cm deep), downed woody debris	Manmade rows of till Not in use waste site near old camp	Mixedwood forest	Red maple, Red oak, Red pine, Balsam fir, White pine, Largetooth aspen, Hazelnut, Mayflower, Wild sarsaparilla, Ground pine,

Date and Site Name	Easting	Northing	Ground description	Anthropogenic factors	Type of Forest	List of Vegetation Present
June 19, 2014 NPDVS8	298683	5117724	Rock fragments >5 mm in diameter, leaf litter (3 cm deep), woody litter, moss: pleurozum schreberi & polytricum sp.	None	Mixedwood forest	Red maple, Largetooth aspen, White spruce, Balsam fir, Red pine, Striped maple, Mayflower, Red maple, Starflower
June 19, 2014 NPDVS9	294728	5117692	Leaf litter (2 cm deep), moss (pleurozum schreberi & plume moss)	Manmade hill from small boulders	Mixedwood forest	Largetooth aspen, Sugar maple, Red maple, White pine, Balsam fir, Red osier dogwood, Wild sarsaparilla, Mayflower
June 19, 2014 NPDSV10	294526	5117654	Rock fragments >5 mm in diameter, leaf litter (2 cm deep), woody litter	Powerline	Cleared	Sugar maple, Ironwood, Balsam fir, Raspberry, Red maple, Wild sarsaparilla, Mayflower, Strawberry, Yarrow, Cow vetch, Redtop, Bladder campion
June 20, 2014 NPDVS11	294538	5117596	Leaf litter (10 cm deep), lots of woody debris, moss	None	Mixedwood forest	Largetooth aspen, Red maple, White birch, Balsam fir, Ironwood, Starflower, Mayflower, Bunchberry

Date and Site Name	Easting	Northing	Ground description	Anthropogenic factors	Type of Forest	List of Vegetation Present
June 20, 2014 NPDVS12	294333	5117552	Leaf litter (2cm deep), moss (ribbed bog moss & haircap moss)	Near Hwy 17	Mixedwood forest near a bog	White spruce, Yellow birch, White ash, Balsam fir, Bunchberry, May flower Lady fern, Ostrich fern
June 20, 2014 NPDVS13	294388	5117521	Rock fragments >5mm in diameter, leaf litter (5 cm deep), moss (pleurozum schreberi & coral lichen)	Near Hwy 17	Mixedwood forest	White spruce, White birch, Red maple, Yellow birch, Balsam fir, Basswood, Starflower, Bunchberry, Lady fern, Mayflower, Goldthread, Ostrich fern, Sensitive fern, Wild sarsaparilla

Shoreline Characterization

The shoreline characterization had a similar process as the terrestrial however two locations were selected in areas impacted by anthropogenic activities, (the location of two effluent outflow pipes located in the Ottawa River). In addition to the anthropogenic survey sites, two other natural sites were selected on the shoreline further down from the first sites to provide a normal or basis of reference (Figure 2-6). At each of the shoreline characterization sites the following information was recorded in detail: location information, aquatic vegetation (floating, submerging, and emergent), breeding activity, known discharges into water, vegetation layers of adjacent forest (lower canopy, ground layer), anthropogenic features, habitat features, forest type, wildlife present, and weather conditions.

Table 2-5
Ottawa River shoreline survey characterization details.

Date and Site Name	Easting	Northing	Bank Description	Anthropogenic Factors	Adjacent Upland Site Description	List of In-Water Vegetation Present
July 18, 2014 Site #1	295104	5118200	Small stones, slight 5% slope and no erosion present	Manmade shoreline and presence of waste items	Dense jack pine mixed forest	Marsh spikerush
June 18, 2014 Site #2	295023	5118239	Small stones and 20% slope. Minimal signs of erosion	Manmade shoreline and presence of waste items, property fencing and campfire evidence	Jack pine mixed forest	One emergent plant species not identified
June 18, 2014 Site #3	294970	5118315	Boulders and gravel with a slope 15% (90% at the top of the bank). Bank erosion present	Manmade shoreline	Flat ground covered with gravel and no vegetation present	No vegetation present, only rocks

Date and Site Name	Easting	Northing	Bank Description	Anthropogenic Factors	Adjacent Upland Site Description	List of In-Water Vegetation Present
July 24, 2014 Site #4	294884	5118403	Rocky with large boulders and a 40% slope. No erosion present	Storm water drain nearby	Mixedwood forest	Pondweed sp.
July 24, 2014 Site #5	295108	5118162	Sand and boulders with a 20% slope and no bank erosion	Old waste items present	Sparse forest with open canopy. Part of the forest is dominated by Eastern White-cedar	Marsh spikerush

No species at risk were identified during the surveys. Terrestrial and shoreline characterization information could be used in the future to assess the presence of habitat for other species.

2.2.2.5.2 Recommendations

- No species at risk were confirmed during the site characterization therefore, no special mitigation measures are required.
- Provide an awareness training session to workers prior to the site decommissioning. Report sighting of any species to Environmental Protection (EnvP).

2.2.3 Other Sources of Information

2.2.3.1 Fish species

We have consulted other sources of information such as the Department of Fisheries and Oceans (DFO) maps available for the Ottawa River [27] as well data collected as part of the CNL's Environmental Monitoring Program [28] to review the fish species present in the reach of the Ottawa River where the NPD site is located. One species known to be present in the Ottawa River is the Lake Sturgeon and verbal communication reported the potential presence of the River Redhorse. No other fish species were reported in the River in the vicinity of the NPD site.

2.2.3.1.1 Recommendations

Both fish species are known to spawn during May and early June [29], [30], therefore it is recommended to conduct all in-water work outside of the spawning period window for spring and summer spawning fish species which extend between May 1 and June 30, as directed by DFO [31].

Other DFO mitigation measures as outlined on their website [32] must also be implemented for the environmental aspects:

- Contaminant and spill management;
- Erosion and sediment control;
- Shoreline or bank re-vegetation and stabilization;
- Fish protection, and;
- Operation of machinery.

3. CONCLUSION AND RECOMMENDATIONS

The surveys conducted covered the entire suite of potential species at risk that could be present in the working area during the decommissioning period of the NPD site. The following recommendations should be considered during the preparation of the EER required, at minimum, prior to decommissioning of the site.

Species	Recommendations
Monarch	<ul style="list-style-type: none"> • No removal of nectaring plants outside of the construction area; • No use of pesticides on the NPD site unless reviewed and approved by Environmental Protection (EnvP).
Bald eagle	<ul style="list-style-type: none"> • Due to the distance between the nest and the construction area, no mitigation measures are required. • Monitor nest occupancy every year.
Chimney Swift	<ul style="list-style-type: none"> • Build a replacement structure.
Migratory birds	<ul style="list-style-type: none"> • Activities requiring vegetation removal such as grass mowing, brushing and tree cutting must be conducted outside of the migratory birds breeding season which extends between April 20th to August 20th. • If avoidance or rescheduling of the work outside the breeding season is not possible and nest removal is likely, survey of the area to be cleared must be conducted by an avian biologist, no more than 2 days prior to the commencement of work, to ensure that no nest will be damaged or destroyed. If this survey is not possible, a permit application to Environment Canada must be filed but only for overabundant species or species causing damage or danger.
Little brown myotis Northern myotis Tri-colored bat Eastern small footed myotis	<ul style="list-style-type: none"> • A visual inspection to be completed inside the building to confirm that no roosts are present in the building prior to decommissioning; • All potential entry points around the building should be plugged; • Any bat sightings inside the building must be reported to EnvP.
Fish species	<ul style="list-style-type: none"> • No in-water work during the fish spawning period which extends from May 1 to June 30.

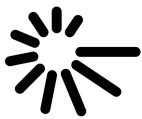
Species	Recommendations
	<ul style="list-style-type: none"> Follow DFO mitigation measures to avoid causing harm to fish and fish habitat.
Other species	<ul style="list-style-type: none"> Include other potential species at risk listed above and habitat description in the awareness training package that will be offered to workers prior to the site decommissioning. Report sightings of any species to EnvP.

Finally it is also recommended to work closely with Environmental Protection to monitor any changes in species status or addition of new species on Schedule I of SARA that could trigger additional survey requirements.

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NPD DECOMMISSIONING

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Report, General

Current Groundwater Quality at NPD

NPD Decommissioning

64-509247-REPT-001

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1. INTRODUCTION

The Nuclear Power Demonstration (NPD) facility was the prototype of the CANDU power reactor. Construction of the facility began in 1956, and the reactor went critical in 1962. The station was operated between then and 1987 by Ontario Hydro (now Ontario Power Generation), and in addition to providing power and reactor design information, the station served as the training facility for Ontario Power Generation's CANDU station staff. Following the shutdown of NPD in 1987 and the removal of the training facility, and most of the other supporting buildings, the facility was transferred to Atomic Energy of Canada Limited (AECL) who have undertaken further decommissioning work and have maintained the facility in a safe shutdown state.

Groundwater quality has been evaluated at the NPD site at various times over the past 30 years, and earlier this year the Prototype Reactor Decommissioning Program (PRDP) requested a comprehensive sampling of monitoring wells on the NPD property as part of data collection and updating for the next phase of decommissioning at the site. This report describes the survey that was undertaken, and presents and discusses the results. The report begins with a brief review of the geologic and hydrogeologic setting to provide the context. This is followed by a brief review of previous groundwater quality findings, and then by the current sampling and results.

2. SETTING

The Nuclear Power Demonstration (NPD) Decommissioning Facility is a 370 hectare block of property owned by Atomic Energy of Canada Limited (AECL) that is located on the southwest bank of the Ottawa River immediately east of the des Joachims hydroelectric station. Figure 1 displays the NPD property and the adjacent region using Natural Resources Canada's 1:50,000 map (sheet 31K4) as the base. Bedrock, which consists of granitic Precambrian biotite and hornblende gneisses, is the dominant control on topography in the region, and appreciable portions of the region around NPD have been mapped as bedrock outcrop (i.e., less than about 1.5 m of unconsolidated sediments). Figure 2 shows the surficial geology of the area mapped by Gadd [1]. Bedrock is exposed at, or almost at, ground surface along the Quebec shoreline of the Ottawa River across from NPD, and bedrock exposures are widespread to both the east and west of the tailrace channel downstream of the des Joachims hydroelectric station. The topographic high just north of Tee Lake is a bedrock ridge, and bedrock is locally exposed between the NPD property and Meilleurs Bay and to the northeast of Highway 17.

Bouldery sandy glacial till, deposited by the last continental glaciation, overlies the bedrock in parts of the study area and forms the surface material in much of the area between the Tee Lake bedrock ridge and Highway 17. Fluvial sand and gravel deposited by the Ottawa River between about 11,000 and 5,000 years before present overlies the till, or in some cases directly overlies bedrock, and forms the surficial material on the portion of the NPD property surrounding the station itself. On the NPD property coarse sand is a major component of these fluvial deposits. Sand and gravel strata are reasonably common, however, and as Gadd's map shows (Figure 2) there were two sand and gravel pits on the NPD site prior to its development. At the south end of the map area the fluvial deposits grade into fine sand. Gadd also mapped several small areas of recent organic soils that have accumulated in wetlands. Several of these are located on areas of bedrock outcrop, and one band of organic deposits is mapped on the NPD property near the northwest boundary between the sand and gravel deposits and the portion of the NPD property that is bedrock outcrop.

The reactor and the associated facilities at NPD occupy only a small portion of the 370 hectare site property, with most of the land serving as a facility buffer zone. The station and its support structures, the training centre, and the two landfills on the site are located in 43 hectare region adjacent to the Ottawa River, approximately centred on the site's 2,800 m of river frontage. The developed region is about 600 m northeast of the intersection between Highway 17 and the site's main access road. This places the developed portion of the facility in a portion of the site where fluvial sand and gravel are the surficial material, and oddly enough the two landfill sites on the NPD property are located in the two former gravel pits shown on Figure 2.

The NPD reactor and a number of the ancillary components were constructed in a bedrock excavation, with non-nuclear components of the station in an above-grade structure. From a groundwater perspective, one of the key aspects of the station's construction is the presence of a tile drain system surrounding the reactor building. The tile drains are shown in plan view on Figure 3 and in section on Figure 4. The drains were installed in shallow trenches in the bedrock

surface in order to keep the unconsolidated material (granular fill around the station) unsaturated. Tile Drain 1, which runs along the southwest side of the station, collects an average of $11.2 \text{ L}\cdot\text{s}^{-1}$ of groundwater that flows towards the station and routes this water to the Ottawa River at the Tile Drain 1 Outfall (Figure 3). The station's design also means that for portions of the facility below the water table any leakage is in to the station, and that there can be no contaminant releases to the local groundwater flow system. Groundwater seepage in to the station is directed to the Wells Area Sump (Figure 4) which is the lowest point in the station, and this sump is periodically pumped to the Ottawa River after the water has been sampled and analysed.

3. PREVIOUS GROUNDWATER MONITORING AT NPD

Information on the monitoring wells that have been installed at the NPD site is summarized in Table 1. The wells were installed in association with 4 investigations. The first set of wells were installed in May of 1988 to provide information on possible groundwater contamination arising from Landfill 1 (Figure 3), which is the landfill used for non-radiological and non-hazardous waste generated at NPD [2]. The 1988 investigation of Landfill 1 defined groundwater flow directions and velocities in the vicinity of the landfill site, and sampled and analysed the wells for radiological parameters (tritium, gross alpha, and total beta), for major standard major water quality parameters, and for trace metals. In 1995, a subset of the Landfill Site 1 wells were re-sampled and analysed for the parameter groups tested in 1988 but were also analysed for PCBs and the suites of organic parameters defined by the Ontario Ministry of the Environment's Analytical Test Groups (ATGs) 16 (halogenated volatiles), 17 (non-halogenated volatiles), 19 (base-neutral extractables), and 20 (phenolics or acid extractables). Those investigations found that groundwater downgradient of Landfill 1 had the character of very dilute sanitary landfill leachate, with manganese and iron exceeding Health Canada aesthetic objectives for drinking water quality, while groundwater upgradient of the landfill did not exceed those criteria. Groundwater from the most affected well (NPD-5) contained slightly elevated concentrations of a number of major ions, but the concentrations of all these parameters were below drinking water quality guidelines and concentrations decreased between 1988 and 1995. Tritium was found in groundwater from NPD-6 at concentrations of $1090 \text{ Bq}\cdot\text{L}^{-1}$ in 1988 and $290 \text{ Bq}\cdot\text{L}^{-1}$ in 1995, in both cases well below drinking water concentration limits. No other radiological anomalies were found in the two sampling campaigns. The suites of analyses for trace organics and for PCBs conducted on the 1995 samples were all below analytical detection limits.

In 1989, ETB installed a second set of monitoring wells around Landfill 2 (Figure 3), which occupies the former gravel pit located 420 m northwest of the NPD station. This landfill was reported to have been used for rock rubble generated during the construction of the station, but there was little documentation of its history. Six boreholes were drilled and instrumented in and adjacent to the fill in Landfill 2, and the drilling indicated that indeed the site had indeed been used, at least primarily, for construction rubble [4]. The wells were sampled for radionuclides (tritium, gross alpha, and total beta) and for pH, redox potential, conductance, and major anions and cations. There were no anomalies in groundwater quality below and downgradient of Landfill 2.

The third hydrogeologic assessment of the NPD site was undertaken in 1989-1990 for Public Works Canada as part of a characterization of the NPD station and the former location of the training centre when consideration was being given to converting the site to an RCMP training facility [5]. That assessment did not identify any groundwater contamination issues.

The fourth groundwater evaluation at NPD was initiated in 1993 when decommissioning of non-nuclear portions of the station encountered diesel fuel contamination in soil at the north corner of the station building (in the vicinity of wells BH14-01, BH15-01, and BH16-01 on Figure

3), where an underground fuel tank for the site's backup generator was located. The storage tank and most of the contaminated soil were removed, but some diesel had migrated below the adjacent building footings and could not be recovered. J.D. Paterson and Associates were retained to install monitoring wells, and two wells intended to recover free product diesel fuel [6]. AECL staff operated the recovery wells periodically over the next several years, and the small quantities of diesel that were retrieved were transferred to a storage tank in the station. The consultant was retained by AECL to conduct twice-yearly sampling of monitoring wells adjacent to the leak location and between the station and the Ottawa River for total petroleum hydrocarbons. The analyses were changed to F1 to F4 hydrocarbon fractions in 2005, where F1 are compounds with 6 to 10 carbon atoms, F2 with 10 to 16, F3 with 16 to 34, and F4 with 34 to 50 carbon atoms. The results of those samples were reported to AECL in a series of short reports or letters – since the information is not readily available elsewhere, Table 2 provides a summary of these data that ETB has compiled for the period between 1993 and 2008.

4. CURRENT CAMPAIGN

4.1 Sampling Matrix and Methods

ETB and Prototype Reactor Decommissioning staff began this project by seeking out the wells on the NPD site, collecting differentially-corrected GPS coordinates for the wells that could be located, and measuring them for static water levels. This was undertaken on 2014 June 24, and of the 34 wells listed in Table 1, six wells (NPD-1-I, NPD-5-II, NPD-6-I, MT-2, MT-4, and MT-10) could not be located. Nine of the wells that were located were found to be dry.

Table 3 provides a summary of the status of the monitoring wells that were found at the NPD site, the static water elevations for wells that were not dry, the volumes of water removed when the wells were cleaned on 2014 July 8, and the dates that the wells were sampled. The project proponent had furnished ETB with a listing of the parameter groups for which groundwater analyses were required, based on the potential for groundwater contamination in various portions of the NPD site given the facilities' histories. Table 4 lists this sampling matrix, modified to reflect the wells that were actually still present and which contained sufficient water to be sampled.

For the wells that did contain water, the standing volume in the well screen and riser pipe was calculated. On 2014 July 8 all of the wells to be sampled were re-visited and cleaned by pumping out either at least twice the volume of water standing in the well or by pumping the well to dryness. The wells were pumped either using a peristaltic pump or, when the depth to water exceeded 8 m, using a Waterra foot valve attached to a suitable length of 1.3 cm ID polyethylene tubing. In both cases, the water was collected in a graduated vessel to determine the volume recovered, and this volume was recorded.

Groundwater sampling was undertaken on 2014 July 9 and July 11, using a Waterra foot valve and 1.3 cm ID polyethylene tubing. Groundwater temperature and electrical conductances were measured at the well head using a YSI Model 30 conductivity meter and a cell calibrated with YSI standard solutions, and pH using a Beckman Model 265 meter and 511275 AB electrode, calibrated with Beckman buffer solutions. Samples for the various analysis groups were collected in appropriate containers, with filtering at the wellhead through 0.45 micron cartridge filters when required. Sample preservation (as required) was also performed at the wellhead. The samples were transported in coolers with freezer packs and kept refrigerated until analysed. Storage times were maintained in compliance with those recommended by the Ontario Ministry of the Environment. Field blanks consist of distilled water that was transported to the field and processed at the wellhead using handling, filtering, and sample preservation procedures identical to those employed for the samples.

Note that water that discharges from Tile Drain System 1 to the Ottawa River was included in the sampling campaign, since the tile drain collects overburden groundwater from a substantial portion of the NPD property to the west and southwest of the station.

4.2 Results and Discussion

4.2.1 Groundwater Flow Patterns

Table 3 provides water table elevations for site wells that contained water when surveyed at the start of this campaign. Depths to water were measured from the top of the well riser pipe. The elevations of the MT-series of riser pipes were drawn from the MacLarentech report [5]. When AECL installed the NPD-series of wells, elevations of the wells around Landfill Sites 1 and 2 were referenced to a local datum only. During this project, elevations relative to mean sea level were determined using the differentially-corrected GPS data, which are accurate only to between 0.5 and 1 m. To preserve correct relative elevations for the NPD-series of wells, an average offset between the local datums and sea level was determined and applied to all of the wells at a given landfill site. ETB has had no information on elevations that may have been previously determined for the J.D. Paterson series of wells, so for these the point GPS elevations were applied.

Figure 3 displays water table contours interpolated from the static water elevations in the monitoring wells, combined with invert elevation data for the tile drains around the NPD station and with elevations of permanent local surface water bodies (in this case the Ottawa River). The water table contours generated from these data place wells NPD-5 and NPD-7 downgradient of Landfill 1, and wells NPD-9, NPD-10, and NPD-13 downgradient of Landfill 2. The plot indicates that wells BH-13-01, BH-12-01, MT-8, and BH-07-01 are downgradient of the northern corner of the station where the underground diesel fuel leak occurred. The water table contours also indicate that any shallow groundwater contamination from Landfill 1 is collected by the tile drain system around the NPD station, as previously inferred in [2] and [5]. The localized coverage provided by the available monitoring wells, however, also leads to some limitations in the accuracy of the overall water table configuration shown on Figure 3. One aspect of this is the station tile drains' limited water table catchment indicated by the water table contours. The average discharge from Tile Drain 1 (11.2 L s^{-1}) requires a catchment area of about 117 ha, and to achieve this we would expect an appreciably greater focussing of groundwater flow towards the station than is indicated by the contours shown on Figure 3. Nevertheless, the indicated groundwater flow directions in areas of particular interest (the landfill sites and the station itself) are reliable since these locations have a reasonable density of monitoring wells. **Groundwater Radiological Quality**

Radionuclide analyses were performed on all of the groundwater samples and Table 5 summarizes the concentrations of tritium, total beta, and gross alpha activity measured in the groundwater samples after the samples had been stored for 3 weeks to ensure that, if present, ^{90}Sr would be in secular equilibrium with its ^{90}Y daughter. The table also provides the radionuclide results for two field blanks and for two duplicate samples. It also lists Health Canada's drinking water quality guideline criteria [7]. The values listed for total beta and gross alpha are the guideline's screening criteria – waters that exceed these values should be

analysed for specific beta and alpha emitters if their suitability for drinking water is being assessed.

With one exception, groundwater tritium concentrations at NPD range from below the detection limit of $30 \text{ Bq}\cdot\text{L}^{-1}$ to $82 \text{ Bq}\cdot\text{L}^{-1}$. With 1-sigma counting standard deviations averaging $22 \text{ Bq}\cdot\text{L}^{-1}$, most of the results do not show significant differences. The one exception is the sample from BH-13-01, which yielded a tritium concentration of $300 \text{ Bq}\cdot\text{L}^{-1}$. This well is located immediately downgradient of the northern corner of the NPD station and its primary purpose has been to provide monitoring for petroleum hydrocarbon contamination from the former location of the leaking underground diesel fuel tank. The source of this slightly elevated tritium is undetermined, but the concentration is well below the drinking water limit of $7000 \text{ Bq}\cdot\text{L}^{-1}$. The slightly elevated tritium concentrations in groundwater from BH-07-01 ($82 \text{ Bq}\cdot\text{L}^{-1}$) and MT-8 ($65 \text{ Bq}\cdot\text{L}^{-1}$) could be viewed as evidence of the downstream end of a small tritium plume that passes through BH-13-01, but as noted above the analytical uncertainties associated with these measurements make this inference to be of questionable significance.

Almost all of the NPD groundwater samples contained total beta activity at concentrations below the detection limit, which averaged $0.28 \text{ Bq}\cdot\text{L}^{-1}$. The two exceptions to this were the samples from MT-5 ($0.40 \text{ Bq}\cdot\text{L}^{-1}$) and BH-12-01 ($0.37 \text{ Bq}\cdot\text{L}^{-1}$), but in both cases these are within 1 standard deviation of the detection limit and hence not significant. All of the total beta concentrations are below the Health Canada screening criterion for drinking water, meaning that from that guideline's perspective no further beta measurements are required.

All of the NPD groundwater samples contained gross alpha activity at concentrations below the detection limit, which averaged $0.19 \text{ Bq}\cdot\text{L}^{-1}$. This is below the Health Canada drinking water screening criterion for gross alpha activity, so from this guideline's perspective no further alpha analyses are required.

Gamma spectral analyses were not conducted on the NPD groundwater samples since there was no detectable alpha activity and either undetectable or non-significant total beta activity. The detection limits for gamma-emitting radionuclides vary depending on the yield and energy of specific gamma rays, but using our standard analytical protocol the detection limits for gamma emitters are generally greater than $1.5 \text{ Bq}\cdot\text{L}^{-1}$. With the observed total beta and gross alpha activities, no gamma emitters would be identified.

4.2.3 Major Ion Water Quality

Table 6 provides wellhead measurements (temperature, pH, and electrical conductance) measurements for the 2014 July NPD groundwater samples, as well as the concentrations of dissolved organic carbon (DOC) and major anions (alkalinity as HCO_3^- , Cl^- , F^- , Br^- , SO_4^{2-} , PO_4^{3-} , and NO_3^-). Table 7 lists the concentrations of ammonia, Total Kjeldahl Nitrogen (TKN), and major cations. Table 8 lists the concentrations of Mn, Al, Ba, Pb, Cu, and Zn, while Table 9 lists the concentrations of Cr, Co, Ni, As, Cd, and U. The tables include the drinking water quality maximum acceptable concentrations or aesthetic objectives where such parameters have been specified by Health Canada [7]. With the exception of NPD-5-I, which is downgradient of

Landfill 1, groundwater pHs ranged from 5.7 to 7.0. The groundwater at NPD-5-1 had a pH of 8.6, which is comparable to the pH observed there in 1988 and which was attributed to this well being screened in glacial till rather than the (probably) less calcareous fluvial sand and gravel. The highest electrical conductance was observed at NPD-2-1, which is upgradient of Landfill 1 but which, based on its chloride content (also the highest in the data set) is most affected by road salt contamination arising from Highway 17. All of the wells around Landfill 1 are affected to some degree with road salt contamination, whereas wells in the vicinity of Landfill 2 (NPD-9 to NPD-14) have chloride concentrations that average $0.5 \text{ mg}\cdot\text{L}^{-1}$.

Groundwater passing below the Landfill 2 site, therefore, is recharged north of Highway 17.

Apart from the low levels of road salt contamination, the local groundwaters have major ion characteristics that are consistent with short-residence-time groundwaters in soils low in carbonate minerals. Although wellhead measurements of redox potential could not be made (due to insufficient water production from the wells) the very low iron concentrations and the presence of moderate concentrations of sulphate show that the local groundwaters are now oxidizing, both upgradient and downgradient of Landfill 1. The concentrations of Manganese did marginally exceed the aesthetic objective for drinking water ($50 \text{ ug}\cdot\text{L}^{-1}$) in groundwater samples from NPD-10 ($52 \text{ ug}\cdot\text{L}^{-1}$), which is downgradient of Landfill 2. The concentration of manganese in groundwater from MT-8, which is downgradient of the northern portion of the NPD station, was $280 \text{ ug}\cdot\text{L}^{-1}$ in the 2014 July sample. The manganese anomalies at both of these locations do indicate slightly reducing conditions at these locations in the flow system. Given the absence of other indicators of reducing conditions, however, the manganese results are not interpreted to be a result of landfill leachate contamination delivering appreciable quantities of degradable organics to the local flow system.

The general absence of strongly reducing conditions in the local groundwater flow system is also supported by the near absence of ammonia and of Total Kjeldahl Nitrogen (or TKN, which provides the total amount of nitrogen present in organic compounds, ammonia, and ammonium). Elevated concentrations of TKN in groundwater are indicative of inputs of organic degradation products from sewage or readily decomposed organic materials (e.g., food wastes in landfills). Stable Sr, which lies between major and a trace element in terms of its concentrations in study area groundwater, is correlated with the concentrations of calcium. Strontium is a calcium analogue and commonly substitutes for calcium in minerals – it is not considered indicative of contamination in the NPD groundwaters.

4.2.4 Trace Element Water Quality

Table 8 and Table 9 present the results of analyses of NPD groundwaters collected around the two landfill sites and from around the NPD station for trace elements. When detected, all of these elements are present in concentrations well below drinking water guidelines and there is no evidence for increased concentrations downgradient of the two landfill sites or the station itself.

4.2.5 Anthropogenic Organic Compounds

Table 10 lists the results of the analyses for total PCBs and for petroleum-related hydrocarbons in the groundwater samples specified for these determinations. None of the groundwaters contained detectable concentrations of PCBs. The laboratory performing the analyses for anthropogenic organic compounds (RPC of Fredericton, New Brunswick) employs a classification of petroleum components by molecular weight of carbon, but the analysis scheme provides essentially the same information as that obtained using the Ontario Ministry of the Environment F1 to F4 classification. As Table 10 lists, trace concentrations of Total Petroleum Hydrocarbons (TPHs) were detected in the groundwater samples from wells BH-12-01 and BH-13-01, which are immediately downgradient of the diesel fuel leak. High molecular weight petroleum hydrocarbons were, however, also detected in the sample from BH-09-01, which is downgradient from the southern side of the NPD station but not on a flowpath from the former location of the underground diesel tank. The absence of volatile components and the fact that most of the hydrocarbons fall in the C21 - C32 fraction indicate that the material is either very old or was consisted from the start of non-volatile hydrocarbons (e.g., lubricating oil). It should be noted that all of the petroleum hydrocarbon concentrations are extremely low (in fact, below the detection limits for the analyses supplied by J.D. Paterson and Associates).

Table 11, Table 12, and Table 13 list the results of groundwater analyses for the halogenated volatile organic compounds that make up Analytical Test Group 16 for the wells specified in the site's sampling matrix (wells around Landfill 1 and the available MacLarentech wells). None of the compounds were detected. Table 14 provides the results for Analytical Test Group 17 (non-halogenated volatiles) and ATG-18 (soluble volatiles), which again were conducted on samples from the vicinity of Landfill 1 and the NPD station. None of the compounds were detected in the set of groundwater samples. Table 15, Table 16, Table 17, and Table 18 list the compounds that comprise ATG-19, which are organics extractable from water under neutral and basic pHs and which include a variety of polyaromatic hydrocarbons (PAHs). Samples from all of the available study area wells except NPD-7 and BH-07-01 were submitted for analyses of ATG-19 parameters (the two wells were excluded because of the limited quantity of groundwater available). None of the ATG-19 parameters were detected with the exception of Bis(2-ethylhexyl)phthalate, which is a very widely used plasticizer. Its presence in both of the travelling blanks shows it to arise from the sampling equipment, and no significance is attached to its detection in a number of the groundwater samples. Table 19 and Table 20 list the results of groundwater analyses for compounds in ATG-20, organics extractable from water under acidic pHs and which include a number of phenolics. There were no detectable concentrations of any of these compounds in the NPD samples. Table 21 lists the results for ATG-23, which consists of polychlorinated organic compounds extractable under neutral pH conditions. Again, there were no detections of compounds in this class.

5. CONCLUSIONS

Twenty-seven of the 34 monitoring wells that have been installed at NPD were located in 2014 June, and 18 of them had sufficient water for sampling. Water discharging from Tile Drain 1, the leg of the drainage system around the NPD station that intercepts groundwater flowing towards the station through the overburden and which discharges to the Ottawa River at an average rate of $11.2 \text{ L}\cdot\text{s}^{-1}$, was also sampled in this campaign. The locations of all of the monitoring wells found in 2014 June were determined by differentially-corrected GPS measurements, which provide locations and elevations accurate to 1 m or less. Static water level measurements were used to determine water table elevations and these data were combined with invert elevations for the stations tile drains and with elevations of permanent surface water features to generate a water table contour map. Because of the variable density of monitoring wells, the accuracy of the water table contour map is also somewhat variable. In the vicinity of the landfill sites and the station, which is where most of the monitoring wells are located, groundwater flow directions defined sufficiently well to define the flowpaths between those features and the sampling locations. It should be noted that the reactor and most of the structures associated with the handling of fuel are located in a bedrock excavation and lie below the water table. As a result, any groundwater leakage associated with this part of the station is inwards rather than outwards, with the water being collected in the Wells Area Sump where it is sampled prior to periodic pumping to the Ottawa River.

All of the groundwater samples were analysed for tritium, total beta, and gross alpha activity. Tritium concentrations were, with one exception, less than $85 \text{ Bq}\cdot\text{L}^{-1}$, and in several samples below the detection limit of $30 \text{ Bq}\cdot\text{L}^{-1}$. These results are consistent with local washout of tritiated water vapour that is periodically vented to the atmosphere from the station. Groundwater from well BH-13-01, about 7 m downgradient (towards the Ottawa River) from the northern corner of the station building, contained $300 \text{ Bq}\cdot\text{L}^{-1}$ of tritium. Although anomalous, this is well below the drinking water maximum acceptable concentration (MAC) of $7000 \text{ Bq}\cdot\text{L}^{-1}$. Groundwater concentrations of total beta activity were mostly below the detection limit of $0.28 \text{ Bq}\cdot\text{L}^{-1}$, and for all three of the samples that reported a total beta concentration the value was less than 1 counting standard deviation above the detection limit and hence not statistically significant. No samples contained gross alpha activity that exceeded the detection limit of $0.16 \text{ Bq}\cdot\text{L}^{-1}$. Because the total beta and gross alpha concentrations were less than the detection limits achievable by gamma spectrometry, no gamma analyses were performed on the groundwater samples.

The inorganic water quality results show that there are no significant effects on groundwater quality from either of the landfill sites or from the station itself. The suites of organic analyses also showed no detectable concentrations of:

- Total PCBs,
- Volatile halogenated organics in Analytical Test Group 16 (ATG-16),
- Volatile non-halogenated organics in ATG-17,
- Water-soluble volatile organics in ATG-18,

- Base/neutral extractable organics (including various PAHs) in ATG-19,
- Acid extractable organics (including phenol and various chlorinated phenols) in ATG-20, and
- Neutral chlorinated extractable organics in ATG-23.

The analyses for petroleum hydrocarbons detected up to $70 \text{ ug}\cdot\text{L}^{-1}$ of hydrocarbons with carbon contents of greater than 10 carbon atoms per molecule in samples from wells BH-09-01, BH-12-01, and BH-13-01. The latter two of these wells are immediately downgradient of the former location of the leaking underground diesel fuel tank. The tank and most of the contaminated soil were removed in 1993, but some fuel contamination extended into soil below the building and could not be completely recovered. Subsequent groundwater monitoring found decreasing levels of hydrocarbon contamination in this region, so the presence of trace concentrations of high-molecular weight fuel hydrocarbons in samples from these two wells is not unexpected. The detection of a trace amount of low-volatility hydrocarbons in groundwater from BH-09-01 is a bit less expected, since this well is not apparently downgradient of the diesel leak location. It is, however, downgradient of the NPD station. None of the samples contains total petroleum hydrocarbon concentrations that exceed the $200 \text{ ug}\cdot\text{L}^{-1}$ concentration recommended in the Environment Canada guideline for high-sensitivity sites.

In conclusion, the groundwater sampling and analysis campaign undertaken at NPD in the summer of 2014 did not detect any instances of groundwater contamination that exceed available federal water quality guidelines for drinking water.

6. ACKNOWLEDGEMENTS

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Table 1
Summary of information on monitoring wells that have been installed on the NPD property

Borehole	Monitor	Date	Agency	GPS UTM Coords (NAD83)		Elevation (m asl)		Stick-Up (m)	Diameter (cm)	Material	Screen	Depth Below Grade (m)	
				Easting	Northing	TOP	Grade					From	To
NPD- 1	I	1988	AECL	294612.7	5118014.9	141.76	140.96	0.80	3.2	PVC	Johnson	9.79	10.55
NPD- 2	I	1988	AECL	294579.5	5118045.5	141.54	140.61	0.93	3.2	PVC	Johnson	9.26	10.02
NPD- 4	I	1988	AECL	294570.0	5118087.8	142.20	141.65	0.55	3.2	PVC	Johnson	11.90	12.66
NPD- 5	I	1988	AECL	294685.1	5118080.8	136.69	135.92	0.77	3.2	PVC	Johnson	11.05	11.81
NPD- 5	II	1988	AECL	294685.1	5118080.8	136.61	135.91	0.70	3.2	PVC	Johnson	8.65	9.41
NPD- 6	I	1988	AECL	294654.0	5118102.2	136.23	135.24	0.99	3.2	PVC	Johnson	9.19	9.95
NPD- 7	I	1988	AECL	294633.1	5118123.9	135.15	134.15	0.99	3.2	PVC	Johnson	7.31	8.08
NPD- 8	I	1988	AECL	294587.3	5118151.1	144.42	143.56	0.85	3.2	PVC	Johnson	15.86	16.62
NPD- 9	I	1989	AECL	294528.7	5118484.4	134.94	134.10	0.84	3.2	PVC	0.25 mm	2.41	3.93
NPD- 10	I	1989	AECL	294546.4	5118537.4	134.06	133.20	0.86	3.2	PVC	0.25 mm	1.49	3.01
NPD- 11	I	1989	AECL	294490.4	5118504.8	137.43	136.60	0.83	3.2	PVC	0.25 mm	4.58	6.10
NPD- 12	I	1989	AECL	294503.9	5118456.7	135.65	134.70	0.95	3.2	PVC	0.25 mm	2.73	4.25
NPD- 13	I	1989	AECL	294536.3	5118568.1	138.14	137.20	0.94	3.2	PVC	0.25 mm	6.17	7.69
NPD- 14	I	1989	AECL	294454.3	5118453.3	137.72	136.80	0.92	3.2	PVC	0.25 mm	4.78	6.30
MT- 1		1989	MacL	294592.7	5117997.8	140.02	139.27	0.75	5.0	PVC	TriLoc 0.010"	8.98	10.5
MT- 2		1989	MacL	294690.7	5118088.3	134.34	134.02	0.32	5.0	PVC	TriLoc 0.010"	13.60	15.12
MT- 3		1989	MacL	294538.0	5118507.9	131.68	131.06	0.62	5.0	PVC	TriLoc 0.010"	1.37	2.90
MT- 4		1989	MacL	294926.1	5118082.3	135.49	134.92	0.57	5.0	PVC	TriLoc 0.010"	9.90	11.42
MT- 5		1989	MacL	294805.5	5118198.7	128.65	128.02	0.63	5.0	PVC	TriLoc 0.010"	6.30	7.82
MT- 7		1989	MacL	294880.9	5118295.5	128.63	127.85	0.78	5.0	PVC	TriLoc 0.010"	5.93	7.45
MT- 8		1989	MacL	294919.6	5118317.6	115.28	114.70	0.58	5.0	PVC	TriLoc 0.010"	1.53	3.05
MT- 9		1989	MacL	295010.9	5118150.2	125.18	124.65	0.53	5.0	PVC	TriLoc 0.010"	2.48	4.00
MT- 10		1989	MacL	295045.4	5117958.1	135.58	134.99	0.59	5.0	PVC	TriLoc 0.010"	5.49	7.07
BH- 06-01		1993	JDP	294919.1	5118339.2	116.14	115.54	0.60	3.2	PVC		1.52	3.04
BH- 07-01		1993	JDP	294932.1	5118307.5	115.56	114.66	0.90	3.2	PVC		1.54	3.06
BH- 08-01		1993	JDP	294949.6	5118291.9	115.53	114.83	0.70	3.2	PVC		1.51	3.03

Borehole	Monitor	Date	Agency	GPS UTM Coords (NAD83)		Elevation (m asl)		Stick-Up (m)	Diameter (cm)	Material	Screen	Depth Below Grade (m)	
				Easting	Northing	TOP	Grade					From	To
BH- 09-01		1993	JDP	294966.5	5118276.5	115.60	115.01	0.59	3.2	PVC		1.49	3.01
BH- 10-01		1993	JDP	294988.1	5118255.3	115.69	115.58	0.11	3.2	PVC		1.56	3.08
BH- 11-01		1993	JDP	294913.8	5118255.1	128.20	128.29	-0.09	5.0	PVC		6.04	9.09
BH- 12-01		1993	JDP	294875.8	5118290.0	128.29	127.88	0.41	5.0	PVC		5.51	10.08
BH- 13-01		1993	JDP	294880.4	5118264.3	128.33	128.41	-0.08	5.0	PVC		5.34	9.91
BH- 14-01		1993	JDP	294872.1	5118260.1	129.15	128.27	0.88	3.2	PVC		2.98	4.50
BH- 15-01		1993	JDP	294874.4	5118265.4	129.18	128.50	0.68	3.2	PVC		3.95	7.00
BH- 16-01		1993	JDP	294870.5	5118261.8	128.99	128.40	0.59	3.2	PVC		3.95	7.00

Agency: AECL – Atomic Energy of Canada Limited
 MacL – MacLarentech
 JDP – J.D. Paterson & Associates

Table 2
Summary of total petroleum hydrocarbon (TPH) data from 1993 to 2004 and of the combined F1 to F4 hydrocarbon concentrations from 2005 to 2011 in groundwater samples collected at the NPD site

Date	Total Petroleum Hydrocarbons (ug/L)													
	BH06-01	BH07-01	BH08-01	BH09-01	BH10-01	BH11-01	BH12-01	BH13-01	BH14-01	BH15-01	BH16-01	MT-5	MT-8	MT-9
1993 Jan 19													200	
1993 Apr 20													190	
1994 Apr 27													200	
1995 Jun 21													< 100	
1995 Aug 07													-	
1996 Jun 26													< 100	
1997 Aug 05													< 100	
2000 Jun 15													<100	
2001 May 14													<100	
2001 Nov 13	<100													
2001 Nov 20		<100	<100	<100	300									
2001 Nov 21						4400	<100	<100						
2002 Jun 18	100	<100	<100	<100	<100	<100	Dry	<100	Dry	Dry	10100	<100	<100	<100
2003 May 27	Dry	100	Dry	<100	Dry	Dry	<100	<100	<100	Dry	Dry	<100	<100	<100
2003 Sep 22	Dry	<100	Dry	<100	Dry	Dry	<100	<100	Dry	Dry	1300	<100	<100	500
2004 Apr 22	<100	<100	<100	<100	<100	<100	<100	<100	<100	Dry	<100	<100	<100	<100
2004 Oct 19	Dry	Dry	Dry	Dry	Dry	Dry	<100	<100	Dry	Dry	Dry	<100	<100	<100
	Combined F1 to F4 (C6-C50) Hydrocarbons (ug/L)													
2005 May 06	Dry	<100	<100	<100	<100	Dry	<100	<100	<100	Dry	<100	<100	<100	<100
2005 Oct 17	Dry	<100	Dry	Dry	Dry	Dry	<100	<100	Dry	Dry	Dry	<100	400	<100
2006 Apr 28	<100	<100	<100	<100	<100	<100	<100	<100	<100	Dry	<100	<100	<100	200
2006 Oct 11	Dry	<100	<100	<100	Dry	<100	<100	200	Dry	Dry	<100	<100	<100	<100
2007 May 17	Dry	<100	Dry	<100	Dry	Dry	<100	<100	Dry	Dry	Dry	<100	<100	<100
2007 Oct 24	Dry	Dry	Dry	Dry	Dry	Dry	<100	<100	Dry	Dry	Dry	<100	<100	<100
2008 May 22	Dry	<100	<100	<100	<100	Dry	<100	<100	Dry	Dry	Dry	<100	<100	Dry
2008 Oct 16	Dry	Dry	Dry	Dry	Dry	Dry	<100	<100	Dry	Dry	Dry	<100	<100	<100

Date	Total Petroleum Hydrocarbons (ug/L)													
	BH06-01	BH07-01	BH08-01	BH09-01	BH10-01	BH11-01	BH12-01	BH13-01	BH14-01	BH15-01	BH16-01	MT-5	MT-8	MT-9
2009 May 19	Dry	<100	<100	<100	Dry	Dry	<100	<100	Dry	Dry	<100	<100	<100	Dry
2009 Oct 15	Dry	Dry	Dry	<100	Dry	Dry	100	<100	Dry	Dry	300	<100	<100	<100
2010 Apr 13	Dry	<100	Dry	<100	Dry	Dry	<100	<100	<100	<100	500	<100	<100	<100
2010 Oct 19	Dry	Dry	Dry	<100	Dry	Dry	<100	<100	Dry	Dry	<100	<100	<100	<100
2011 Apr 28	<100	<100	<100	<100	<100	<100	<100	<100	Dry	Dry	Dry	<100	<100	<100
2011 Oct 20	Dry	Dry	Dry	<100	Dry	Dry	<100	<100	Dry	<100	<100	<100	<100	<100

Table 3
Monitoring well status and static water elevations

Location	Monitor	Stickup (m)	Cleanout Date	Depth from TOP (m)		Static Water Elev (m asl)	Volume (L)		Pumped Dry ?	Sampling Date
				Total	to Water		Standing	Removed		
NPD- 2	I	0.89	2014 Jul 08	11.14	9.77	131.77	1.20	3.0		2014 Jul 10
NPD- 4	I	0.83	2014 Jul 08	13.62	11.34	130.86	1.90	5.0		2014 Jul 10
NPD- 5	I	0.76	2014 Jul 08	13.01	8.79	127.90	3.39	3.5	Y	2014 Jul 09
NPD- 7	I	1.00	2014 Jul 08	9.46	7.10	128.05	1.90	2.0	Y	2014 Jul 09
NPD- 8	I	0.81	2014 Jul 08	17.91	15.71	128.71	1.75	5.0		2014 Jul 10
NPD- 9	I	0.88	2014 Jul 08	4.55	1.62	133.32	2.36	2.5	Y	2014 Jul 09
NPD- 10	I	0.98	2014 Jul 08	4.03	1.49	132.57	2.04	3.0	Y	2014 Jul 09
NPD- 11	I	0.92	2014 Jul 08	6.84	3.89	133.54	2.37	5.0		2014 Jul 09
NPD- 12	I	0.92	2014 Jul 08	4.12	2.24	133.41	1.51	4.0		2014 Jul 09
NPD- 13	I	0.94	2014 Jul 08	7.22	6.82	131.32	0.32	0.4	Y	2014 Jul 09
NPD- 14	I	0.91	2014 Jul 08	7.06	4.17	133.55	2.32	5.0		2014 Jul 09
MT- 1	I	0.70	2014 Jul 08	11.21	8.60	131.42	4.75	10.0		2014 Jul 10
MT- 5	I	0.12	2014 Jul 08	7.21	3.21	125.44	7.85	18.0		2014 Jul 11
MT- 7	I	0.00		7.05	dry		na	na		
MT- 8	I	0.90	2014 Jul 08	3.91	2.07	113.21	3.61	8.0		2014 Jul 11
MT- 9	I	0.78	2014 Jul 08	4.57	3.15	122.03	2.79	6.0		2014 Jul 11
BH- 06-01		0.60		3.61	dry		na	na		
BH- 07-01		0.90	2014 Jul 08	3.59	3.27	112.29	0.26	0.3	Y	2014 Jul 09
BH- 08-01		0.70		3.52	3.42	112.11	0.08	na		
BH- 09-01		0.59	2014 Jul 08	3.68	2.33	113.27	1.09	3.0		2014 Jul 11
BH- 10-01		0.11		3.01	2.91	112.78	0.08	na		
BH- 11-01		-0.09		8.81	8.70	119.60	0.21	na		
BH- 12-01		0.41	2014 Jul 08	10.14	8.10	120.19	4.01	10.0		2014 Jul 11
BH- 13-01		-0.08	2014 Jul 08	9.67	7.48	120.85	1.76	4.5		2014 Jul 11
BH- 14-01		0.88		5.14	dry		na	na		
BH- 15-01		0.68		7.45	dry		na	na		
BH- 16-01		0.59		7.45	dry		na	na		
NPD Tile Drain										2014 Jul 11

Table 4
Sampling matrix for wells at NPD

Location	Monitor	Sample?	GPS Location & Elevation	Wellhead Params	Radiological	Anions & DOC	TKN	Alkalinity	Major Cations	Trace Metals	Volatiles (ATGs 16-18)	Phenolics (ATG 20)	PCBs (Total)	PAHs (ATG-19)	Petroleum Components (F1 - F4)	
NPD- 1	I	Not Found														
NPD- 2	I	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NPD- 4	I	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NPD- 5	I	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NPD- 5	II	Not Found														
NPD- 6	I	Not Found														
NPD- 7	I	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NPD- 8	I	Yes	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
NPD- 9	I	Yes	Y	Y	Y	Y		Y	Y	Y			Y			
NPD- 10	I	Yes	Y		Y	Y		Y	Y	Y			Y			
NPD- 11	I	Yes	Y	Y	Y	Y		Y	Y	Y			Y			
NPD- 12	I	Yes	Y	Y	Y	Y		Y	Y	Y			Y			
NPD- 13	I	Yes	Y	Y	Y	Y		Y	Y	Y			Y			
NPD- 14	I	Yes	Y	Y	Y	Y		Y	Y	Y			Y			
MT- 1		Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MT- 2		Not Found														
MT- 3		Not Found														
MT- 4		Not Found														
MT- 5		Yes	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
MT- 7		Dry														
MT- 8		Yes	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y
MT- 9		Yes	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
MT- 10		Not Found														
BH- 06-01		Dry														
BH- 07-01		Partial	Y	Y	Y								Insufficient Water			
BH- 08-01		Dry														
BH- 09-01		Yes	Y	Y	Y							Y		Y	Y	
BH- 10-01		Dry														
BH- 11-01		Dry														
BH- 12-01		Yes	Y	Y	Y							Y		Y	Y	
BH- 13-01		Yes	Y	Y	Y							Y		Y	Y	
BH- 14-01		Dry														
BH- 15-01		Dry														
BH- 16-01		Dry														
NPD Tile Drain 1				Y	Y	Y		Y	Y	Y	Y					

Table 5
Concentrations of tritium, total beta, and gross alpha activity in NPD groundwater samples, 2014 July

Sample ID	Sampling Date	Tritium			Total Beta			Gross Alpha		
		(Bq/L)	1s	MDA	(Bq/L)	1s	MDA	(Bq/L)	1s	MDA
Health Can. Drinking Water		7000			1.0 ¹			0.5 ¹		
NPD- 2 - I	2014 Jul 10	<	30		<	0.28		<	0.22	
NPD- 4 - I	2014 Jul 10	<	30		<	0.25		<	0.16	
NPD- 5 - I	2014 Jul 09	<	30		<	0.25		<	0.18	
NPD- 7 - I	2014 Jul 09		32 ± 21	30	<	0.29		<	0.21	
NPD- 8 - I	2014 Jul 10		43 ± 21	30	<	0.23		<	0.16	
NPD- 9 - I	2014 Jul 09		71 ± 22	30	<	0.30		<	0.19	
NPD- 10 - I	2014 Jul 09		51 ± 21	30	<	0.31		<	0.20	
NPD- 11 - I	2014 Jul 09		35 ± 21	30	<	0.29		<	0.18	
NPD- 12 - I	2014 Jul 09		37 ± 21	30	<	0.30		<	0.19	
NPD- 13 - I	2014 Jul 09		53 ± 21	30	<	0.32		<	0.20	
NPD- 14 - I	2014 Jul 09		51 ± 21	30	<	0.28		<	0.17	
NPD- 1 - I	2014 Jul 10		38 ± 21	30	<	0.29		<	0.19	
MT- 5 - I	2014 Jul 09		45 ± 21	30		0.40 ± 0.13	0.34	<	0.22	
MT- 8 - I	2014 Jul 11		65 ± 22	30	<	0.27		<	0.19	
MT- 9 - I	2014 Jul 11		43 ± 21	30	<	0.29		<	0.18	
BH- 07-01	2014 Jul 09		82 ± 22	30	<	0.29		<	0.21	
BH- 09-01	2014 Jul 11		53 ± 21	30	<	0.28		<	0.21	
BH- 12-01	2014 Jul 11		60 ± 22	30		0.37 ± 0.10	0.23	<	0.17	
BH- 13-01	2014 Jul 11		296 ± 26	30	<	0.22		<	0.21	
NPD-TD	2014 Jul 11		50 ± 21	30		0.25 ± 0.09	0.25	<	0.19	
Field Blank	2014 Jul 09		39 ± 21	30	<	0.32		<	0.18	
Field Blank	2014 Jul 11	<	30		<	0.28		<	0.16	
MT- 5 - I Dup	2014 Jul 09		31 ± 21	30	<	0.38		<	0.23	
BH- 12-01 Dup	2014 Jul 11		80 ± 22	30	<	0.22		<	0.21	

¹ Health Canada Screening Limit: If exceeded, specific radionuclide analyses should be undertaken.

Table 6
Wellhead data (temperature, pH, conductance) and major anion concentrations in NPD groundwater samples, 2014 July

ID	Collection Date	Temp (°C)	pH	E.C. (uS/cm)	DOC (mg/L)	Alkalinity (mg/L) (as HCO ₃ ⁻)	Cl ⁻ (mg/L)	F ⁻ (mg/L)	Br ⁻ (mg/L)	SO ₄ ³⁻ (mg/L)	PO ₄ ³⁻ (mg/L)	NO ₃ ⁻ (mg/L)
Health Can. Drinking Water							250 ¹	1.5		500 ¹		45
NPD- 2 - I	2014 Jul 10	10.3	5.93	190	1.71	28	81.8	0.04	< 0.06	8.07	< 0.29	< 0.07
NPD- 4 - I	2014 Jul 10	9.1	5.85	97	1.37	19	36.6	< 0.04	< 0.06	5.78	< 0.29	0.48
NPD- 5 - I	2014 Jul 09	9.4	8.63	122	0.99	65	42.3	0.33	< 0.06	13.4	< 0.29	0.19
NPD- 7 - I	2014 Jul 09	11.2	5.99	126	1.83	35	44.3	0.06	< 0.06	9.00	< 0.29	0.81
NPD- 8 - I	2014 Jul 10	10.3	5.83	60	1.06	28	10.9	0.05	< 0.06	7.06	< 0.29	0.69
NPD- 9 - I	2014 Jul 09	na	5.80	48	1.34	33	0.49	< 0.04	< 0.06	10.6	< 0.29	0.44
NPD- 10 - I	2014 Jul 09	11.2	5.66	39	2.11	37	0.45	0.06	< 0.06	7.30	< 0.29	0.32
NPD- 11 - I	2014 Jul 09	9.3	5.71	37	1.73	31	0.45	0.04	< 0.06	6.80	< 0.29	0.70
NPD- 12 - I	2014 Jul 09	10.9	5.75	44	1.20	39	0.43	< 0.04	< 0.06	9.26	< 0.29	< 0.07
NPD- 13 - I	2014 Jul 09	13.4	6.41	48	5.27	29	0.61	0.07	< 0.06	8.30	< 0.29	0.78
NPD- 14 - I	2014 Jul 09	9.7	5.85	41	1.65	32	0.40	< 0.04	< 0.06	9.44	< 0.29	0.38
MT- 1 - I	2014 Jul 10	9.6	6.24	114	1.13	23	41.6	< 0.04	< 0.06	5.62	< 0.29	0.27
MT- 5 - I	2014 Jul 09	8.8	5.86	72	1.37	33	13.2	0.04	< 0.06	7.85	< 0.29	0.99
MT- 8 - I	2014 Jul 11	13.2	6.29	113	1.99	69	3.17	0.07	< 0.06	25.0	< 0.29	0.20
MT- 9 - I	2014 Jul 11	11.7	6.01	56	1.46	55	0.40	0.06	< 0.06	6.60	< 0.29	0.90
BH- 07-01	2014 Jul 09	15.3	6.88	133								
BH- 09-01	2014 Jul 11	14.2	7.03	120								
BH- 12-01	2014 Jul 11	9.5	5.83	73								
BH- 13-01	2014 Jul 11	11.6	6.99	197								
NPD-TD	2014 Jul 11	9.2	6.38	118	1.44	29	35.0	< 0.04	< 0.06	9.99	< 0.29	1.39
Field Blank	2014 Jul 09				0.45	2	0.05	< 0.04	< 0.06	0.09	< 0.29	< 0.07
MT- 5 - I Dup	2014 Jul 09				1.38	32	13.2	0.05	< 0.06	7.99	< 0.29	0.91

¹ Aesthetic Objective

² Operational Guidance

Table 7
Ammonia, TKN, and major cation concentrations in NPD groundwater samples, 2014 July

ID	Collection Date	NH ₃ ⁻ (mg/L)	TKN (mg/L)	Na ⁺ (mg/L)	K ⁺ (mg/L)	Mg ²⁺ (mg/L)	Ca ²⁺ (mg/L)	Sr		Fe	
								(ug/L)	1s	(ug/L)	1s
Health Can. Drinking Water				200 ¹							300 ¹
NPD- 2 - I	2014 Jul 10	0.15	< 0.25	33.6	2.06	2.62	7.28	68 ± 3		8.2 ± 0.3	
NPD- 4 - I	2014 Jul 10	0.14	< 0.25	18.2	1.11	1.12	3.39	34 ± 2		67 ± 3.0	
NPD- 5 - I	2014 Jul 09	0.07	< 0.5	12.4	6.72	1.43	16.0	300 ± 10		6.0 ± 0.2	
NPD- 7 - I	2014 Jul 09			17.2	1.95	3.40	8.57	68 ± 3		15 ± 1	
NPD- 8 - I	2014 Jul 10	0.14	< 0.25	7.12	1.13	1.62	4.49	34 ± 2		26 ± 1	
NPD- 9 - I	2014 Jul 09			1.86	1.34	2.03	6.06	42 ± 2		131 ± 7	
NPD- 10 - I	2014 Jul 09			1.66	1.16	1.71	4.66	34 ± 2		9.4 ± 0.4	
NPD- 11 - I	2014 Jul 09			1.55	1.06	1.59	4.44	33 ± 2		5.2 ± 0.2	
NPD- 12 - I	2014 Jul 09			1.92	1.06	1.86	5.39	38 ± 2		7.1 ± 0.3	
NPD- 13 - I	2014 Jul 09			1.93	2.81	1.97	5.66				
NPD- 14 - I	2014 Jul 09			1.65	1.36	1.79	4.72	33 ± 2		25 ± 1	
MT- 1 - I	2014 Jul 10	0.14	0.3	18.4	1.40	1.89	5.44	48 ± 2		10 ± 1	
MT- 5 - I	2014 Jul 09			8.02	1.19	2.07	5.66	45 ± 2		9.3 ± 0.4	
MT- 8 - I	2014 Jul 11			4.71	2.56	4.95	15.5	131 ± 7		77 ± 4	
MT- 9 - I	2014 Jul 11			9.45	1.16	1.45	3.69	29 ± 1		14 ± 1	
NPD-TD	2014 Jul 11			15.9	1.59	2.80	7.97	70 ± 3		3.6 ± 0.1	
Field Blank	2014 Jul 09	0.14	< 0.25	0.04	0.02	0.004	0.027	< 0.05		< 0.16	
MT- 5 - I Dup	2014 Jul 09			8.04	1.20	2.09	5.66	46 ± 2		8.0 ± 0.3	

¹ Aesthetic Objective

² Operational Guidance

Table 8
Trace element concentrations in NPD groundwater samples, 2014 July

ID	Collection Date	Mn		Al		Ba		Pb		Cu		Zn	
		(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s
Health Can. Drinking Water		50 ¹		100 ²		1000		10		1000 ¹		5000 ¹	
NPD- 2 - I	2014 Jul 10	1.9 ± 0.2		12 ± 1		3.0 ± 0.5		< 0.12		0.74 ± 0.08		1.7 ± 0.2	
NPD- 4 - I	2014 Jul 10	3.3 ± 0.2		21 ± 1		3.7 ± 0.5		< 0.12		0.45 ± 0.08		0.4 ± 0.2	
NPD- 5 - I	2014 Jul 09	7.1 ± 0.4		14 ± 1		9.8 ± 0.7		< 0.12	<	0.2		0.2 ± 0.2	
NPD- 7 - I	2014 Jul 09	4.5 ± 0.3		33 ± 2		4.6 ± 0.5		< 0.12		2.1 ± 0.10		3.2 ± 0.3	
NPD- 8 - I	2014 Jul 10	1.6 ± 0.2		11 ± 1		3.3 ± 0.5		< 0.12		0.29 ± 0.08		0.4 ± 0.2	
NPD- 9 - I	2014 Jul 09	8.1 ± 0.4		95 ± 5		5.9 ± 0.5		< 0.12		1.0 ± 0.09		0.9 ± 0.2	
NPD- 10 - I	2014 Jul 09	52 ± 3.0		15 ± 1		5.0 ± 0.5		< 0.12		0.84 ± 0.09		2.9 ± 0.2	
NPD- 11 - I	2014 Jul 09	1.1 ± 0.2		11 ± 1		4.4 ± 0.5		< 0.12		0.67 ± 0.08		1.3 ± 0.2	
NPD- 12 - I	2014 Jul 09	1.5 ± 0.2		18 ± 1		4.6 ± 0.5		< 0.12		0.89 ± 0.09		1.3 ± 0.2	
NPD- 13 - I	2014 Jul 09												
NPD- 14 - I	2014 Jul 09	17 ± 1		51 ± 2		8.9 ± 0.6		< 0.12		1.9 ± 0.10		4.1 ± 0.3	
MT- 1 - I	2014 Jul 10	0.6 ± 0.2		4.4 ± 0.3		5.3 ± 0.5		< 0.12		0.31 ± 0.08		0.2 ± 0.2	
MT- 5 - I	2014 Jul 09	< 0.6		5.4 ± 0.3		3.5 ± 0.5		< 0.12		0.82 ± 0.09		0.9 ± 0.2	
MT- 8 - I	2014 Jul 11	280 ± 10		2.9 ± 0.3		9.9 ± 0.7		< 0.12		3.3 ± 0.20		1.8 ± 0.2	
MT- 9 - I	2014 Jul 11	3.0 ± 0.2		15 ± 1		11 ± 1		< 0.12		0.90 ± 0.09		0.5 ± 0.2	
NPD-TD	2014 Jul 11	< 0.6		4 ± 0		9.7 ± 0.7		< 0.12		0.89 ± 0.09		2.1 ± 0.2	
Field Blank	2014 Jul 09	< 0.6		< 0.8		1.9 ± 0.5		< 0.12		0.17 ± 0.08		1.2 ± 0.2	
MT- 5 - I Dup	2014 Jul 09	< 0.6		6.0 ± 0.4		3.6 ± 0.5		< 0.12		0.81 ± 0.09		1.0 ± 0.2	

¹ Aesthetic Objective

² Operational Guidance

Table 9
Trace element concentrations in NPD groundwater samples, 2014 July (continued)

ID	Collection Date	Cr		Co		Ni		As		Cd		U	
		(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s	(ug/L)	1s
Health Can. Drinking Water		50						10		5		20	
NPD- 2 - I	2014 Jul 10	0.14	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 4 - I	2014 Jul 10	0.28	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 5 - I	2014 Jul 09	0.11	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	0.26	± 0.03
NPD- 7 - I	2014 Jul 09	0.67	± 0.05	0.64	± 0.05	4.9	± 0.3	<	0.9	0.11	± 0.01	<	0.07
NPD- 8 - I	2014 Jul 10	0.21	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 9 - I	2014 Jul 09	0.15	± 0.03	0.18	± 0.04	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 10 - I	2014 Jul 09	<	0.09	0.32	± 0.05	<	0.8	<	0.9	0.02	± 0.01	<	0.07
NPD- 11 - I	2014 Jul 09	0.06	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 12 - I	2014 Jul 09	0.05	± 0.03	0.18	± 0.04	<	0.8	<	0.9	<	0.03	<	0.07
NPD- 13 - I	2014 Jul 09												
NPD- 14 - I	2014 Jul 09	0.03	± 0.03	1.00	± 0.10	<	0.8	<	0.9	0.04	± 0.01	<	0.07
MT- 1 - I	2014 Jul 10	0.29	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
MT- 5 - I	2014 Jul 09	0.03	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
MT- 8 - I	2014 Jul 11	<	0.09	1.50	± 0.10	<	0.8	<	0.9	0.06	± 0.01	<	0.07
MT- 9 - I	2014 Jul 11	0.41	± 0.04	0.15	± 0.04	<	0.8	<	0.9	<	0.03	<	0.07
NPD-TD	2014 Jul 11	0.24	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
Field Blank	2014 Jul 09	<	0.09	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07
MT- 5 - I Dup	2014 Jul 09	0.11	± 0.03	<	0.13	<	0.8	<	0.9	<	0.03	<	0.07

Table 10
Total PCB and fuel-related hydrocarbon concentrations in NPD groundwater, 2014 July

Sample ID	Date Sampled:	Total PCBs	Petroleum Hydrocarbons								
			Benzene	Toluene	Ethylbenzene	Xylenes	VPH ¹ C6-C10 (Less BTEX)	EPH ² >C10 - C16	EPH >C16 - C21	EPH >C21-C32	Modified TPH ³ Tier 1
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.1	1	1	1	1	10	10	10	10	20
NPD- 2 - I	2014 Jul 10	< 0.1									
NPD- 4 - I	2014 Jul 10	< 0.1									
NPD- 5 - I	2014 Jul 09	< 0.1									
NPD- 7 - I	2014 Jul 09	< 0.1									
NPD- 8 - I	2014 Jul 10	< 0.1									
NPD- 9 - I	2014 Jul 09	< 0.1									
NPD- 10 - I	2014 Jul 09	< 0.1									
NPD- 11 - I	2014 Jul 09	< 0.1									
NPD- 12 - I	2014 Jul 09	< 0.1									
NPD- 14 - I	2014 Jul 09	< 0.1									
MT- 1 - I	2014 Jul 10	< 0.1									
MT- 5 - I	2014 Jul 09	< 0.1									
MT- 8 - I	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	< 10	< 10	10	< 20
MT- 9 - I	2014 Jul 11	< 0.1	< 1	< 1	< 1	< 1	< 10	10	10	< 10	20
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	10	20	40	70
BH- 12-01	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	30	< 10	< 10	30
BH- 13-01	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	10	20	20	50
NPD-TD	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	< 10	< 10	< 10	< 20
Blank 07/09	2014 Jul 09	< 0.1	< 1	< 1	< 1	< 1	< 10	20	< 10	< 10	20
Blank 07/11	2014 Jul 11										
MT- 5 - I Dup	2014 Jul 09	< 0.1									
BH- 12-01 Dup	2014 Jul 11		< 1	< 1	< 1	< 1	< 10	40	10	10	60

¹ VPH – Volatile Petroleum Hydrocarbons excluding benzene, toluene, xylene

² EPH – Extractable Petroleum Hydrocarbons

³ TPH – Total Petroleum Hydrocarbons

Table 11
Groundwater concentrations of halogenated volatiles (ATG-16) at the NPD site

Sample ID	Date Sampled:	ATG-16 (halogenated volatiles)									
		1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Bromodichloromethane	Bromoform	Bromomethane
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.6	0.7
NPD- 2 - I	2014 Jul 10	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
NPD- 4 - I	2014 Jul 10	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
NPD- 5 - I	2014 Jul 09	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
NPD- 7 - I	2014 Jul 09	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
NPD- 8 - I	2014 Jul 10	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
MT- 5 - I	2014 Jul 09	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
MT- 8 - I	2014 Jul 11	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
MT- 9 - I	2014 Jul 11	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11										
BH- 12-01	2014 Jul 11										
BH- 13-01	2014 Jul 11										
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
Blank 07/11	2014 Jul 11										
MT- 5 - I Dup	2014 Jul 09	<0.5	<0.4	<0.5	<0.5	<0.5	<0.4	<0.4	<0.5	<0.6	<0.7
BH- 12-01 Dup	2014 Jul 11										

Table 12
Groundwater concentrations of halogenated volatiles (ATG-16) at the NPD site (continued)

Sample ID	Date Sampled:	ATG-16 (halogenated volatiles)									
		Carbon tetrachloride	Chloroform	cis-1,3-Dichloropropylene	Dibromochloromethane	Ethylene dibromide	Methylene chloride	Tetrachloroethylene	Trans-1,3-Dichloropropylene	Trichloroethylene	Trichlorofluoromethane
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.6	0.5	0.5	0.7	0.5	0.7	0.5	0.5	0.7	0.5
NPD- 2 - I	2014 Jul 10	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
NPD- 4 - I	2014 Jul 10	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
NPD- 5 - I	2014 Jul 09	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
NPD- 7 - I	2014 Jul 09	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
NPD- 8 - I	2014 Jul 10	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
MT- 5 - I	2014 Jul 09	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
MT- 8 - I	2014 Jul 11	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
MT- 9 - I	2014 Jul 11	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11										
BH- 12-01	2014 Jul 11										
BH- 13-01	2014 Jul 11										
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
Blank 07/11	2014 Jul 11										
MT- 5 - I Dup	2014 Jul 09	<0.6	<0.5	<0.5	<0.7	<0.5	<0.7	<0.5	<0.5	<0.7	<0.5
BH- 12-01 Dup	2014 Jul 11										

Table 13
Groundwater concentrations of halogenated volatiles (ATG-16) at the NPD site (continued)

Sample ID	Date Sampled:	ATG-16 (halogenated volatiles)						
		1,2-Dichloroethane	1,2-Dichloropropane	Chlorobenzene	Chloromethane	Trans-1,2-Dichloroethylene	Vinyl chloride	1,1,1-Trichloroethane
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.6	0.6	0.5	0.9	0.5	0.7	0.5
NPD- 2 - I	2014 Jul 10	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
NPD- 4 - I	2014 Jul 10	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
NPD- 5 - I	2014 Jul 09	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
NPD- 7 - I	2014 Jul 09	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
NPD- 8 - I	2014 Jul 10	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
NPD- 9 - I	2014 Jul 09							
NPD- 10 - I	2014 Jul 09							
NPD- 11 - I	2014 Jul 09							
NPD- 12 - I	2014 Jul 09							
NPD- 14 - I	2014 Jul 09							
MT- 1 - I	2014 Jul 10	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
MT- 5 - I	2014 Jul 09	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
MT- 8 - I	2014 Jul 11	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
MT- 9 - I	2014 Jul 11	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
BH- 07-01	2014 Jul 09							
BH- 09-01	2014 Jul 11							
BH- 12-01	2014 Jul 11							
BH- 13-01	2014 Jul 11							
NPD-TD	2014 Jul 11							
Blank 07/09	2014 Jul 09	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
Blank 07/11	2014 Jul 11							
MT- 5 - I Dup	2014 Jul 09	<0.6	<0.6	<0.5	<0.9	<0.5	<0.7	<0.5
BH- 12-01 Dup	2014 Jul 11							

Table 14
Groundwater concentrations of non-halogenated volatiles (ATG-17) and water-soluble volatiles (ATG-18) at the NPD site

Sample ID	Date Sampled:	ATG-17 (non-halogenated volatiles)						ATG-18	
		Benzene	Ethylbenzene	Styrene	Toluene	o-Xylene	m-Xylene and p-Xylene	Acrolein	Acrylonitrile
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.5	0.5	0.5	0.5	0.5	0.5	4	4
NPD- 2 - I	2014 Jul 10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
NPD- 4 - I	2014 Jul 10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
NPD- 5 - I	2014 Jul 09	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
NPD- 7 - I	2014 Jul 09	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
NPD- 8 - I	2014 Jul 10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
NPD- 9 - I	2014 Jul 09								
NPD- 10 - I	2014 Jul 09								
NPD- 11 - I	2014 Jul 09								
NPD- 12 - I	2014 Jul 09								
NPD- 14 - I	2014 Jul 09								
MT- 1 - I	2014 Jul 10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
MT- 5 - I	2014 Jul 09	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
MT- 8 - I	2014 Jul 11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
MT- 9 - I	2014 Jul 11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
BH- 07-01	2014 Jul 09								
BH- 09-01	2014 Jul 11								
BH- 12-01	2014 Jul 11								
BH- 13-01	2014 Jul 11								
NPD-TD	2014 Jul 11								
Blank 07/09	2014 Jul 09	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
Blank 07/11	2014 Jul 11								
MT- 5 - I Dup	2014 Jul 09	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<4.0	<4.0
BH- 12-01 Dup	2014 Jul 11								

Table 15
Groundwater concentrations of base/neutral extractables (ATG-19) including PAHs at the NPD site, 2014 July

Sample ID	Date Sampled:	ATG-19 (Base-Neutral Extractables, Including PAHs)									
		Acenaphthene	5-Nitro acenaphthene	Acenaphthylene	Anthracene	Atrazine	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.8	1.2	0.8	0.1	0.1	0.2	0.3	0.4	0.4	0.4
NPD- 2 - I	2014 Jul 10	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
NPD- 4 - I	2014 Jul 10	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
NPD- 5 - I	2014 Jul 09	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
NPD- 7 - I	2014 Jul 09										
NPD- 8 - I	2014 Jul 10	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
MT- 5 - I	2014 Jul 09	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
MT- 8 - I	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
MT- 9 - I	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
BH- 12-01	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
BH- 13-01	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
Blank 07/11	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
MT- 5 - I Dup	2014 Jul 09	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4
BH- 12-01 Dup	2014 Jul 11	< 0.8	< 1.2	< 0.8	< 0.1	< 0.1	< 0.2	< 0.3	< 0.4	< 0.4	< 0.4

Table 16
Groundwater concentrations of base/neutral extractables (ATG-19) including PAHs at the NPD site, 2014 July (continued)

		ATG-19 (Base-Neutral Extractables, Including PAHs)									
Sample ID	Date Sampled:										
		Biphenyl	Camphene	1-Chloronaphthalene	2-Chloronaphthalene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Indole
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.6	2.5	1	1	0.2	0.6	0.1	0.6	0.6	0.7
NPD- 2 - I	2014 Jul 10	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
NPD- 4 - I	2014 Jul 10	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
NPD- 5 - I	2014 Jul 09	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
NPD- 7 - I	2014 Jul 09										
NPD- 8 - I	2014 Jul 10	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
MT- 5 - I	2014 Jul 09	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
MT- 8 - I	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
MT- 9 - I	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
BH- 12-01	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
BH- 13-01	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
Blank 07/11	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
MT- 5 - I Dup	2014 Jul 09	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7
BH- 12-01 Dup	2014 Jul 11	< 0.6	< 2.5	< 1.0	< 1.0	< 0.2	< 0.6	< 0.1	< 0.6	< 0.6	< 0.7

Table 17
Groundwater concentrations of base/neutral extractables (ATG-19) including PAHs at the NPD site, 2014 July (continued)

Sample ID	Date Sampled:	ATG-19 (Base-Neutral Extractables, Including PAHs)										
		1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Perylene	Phenanthrene	Pyrene	T-butyl phosphate	Benzyl butyl phthalate	Bis(2-ethylhexyl)phthalate	Di-n-butylphthalate	Di-n-octylphthalate
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.8	0.8	0.9	0.8	0.1	0.1	0.1	0.4	1.01	1.5	2.6
NPD- 2 - I	2014 Jul 10	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	2.4	< 1.5	< 2.6
NPD- 4 - I	2014 Jul 10	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	17	< 1.5	< 2.6
NPD- 5 - I	2014 Jul 09	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	13	< 1.5	< 2.6
NPD- 7 - I	2014 Jul 09											
NPD- 8 - I	2014 Jul 10	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	3.4	< 1.5	< 2.6
NPD- 9 - I	2014 Jul 09											
NPD- 10 - I	2014 Jul 09											
NPD- 11 - I	2014 Jul 09											
NPD- 12 - I	2014 Jul 09											
NPD- 14 - I	2014 Jul 09											
MT- 1 - I	2014 Jul 10	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	< 1.0	< 1.5	< 2.6
MT- 5 - I	2014 Jul 09	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	< 1.0	< 1.5	< 2.6
MT- 8 - I	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	< 1.0	< 1.5	< 2.6
MT- 9 - I	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	< 1.0	< 1.5	< 2.6
BH- 07-01	2014 Jul 09											
BH- 09-01	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	17	< 1.5	< 2.6
BH- 12-01	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	2.3	< 1.5	< 2.6
BH- 13-01	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	2.1	< 1.5	< 2.6
NPD-TD	2014 Jul 11											
Blank 07/09	2014 Jul 09	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	0.1	< 0.4	3.0	< 1.5	< 2.6
Blank 07/11	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	0.1	< 0.4	2.4	< 1.5	< 2.6
MT- 5 - I Dup	2014 Jul 09	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	< 1.0	< 1.5	< 2.6
BH- 12-01 Dup	2014 Jul 11	< 0.8	< 0.8	< 0.9	< 0.8	< 0.1	< 0.1	< 0.1	< 0.4	2.3	< 1.5	< 2.6

Table 18
Groundwater concentrations of base/neutral extractables (ATG-19) including PAHs at the NPD site, 2014 July (continued)

Sample ID	Date Sampled:	ATG-19 (Base-Neutral Extractables, Including PAHs)									
		4-Bromophenyl phenylether	4-Chlorophenyl phenylether	Bis(2-chloroisopropyl)ether	Bis(2-chloroethyl)ether	Diphenyl Ether	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Bis(2-chloroethoxy)methane	Diphenylamine	N-Nitroso-di-n-propylamine
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.1	0.5	0.8	1	0.4	0.4	0.2	0.9	0.5	0.8
NPD- 2 - I	2014 Jul 10	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
NPD- 4 - I	2014 Jul 10	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
NPD- 5 - I	2014 Jul 09	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
NPD- 7 - I	2014 Jul 09										
NPD- 8 - I	2014 Jul 10	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
MT- 5 - I	2014 Jul 09	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
MT- 8 - I	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
MT- 9 - I	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
BH- 12-01	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.6	< 0.9	< 0.5	< 0.8
BH- 13-01	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
Blank 07/11	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
MT- 5 - I Dup	2014 Jul 09	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.2	< 0.9	< 0.5	< 0.8
BH- 12-01 Dup	2014 Jul 11	< 0.1	< 0.5	< 0.8	< 1.0	< 0.4	< 0.4	< 0.6	< 0.9	< 0.5	< 0.8

Table 19
Groundwater concentrations of acid extractables (ATG-20) including phenolics at the NPD site, 2014 July

Sample ID	Date Sampled:	ATG-20 (Acid Extractables, Phenolics)									
		2,3,4,5-Tetrachlorophenol	2,3,4,6-Tetrachlorophenol	2,3,5,6-Tetrachlorophenol	2,3,4-Trichlorophenol	2,3,5-Trichlorophenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2,4-Dichlorophenol
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.4	0.2	0.2	0.4	0.3	0.4	0.3	0.2	0.7	0.4
NPD- 2 - I	2014 Jul 10	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
NPD- 4 - I	2014 Jul 10	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
NPD- 5 - I	2014 Jul 09	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
NPD- 7 - I	2014 Jul 09										
NPD- 8 - I	2014 Jul 10	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
MT- 5 - I	2014 Jul 09	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
MT- 8 - I	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
MT- 9 - I	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
BH- 12-01	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
BH- 13-01	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
Blank 07/11	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
MT- 5 - I Dup	2014 Jul 09	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4
BH- 12-01 Dup	2014 Jul 11	< 0.4	< 0.2	< 0.2	< 0.4	< 0.3	< 0.4	< 0.3	< 0.2	< 0.7	< 0.4

Table 20
Groundwater concentrations of acid extractables (ATG-20) including phenolics at the NPD site, 2014 July (continued)

Sample ID	Date Sampled:	ATG-20 (Acid Extractables, Phenolics)									
		2,6-Dichlorophenol	4,6-Dinitro-o-cresol	2-Chlorophenol	4-Chloro-3-methylphenol	4-Nitrophenol	m-Cresol	o-Cresol	p-Cresol	Pentachlorophenol	Phenol
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.4	0.6	0.8	0.2	0.1	0.2	0.4	0.2	1.2	0.3
NPD- 2 - I	2014 Jul 10	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
NPD- 4 - I	2014 Jul 10	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
NPD- 5 - I	2014 Jul 09	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
NPD- 7 - I	2014 Jul 09										
NPD- 8 - I	2014 Jul 10	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
NPD- 9 - I	2014 Jul 09										
NPD- 10 - I	2014 Jul 09										
NPD- 11 - I	2014 Jul 09										
NPD- 12 - I	2014 Jul 09										
NPD- 14 - I	2014 Jul 09										
MT- 1 - I	2014 Jul 10	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
MT- 5 - I	2014 Jul 09	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
MT- 8 - I	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
MT- 9 - I	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
BH- 07-01	2014 Jul 09										
BH- 09-01	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
BH- 12-01	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
BH- 13-01	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
NPD-TD	2014 Jul 11										
Blank 07/09	2014 Jul 09	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
Blank 07/11	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
MT- 5 - I Dup	2014 Jul 09	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3
BH- 12-01 Dup	2014 Jul 11	< 0.4	< 0.6	< 0.8	< 0.2	< 0.1	< 0.2	< 0.4	< 0.2	< 1.2	< 0.3

Table 21
Groundwater concentrations of neutral chlorinated extractables (ATG-23) at the NPD site,
2014 July

		ATG-23 (Neutral Chlorinated Extractables)											
Sample ID	Date Sampled:	1,2,3,4-Tetrachlorobenzene	1,2,3,5-Tetrachlorobenzene	1,2,4,5-Tetrachlorobenzene	1,2,3-Trichlorobenzene	1,2,4-Trichlorobenzene	2,4,5-Trichlorotoluene	Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachloroethane	Octachlorostyrene	Pentachlorobenzene
Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Analysis Reporting Limit		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NPD- 2 - I	2014 Jul 10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 4 - I	2014 Jul 10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 5 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 7 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 8 - I	2014 Jul 10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 9 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 10 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 11 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 12 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD- 14 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MT- 1 - I	2014 Jul 10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MT- 5 - I	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MT- 8 - I	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MT- 9 - I	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BH- 07-01	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BH- 09-01	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BH- 12-01	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BH- 13-01	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
NPD-TD	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Blank 07/09	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Blank 07/11	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MT- 5 - I Dup	2014 Jul 09	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BH- 12-01 Dup	2014 Jul 11	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

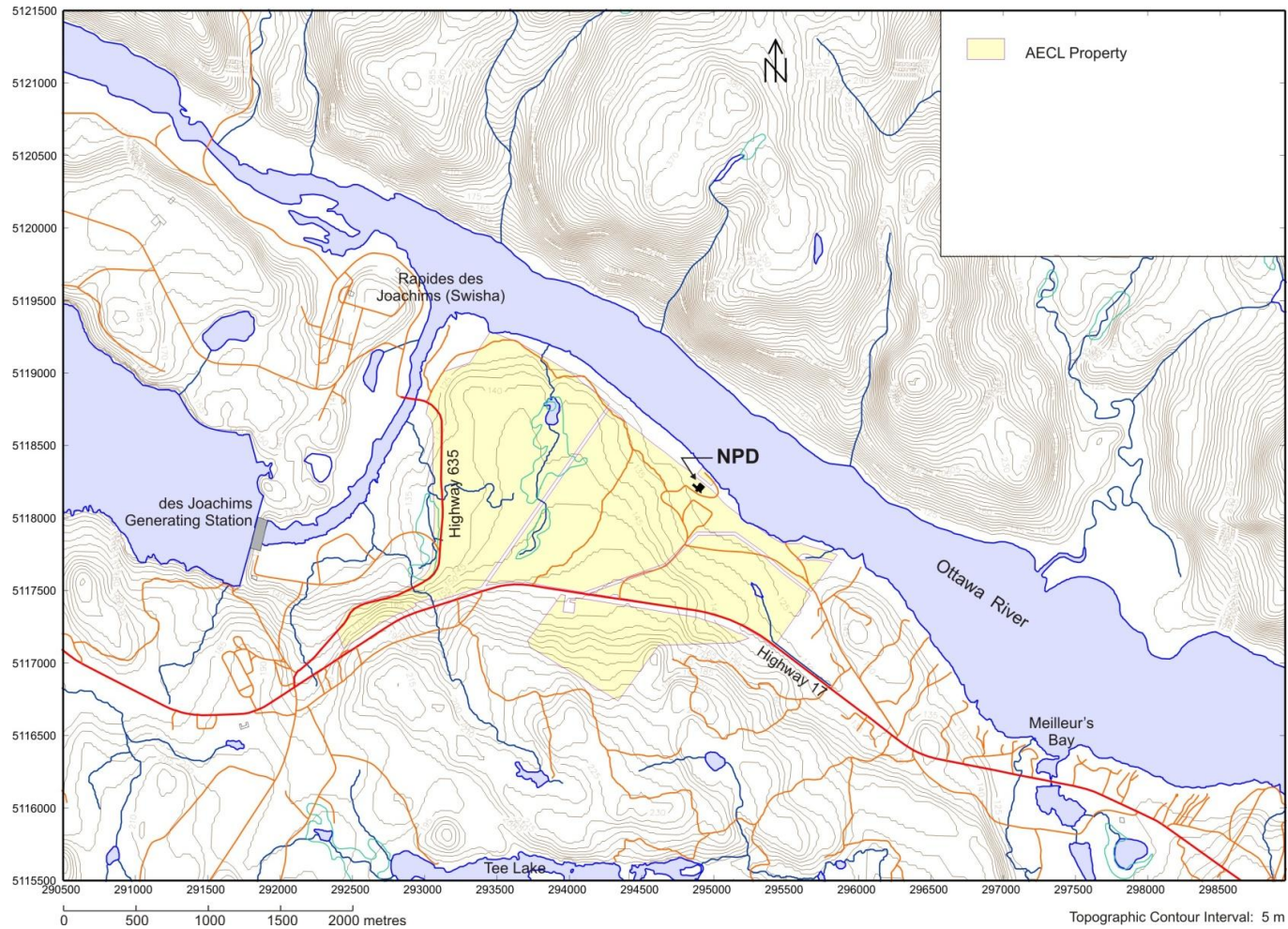


Figure 1 Map of general topography, drainage, and cultural features in the vicinity of the NPD site, based on Natural Resources Canada 1:50,000 topo maps

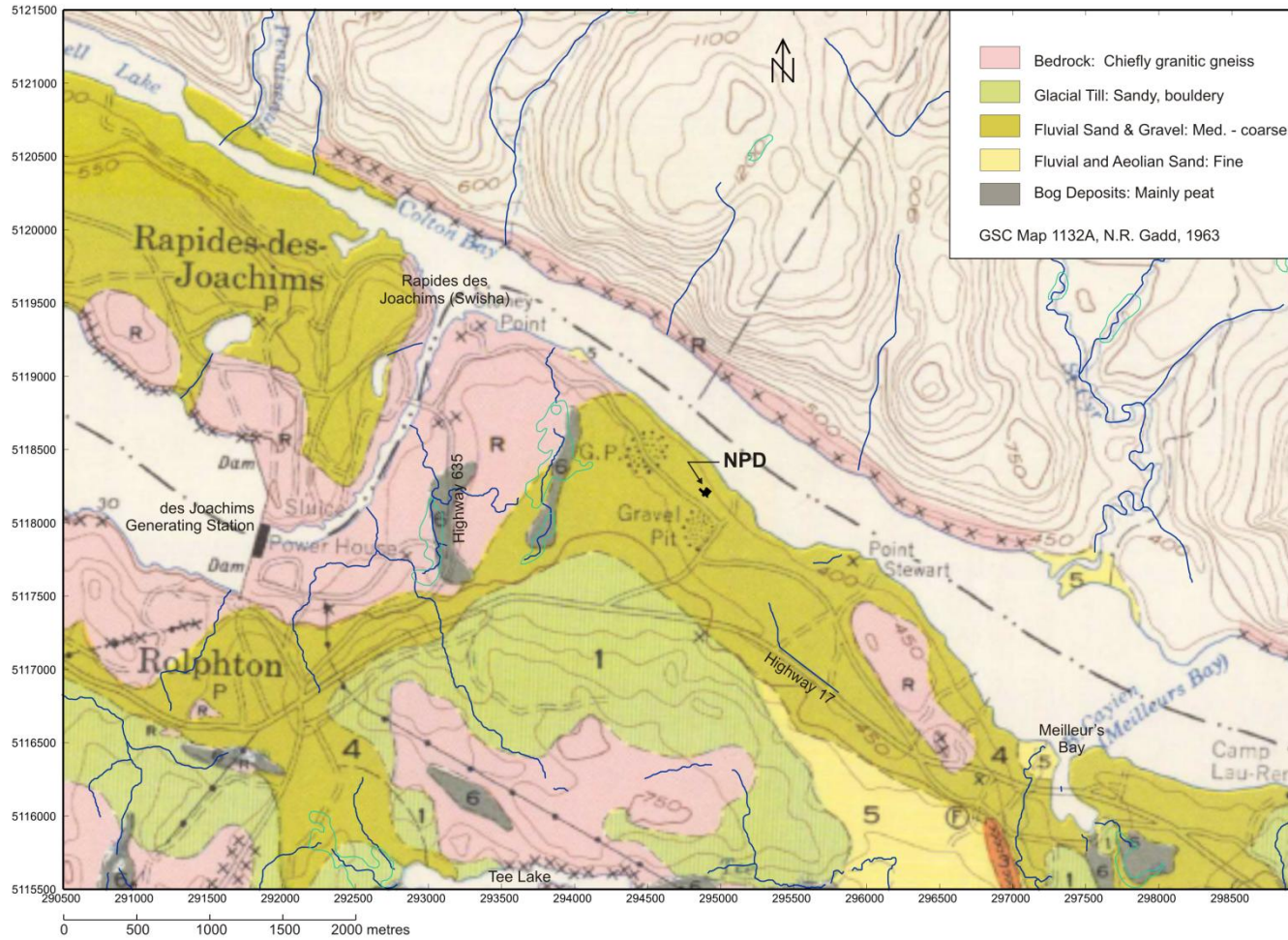


Figure 2 Surficial geology of the region around NPD

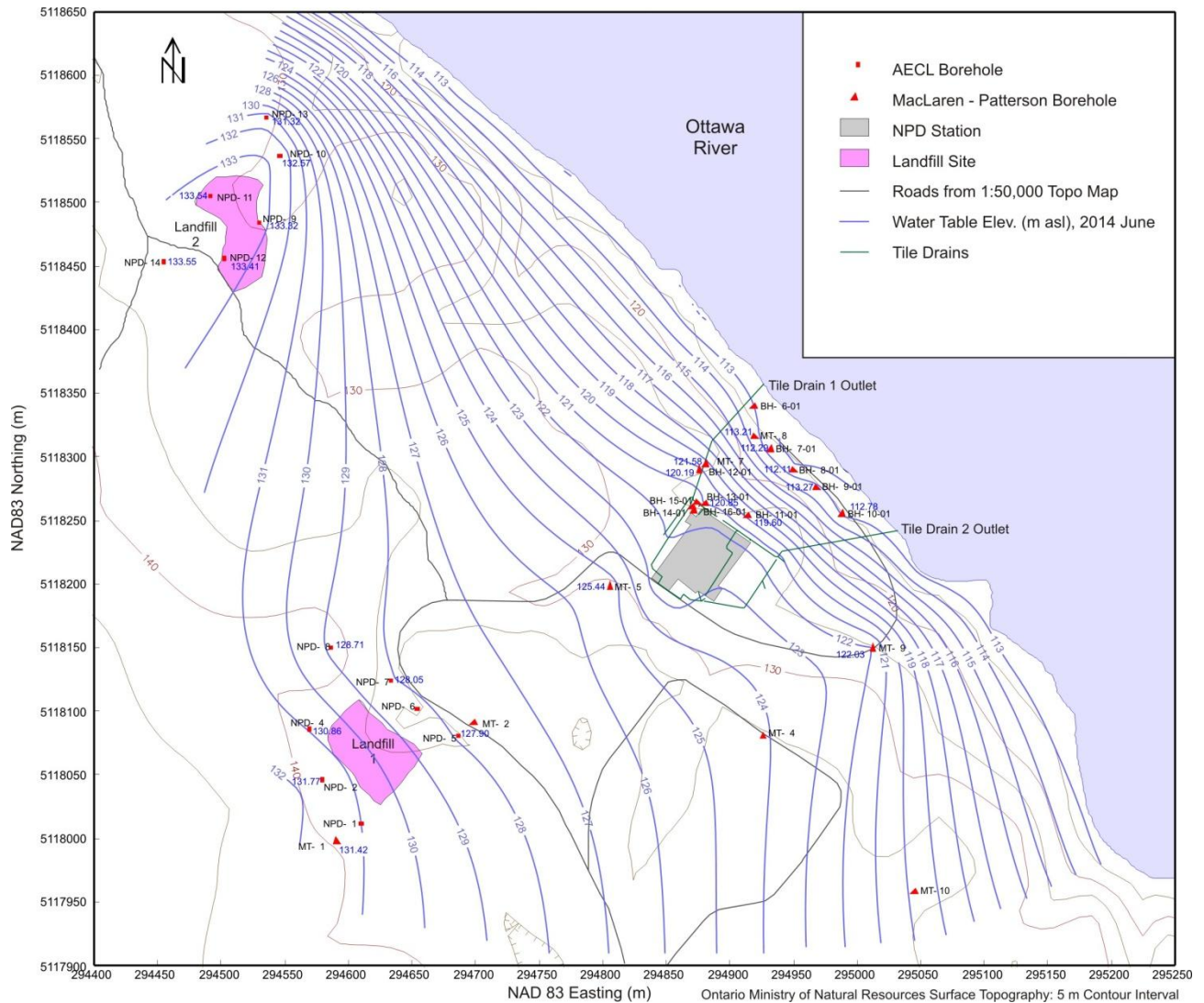


Figure 3 Map of the immediate vicinity of the NPD station, showing the landfill sites, borehole locations, and water table elevation contours for 2014 June 25

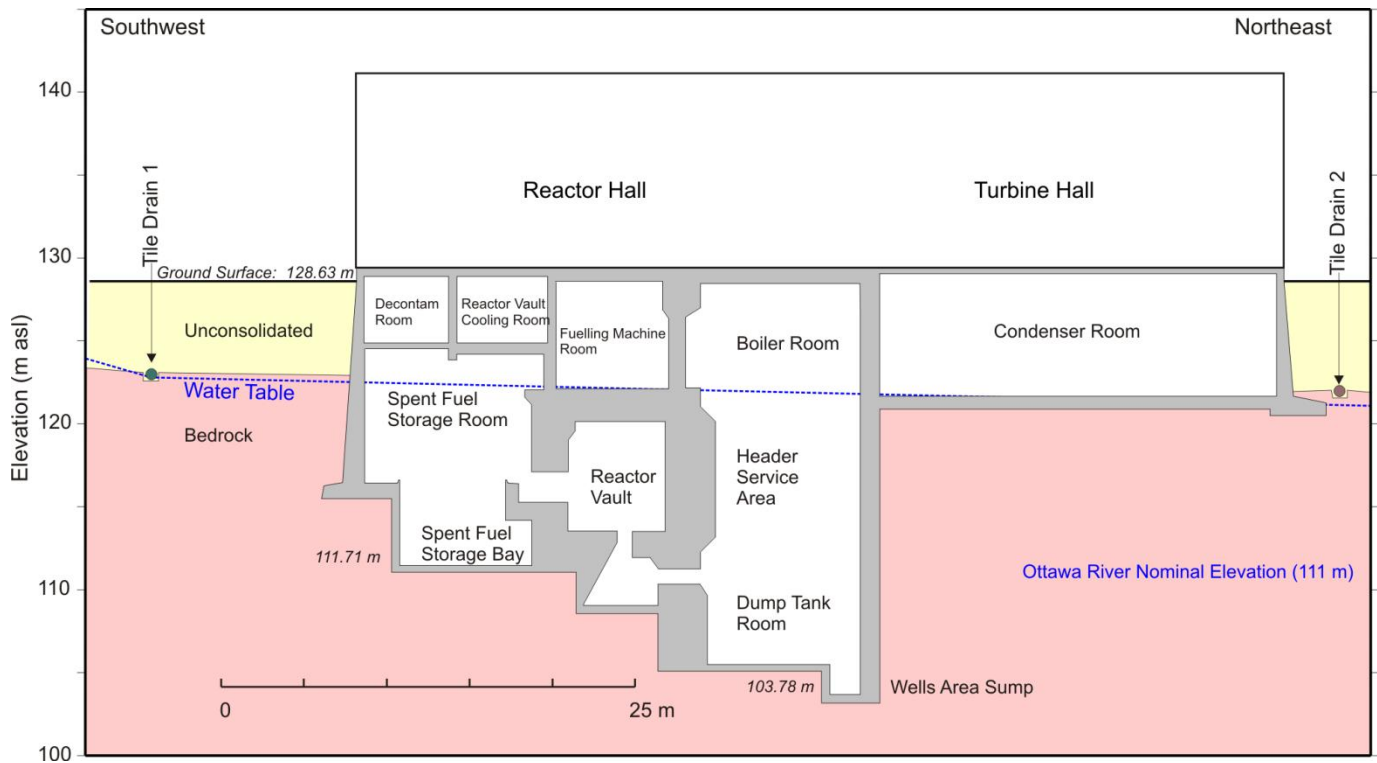


Figure 4 Southwest – northeast cross section through the NPD station



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Environmental, Radiological & Chemical Sciences
Environmental Technologies Branch

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038
Date:	2016/03/28

To: M. Vickerd
From: M. Audet
Cc: C. De Waele, C. Gallagher, J. Olfert, and >CR RECMAN/TRAK
Subject: Results of Sampling Effluent Streams from CNL's Prototype Reactor Decommissioning Sites

Introduction

This memorandum documents the results of a comprehensive effluent sampling and analysis campaign conducted at CNL's Prototype Reactor Decommissioning (PRD) sites; the NPD reactor (Nuclear Power Demonstration) at Rolphton, the Gentilly-1 reactor (G-1) at Gentilly, Quebec and the Douglas Point reactor (DP) at the Bruce Nuclear Generating Station near Tiverton, Ontario. The analytical results are evaluated against various water quality criteria to identify parameters of interest for consideration in the development of requirements for effluent monitoring, per the requirements of CNL's Environmental Monitoring Program [1] and CSA Standard N288.5 [2]. In addition, recommendations are developed where there appears to be opportunities to improve the quality of effluents.

Sampling

Sampling was performed at the three PRD sites by PRD Decommissioning staff in the fall of 2015; 28 and 29 October at G-1, 10 and 11 November at DP and 30 November and 01 December at NPD. Sampling was conducted following an instruction prepared by Canadian Nuclear Laboratories' (CNL) Environmental Technologies Branch (ETB) [3]. This instruction clarified the number of samples to be collected at each sampling location, the types of sample bottles to use and the requirements for sample filtration and preservation that are applicable to the types of analyses to be performed. Quality control measures applied during sampling included the collection of one field blank and one duplicate sample at each of the 3 PRD sites.

Field notes concerning the sampling location, visual characteristics of the effluent samples, and any issues pertaining to sampling were recorded on Water Sampling Log sheets. The field notes were transcribed into Table 1. This table also includes clarifications of the physical characteristics of the sampling locations, as provided by Decommissioning staff. As noted in the Table, many samples were collected (as grab samples) from stagnant water, in some cases with oily films, organic matter (needles and leaves), and floating matter present. There was sufficient volumes of effluents collected for all

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analyses with the exception of Manhole 3 at NPD (sample NPD-MH3), where it was not possible to fill the 1 litre EOC sample bottle and the container for dioxins/furans analysis.

Several issues were noted concerning sample collection and sample preservation. During the sampling campaign at Douglas Point, only 1 NaOH pellet was provided in the sampling kits (2 are required), the sample bottles for anions and DIC/DOC were not presoaked as required, 1 litre amber glass bottles intended for PCB analysis were used for EOC samples, and 1M NaOH preservative was not added in the field for the C-14 samples. During the NPD sampling campaign, it was noted that distilled water was not available to rinse the grab sampler between sampling events, potentially resulting in cross contamination between samples.

These observations and issues are considered in the evaluation of analytical results, below.

Sample Analyses

A wide range of analyses were assumed in the characterization effort, covering all of the analytical categories used in the Operational Control Monitoring (OCM) component of the CRL Groundwater Monitoring Program: physical and inorganic parameters, volatile organic compounds (VOCs), extractable organic compounds (EOCs), including PCBs and dioxins and furans, and radiological constituents. Four laboratories provided analytical services:

- ETB's Groundwater Monitoring Group analysed physical parameters (pH, conductivity), alkalinity and radiologicals (tritium, gross alpha, total beta, tritium, C-14 and gamma spec).
- ETB's Environmental Monitoring Group provided anion analyses, dissolved organic carbon (DOC) and dissolved inorganic carbon (DIC).
- CNL's Analytical Chemistry Branch provide metals and phenolics analyses.
- Research productivity Council (RPC, a commercial laboratory) provided organics analyses (VOCs, EOCs, dioxins and furans, PCBs), cyanide, mercury, ammonia and nitrogen.

Each laboratory applied their standard quality control measures, e.g., blanks and replicates.

Analysis Results

All sampling results are provided in Table 2 (DP), Table 3 (NPD) and Table 4 (G-1). Among the analyte classifications mentioned above, 215 parameters were generated for each of 22 samples collected, totalling 4,730 results. All analyses were performed as intended with the exception of EOC and dioxins/furans analyses for one NPD sample (NPD-MH3), where there was an insufficient volume of water to fill the sample containers.

Evaluation of the analytical results was carried out by two methods; comparative review (identifying anomalous parameter concentrations by visual comparison) and the application of available water quality criteria (water quality objectives and standards for human health and/or ecological protection).

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Comparative Evaluation of Analysis Results

The comparative review identified anomalous levels of physical and inorganic parameters at many of the sampling locations, as would be expected for effluent samples. The review included application of groundwater data from the Provincial Groundwater Monitoring Information System (PGMIS) [4], in which the 97.5 percentile value for various physical, inorganic and organic parameters is used as generic “background” concentrations. The application of reference parameter concentrations for groundwater was deemed appropriate because most of the effluents with ongoing flow are from groundwaters discharging into weeping tile systems installed beneath the buildings.

Table 5 provides a summary of all analytical results considered comparatively anomalous. The most notable anomalies include:

- Mercury at NPD-WAS (wells area sump, 650 ng/L) with lower concentrations in most of the sumps at G-1.
- PCBs in the G-1 sump T-002 (590 ug/L) with lower concentrations in two other G-1 sumps.
- Elevated concentrations of tritium at the NPD wells area sump (1.8 MBq/L) and at one G-1 sum (T-005, 220 kBq/L), in both cases accompanied with low concentrations of ¹³⁷Cs and total beta activity.
- Dioxins and furans at the NPD Wells Area Sump and at G-1’s sump T-002 (197 and 133 pgTEQ/L, respectively).

As shown in Table 2, at the Douglas Point PRD, there were few parameters showing evidence of industrial operations. The two sumps sampled (DP-D3 and DP-D6), which receive groundwater flow from weeping tile systems installed beneath the reactor building, show signs of only road salt contamination (elevated concentrations of conductivity, chloride, and sodium). The same is true of the road side ditch sampled (DP-RDD). Among the 3 catch basins sampled, 2 reported elevated concentrations of metals (aluminum, calcium, copper, iron, lead, vanadium and zinc) and low concentrations (less than 2 ug/L) of polycyclic aromatic hydrocarbons, PAHs (e.g., benzo(a)anthracene, chrysene, phenanthrene and fluoranthrene). The sample from DP-1CB also reported slightly elevated levels of polychlorinated dibenzo-p-dioxins, with the dominant dioxin congener being octachlorodibenzofuran (696 pg/L) and with an elevated toxic equivalency (TEQ) value of 197 pgTEQ/L. Both of these catch basins (DP-1CB and DP-2CB) are located next to vehicle parking areas, possibly accounting for the presence of these types of organic compounds (compounds of this nature can be associated with the combustion of petroleum products). The effluent sample from the third catch basin (DP-5CB) reported elevated concentrations of only 2 metals (copper and iron).

None of the DP effluent samples reported anomalous concentrations of tritium, ¹³⁷Cs or total beta activity. From the gamma spec analysis performed, low concentrations of ²¹²Pb were detected in several DP samples, but these results are not considered significant because one detection was not repeatable in a duplicate sample and another detection occurred in a field blank. In addition, all detections were at or below the activity detection level of roughly 2 Bq/L.

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As shown in Table 3, at the NPD PRD, a wide range of parameters were elevated in the wells area sump (NPD-WAS) effluent sample. These included conductivity, alkalinity, pH, dissolved organic and inorganic carbon, nitrate, sulphate, mercury (650 ng/L), metals (aluminum, cadmium, chromium, copper, iron, potassium, sodium, lead, vanadium and zinc), several extractable organic compounds (pyrene and bis(2-ethylhexyl)phthalate), a wide range of dioxin and furan congeners (mainly octachlorodibenzofuran at 29 ug/L), PCBs (5 ug/L), tritium (1.8 MBq/L), ¹⁴C (55 Bq/L), ¹³⁷Cs (39 Bq/L) and total beta activity (41 Bq/L). Several different sumps within the reactor building drain into the wells area sump (Condenser Pipe Trench and Service Area Sump), with these sumps receiving groundwater and condensation ingress.

Among these parameters, mercury and tritium are the most significant. Among the 2 manholes that were sampled at NPD (NPD-MH2 and NPD-MH3), only manhole 3 reported elevated concentrations of several metals (aluminum, copper, iron, vanadium and zinc) and a low concentration of tritium (2.4 kBq/L). Water in Manhole 2 was flowing steadily at the time of sampling and there was no flow in Manhole 3. Both manholes divert surface water and groundwater discharge from around the NPD Main Building.

At the G-1 PRD, effluents are managed in 2 different ways. All but 2 sumps (P-3 and P-4) are pumped into a portable holding tank (1000 L storage tote), which is transported to the G-2 Waste Water Facility for appropriate management. These sumps (S- and T-series sumps) are therefore not true effluents, but the sampling results are of benefit in defining operational control monitoring of the waste streams.

As shown in Table 4, the effluent sample collected from the P3/P4 sump reported elevated levels of conductivity, alkalinity, chloride and nitrate only, and absent from the analysis results were organic compounds and radiological parameters. The two sumps sampled in the Service Building (S-001 and S-012) reported similar characteristics: elevated conductivity, mercury (35 and 73 ng/L, respectively), metals (aluminum, chromium, copper, potassium, lead and zinc) and low concentrations of tritium (5.1 and 8.2 Bq/mL), ¹³⁷Cs (19.2 and 12.0 Bq/L) and total beta activity (9.8 and 12.9 Bq/L). Elevated levels of conductivity, chloride, sulphate, boron, cadmium, iron and sodium were also evident in the results from sump S-001 and elevated parameters that were unique to sump S-012 include alkalinity, dissolved inorganic carbon, nitrate and vanadium.

Waters sampled in the sumps in the G-1 Turbine Building (T-002, T-004, T-005 and T-007) reported a range of elevated parameters, including mercury, PCBs and radiologicals. As noted above, a relatively high concentration of PCBs was measured at T-002 (590 ug/L). This sump, holding stagnant water, is also characterized as having high pH (10.4) and elevated conductivity, alkalinity, dissolved organic carbon, ammonia and sodium and low concentrations of mercury (39 ng/L), several extractable organic compounds, a range of dioxin and furan congeners (mainly furans), and total beta activity (21 Bq/L). The PCB and contamination could be associated with the turbine lubrication system, which includes a holding tank located directly above the sump. Dioxin and furan contamination, with an elevated toxic equivalency (TEQ) value of 133 pgTEQ/L, may also be associated with the lubrication system, but this is speculative. Sump T-004, also stagnant at the time of sampling, is characterized as having elevated

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conductivity, alkalinity, dissolved inorganic carbon, ammonia and nitrogen and low concentrations of mercury (77 ng/L), several extractable organic compounds, PCBs (1.3 ug/L) and total beta activity (5.1 Bq/L). Sump T-005, which receives ongoing flow from groundwater and precipitation from around the Turbine Building and condensate from Reactor Building dehumidifier, was less affected with physical and inorganic and organic parameters, but more affected with radiologicals. Elevated results included nitrate, mercury (31 ng/L) and PCBs (4.0 ug/L). Radiological contamination in the T-005 sump sample included tritium (220 Bq/mL), ¹³⁷Cs (2.9 Bq/L) and total beta activity (3.3 Bq/L). Lastly, the sample from sump T-007 reported elevated levels of conductivity, chloride, sulphate, calcium, sodium, metals (barium, calcium, iron, potassium, manganese, lead, strontium and zinc) and low concentrations of mercury (33 ng/L) and ¹⁴C (13 Bq/L).

Evaluation of Analysis Results using Water Quality Criteria

Selection of Evaluation Criteria

Effort was applied in identifying appropriate water quality standards to determine which parameters might need inclusion in routine effluent monitoring. While a wide range of standards and guidelines exist for water quality pertaining to human health (drinking water standards) and ecological receptors (environmental quality guidelines), these criteria are not directly applicable in the management of effluents, for which there is recognition (accommodation) that it is not practical in industry to expect/require that effluents generated from industrial processes meet the standards and guidelines that assume chronic exposure by human and non-human biota.

Another consideration in selecting evaluation criteria is the “effluents” generated at the PRD sites are not waters generated from industrial processes (because the reactors and associated systems at the PRD sites have been shut down and disabled in the initial phase of decommissioning), but rather they are either storm waters (rainfall and snow melt) from site storm water drainage systems or groundwaters from building weeping tile systems. The only exception to this is condensate generated from dehumidification equipment. While groundwaters tend to flow into the weeping tile systems steadily, storm waters tend to be intermittent in flow, presenting a further challenge in designing a meaningful effluent monitoring system. As indicated in Table 1, among the 16 sumps and catch basins sampled, only 5 were described as having steady flow at the time of sampling and another 4 were described as having a “trickle” of flow.

For radiological constituents, site-specific release limits can be used to identify parameters that should be considered in deriving the requirements for effluent monitoring. Although these limits are based only on human health considerations, scaling could be applied to the limits to account for 1) the lesser extent of dilution at the locations where ecological receptors would be exposed (e.g., the receiving area at the points of effluent discharge versus a municipal water supply system some distance downstream of the site), and 2) the different type of protection goal applied to ecological receptors (e.g., population effects versus a dose limit that is protective of health effects of exposed individuals). Given the limited number of radionuclides detected in the PRD effluents (tritium, total beta activity

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and ¹³⁷Cs), the recommendations for monitoring established on the basis of DRLs would reasonably apply also to ecological receptors.

For non-radiological constituents, CNL’s Guideline Limit Values from the CNL Environmental Protection Program [5] can be applied to the effluent data. A limited number of parameters, however, are listed in the procedural document; among the 176 parameters included in the non-radiological analyses, only 10 apply in the evaluation (e.g., selected metals). Another observation in reviewing evaluation criteria is that generic criteria (guidelines, standards), such as those published by the Ontario Ministry of the Environment (OME) [6] and the Canadian Council of Ministers of the Environment (CCME) [7], are based simply on literature reviews of published toxicology studies, with the most restrictive value being adopted as the guideline/standard. This is evident in observing that the criteria for many constituents are a small fraction of background concentrations reported by the OME in 2011 [4]. Clearly, the determination of significance of elevated concentrations of various parameters must take into consideration site-specific factors such as the types of ecological receptors present and the degree of mixing at the effluent discharge zone. This type of risk assessment, however, is beyond the scope of the current effluent quality review.

The scheme adopted for evaluating the quality of PRD effluents involves;

- Determining if the measured concentrations exceed the MOE background concentration (97.5th percentile) [4], and if not, the concentrations measured are considered insignificant.
- Determining if the measured concentrations exceed:
 - the CCME environmental quality guidelines (EQGs) for the protection of aquatic life (freshwater) [7],
 - the OME standard for non-potable groundwater use at contaminated sites [4], and
 - the CNL guideline limit values (daily limits) for non-radioactive effluents [5].

Discussion of issues in the application of these criteria is provided below.

Evaluation Discussion

The specific criteria used in the evaluation of effluent quality are listed in Table 2. This Table also indicates the outcome of the evaluation by “screening” columns for each of the PRD sites and by the use of bold typeface on the parameter concentrations that exceed any of the criteria. As noted in footnotes to the table, restrictive, generic criteria that are below the MOE standard for background concentrations are disregarded. Table 6 provides a summary of the parameters for each of the PRD sites that “screened in” using this evaluation methodology. These are referred to as “parameters of potential interest in effluent monitoring” and the determination of which of these parameters warrant routine monitoring as well as the monitoring frequency will be determined in a subsequent evaluation performed by Environmental Protection.

In reviewing the data and the evaluation criteria in Table 2, Table 3 and Table 4, it is apparent that many of the parameters that “screened in” are the result of conservative, generic criteria. Being

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generic, the criteria are based on a wide range of ecological receptors and exposure conditions that may not apply to the specific sites under evaluation. As indicated in the “comment” field of Table 6, the most conservative criteria are associated with the CNL effluent criteria [5], where in the absence of a specified value, the MISA (Municipal-Industrial Strategy for Abatement) method detection limit (MDL) [8] is cited as the default criteria; this approach is not based on toxicological considerations.

In viewing the parameters listed in Table 6, it is clear that some are likely the result of prior nuclear and industrial operations, such as radiological contaminants, mercury and PCBs. Other parameters such as nitrates, iron, copper, cadmium and extractable organic compounds may be less likely attributed to past operations, and the absence of industrial processes that would be the source of anomalous parameters was in itself a basis for parameter screening in the Bruce Power/CNL Douglas Point Environmental Quantitative Risk Assessment [9]. Accordingly, facility personnel should be consulted to determine if there are specific potential sources of these parameters.

Clearly, further evaluation is required to identify the most significant parameters that warrant inclusion in routine effluent monitoring.

Other commentary in Table 6 indicates that some of the PRD effluent sampling points are not true effluents (e.g., many of the G-1 sumps) because the liquids are collected and transferred to the G-2 Waste Water Facility for appropriate management. The analytical results, however, are beneficial in characterizing the wastes streams, which should be of interest to the G-2 process for managing liquid wastes. Another issue identified in Table 6 is the fact that many of the sampling locations are within storm water management systems, which could also be argued as not being true effluents in that industrial processes are not the source of the liquids. In addition, the episodic nature of flow in storm water systems (rainfall and snow melt events) would present a practical challenge in performing routine monitoring, where the samples collected are required to be representative of the stream. It could be for these reasons that the Bruce Power/CNL Douglas Point Environmental Quantitative Risk Assessment did not evaluate storm water systems on the site.

Recommendations for Improvement of Effluent Quality

The characterization of PRD effluents was beneficial in identifying contaminants not previously known to be present; in particular, mercury and dioxins at NPD, and PCBs and furans at G-1. In managing the effluents at these sites and in planning future decommissioning activities, it may be beneficial to investigate the specific sources of these contaminants with a view to reducing residual contamination.

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Table 1
Physical Characteristics of Effluent Sampling Locations at the Prototype Reactor Decommissioning (PRD) Sites, 2015 Fall

Sampling Location	Effluent Type	Sampling Date	Flow	Observations	Sampling Issues Noted	Sampling Gaps
DP-D3	Reactor Building sump (GW)	10-Nov-15	None	D3 sump is open to the environment. No flow at time of sampling (stagnant). Next to road.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; container for PCBs used for EOCs; no preservative added for C-14 sample	No gaps
DP-D6	Reactor Building sump (GW)	11-Nov-15	Steady	Clear water, good flow; sample taken at end of ABS pipe (with solvent in joints). Beside underground spent resin tank.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; no preservative added for C-14 sample	No gaps
DP-D6d	See DP-D6	11-Nov-15	See DP-D6	See DP-D6	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; no preservative added for C-14 sample	No gaps
DP-1CB	Catch basin (storm water run-off)	11-Nov-15	Trickle	Cloudy grey water, with some organic matter. Catch basin is open to the environment and next to road and small parking lot.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; container for PCBs used for EOCs; no preservative added for C-14 sample	No gaps
DP-2CB	Catch basin (storm water run-off)	11-Nov-15	None	Cloudy grey water, live frog in basin; catch basin is shallow. Location is close to Bruce electrical switch yard with transformers and parking area.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; container for PCBs used for EOCs; no preservative added for C-14 sample	No gaps
DP-5CB	Catch basin (storm water run-off)	10-Nov-15	Trickle	Lots of organic matter in basin - needles, leaves, etc.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; container for PCBs used for EOCs; no preservative added for C-14 sample	No gaps
DP-FB	Field blank (QC)	10-Nov-15	n/a		Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; no preservative added for C-14 sample	No gaps

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Sampling Location	Effluent Type	Sampling Date	Flow	Observations	Sampling Issues Noted	Sampling Gaps
DP-RDD	Roadside drainage ditch (run-off from road and parking lot)	10-Nov-15	Steady	Broad, deep drainage ditch beside roadway; slow movement of water.	Only 1 pellet provided for CN sample; container for DIC/DOC was not pre-soaked; no preservative added for C-14 sample	No gaps
NPD-FB	Field blank (QC)	30-Nov-15	n/a			No gaps
NPD-MH2	Manhole (GW and SW drainage from around Main Building)	30-Nov-15	Steady	Small black pieces of organic material; no mixing or flow (stagnant). Next to site where diesel storage tanks leaked to ground (remediated).	All samples collected	No gaps
NPD-MH3	Same as MH2	30-Nov-15	None	Limited volume of water in manhole (sampling volume issue). Organic matter present.	Sample equipment not rinsed with distilled water; insufficient volume for all analyses	EOCs, PCDFs
NPD-WAS	Sump (GW and condensation from inside Main Building, including CPT and SAS sumps)	01-Dec-15	Trickle	Organic matter, cloudy water. Sump has capacity to mix (recirculation) before sampling. 10,000 L pumped out once a year (maybe twice).	Rinsed with WAS liquid but not distilled water	No gaps
NPD-WAS dup	See NPD-WAS	01-Dec-15		See NPD-WAS	Rinsed with WAS liquid but not distilled water	No gaps
S-001	Service Building sump (leaks/spills within building)	29-Oct-15	None	Service Building sump. Some floaties/scum, black floaties.		No gaps
S-012	Service Building sump (leaks from within the moderator tank vault and infiltration into vault and tunnel)	29-Oct-15	5% of flow	Scum floating on sump hole. Service Building sump; 1,000 L transferred in 2015.		No gaps
P3/P4	Reactor Building sumps (GW from weeping tiles under RB and resin vault)	29-Oct-15	Steady	Sumps are next to roadway.		No gaps
G-1 FB	Field blank (QC)	28-Oct-15	n/a		Double-distilled water used	No gaps

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Sampling Location	Effluent Type	Sampling Date	Flow	Observations	Sampling Issues Noted	Sampling Gaps
T-002	Turbine Building sump (GW & precip from around the TB)	28-Oct-15	None	Sheen on water, mould scum and floaties. Turbine lubrication system and oil reservoir tanks is one level above sump, with capped oil line extending downward into room with sump. Large frog living in sump.		No gaps
T-004	Turbine Building sump (GW & precip from around the TB & 1 kitchen sink)	28-Oct-15	None	Blue film on water (possible oil). Sump is in Turbine Building. Interconnections between T-002, T-004, T-005 and T-007 not understood.		No gaps
T-005	Turbine Building sump (GW & precip from around the TB & condensate from RB dehumidifier)	29-Oct-15	95% of flow	Turbine Building sump; 13,000 L transferred in 2015.		No gaps
T-005D	See T-005	29-Oct-15		See T-005		No gaps
T-007	Turbine Building sump (GW & precip from around the TB)	29-Oct-15	None	Stagnant sump water. Turbine Building sump. Truck bay (loading dock) within that area of building.		No gaps

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Table 2
Analytical Results of Effluent Water Samples Collected at the Douglas Point Prototype Reactor Decommissioning (PRD) Site, 2015 Fall

Sample ID	Douglas Point									Evaluation Criteria				Evaluation	
	DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out		
QC Designation			Duplicate				Blank		[2011]	[2016]	[2011]	[2014]			
Date Sampled	10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4			
Alkalinity	mg/L as HCO3-		381.8	278.9	301.0	125.3	166.0	87.5	1.8	338.7	550	ncl	ncl	ncl	OUT
pH (lab)	na		7.84	7.81	7.86	7.48	7.59	6.97	6.01	7.79	8.67	ncl	ncl	9.5	OUT
Conductivity	uS/cm @ 25 °C		1699	1488	1494	170	428	134.7	7.75	2350	3160	ncl	ncl	ncl	OUT
Dissolved Inorganic Carbon (DIC)	mg/L C		60.00	49.61	50.02	16.59	24.73	15.31	0.34	56.68	131	ncl	ncl	ncl	OUT
Dissolved Organic Carbon (DOC)	mg/L C		1.03	1.08	1.03	4.77	1.33	2.49	0.05	0.93	9.80	ncl	ncl	ncl	OUT
Bromide (Br-)	mg/L	0.064	<0.0638	<0.0638	<0.0638	<0.0638	<0.0638	<0.0638	<0.0638	<0.0638	nvl	ncl	ncl	ncl	OUT
Chloride (Cl-)	mg/L	0.042	520.57	430.73	433.17	6.54	67.67	3.44	0.01	847.43	790	120*	2300	ncl	OUT
Fluoride (F-)	mg/L	0.044	0.93	0.85	1.01	<0.0439	0.19	<0.0439	<0.0439	0.65	2.09	0.12*	ncl	ncl	OUT
Nitrate (NO3-)	mg/L	0.072	4.21	9.97	5.24	3.77	2.22	0.60	0.31	3.20	nvl	13	ncl	ncl	OUT
Nitrite (NO2-)	mg/L	0.054	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	nvl	60	ncl	ncl	OUT
Phosphate (PO43-)	mg/L	0.290	<0.2896	<0.2896	<0.2896	<0.2896	<0.2896	<0.2896	0.15	<0.2896	nvl	ncl	ncl	ncl	OUT
Sulphate (SO42-)	mg/L	0.091	27.89	50.85	50.65	4.09	5.88	0.10	<0.0910	28.50	1,070	ncl	ncl	ncl	OUT
Total Cyanide (CN-)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	nvl	ncl	ncl	ncl	OUT
Ammonia (NH3 + NH4+)	mg/L as N	0.05	< 0.05	< 0.05	0.05	0.17	0.08	< 0.05	< 0.05	< 0.05	nvl	22	ncl	ncl	OUT
Total Kjeldahl Nitrogen (TKN)	mg/L as N	0.25	< 0.25	0.2	< 0.25	0.9	0.3	0.5	< 0.25	< 0.25	5.65	ncl	ncl	ncl	OUT
Phenolics (4AAP)	ug/L Phenol		<1.9	<1.9	<1.9	<1.9	<1.9	3.5	2.2	<1.9	13.7	4*	12000	100	OUT
Metals															
Aluminum (Al)	mg/L		0.039	0.039	0.031	4.17	2.65	0.155	0.004	0.044	0.869	0.1*	ncl	ncl	OUT
Boron (B)	mg/L		0.035	0.037	0.043	<0.018	<0.018	<0.018	<0.018	0.021	1.65	0.15*	45	ncl	OUT
Barium (Ba)	mg/L		0.128	0.285	0.287	0.035	0.025	0.007	<0.001	0.106	0.609	ncl	29	ncl	OUT
Calcium (Ca)	mg/L		82.2	70.8	71.1	179	99.5	24.5	0.299	89.1	431	ncl	ncl	ncl	OUT
Cadmium (Cd)	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001	0.00009*	0.0027	ncl	OUT
Chromium (Cr)	mg/L		<0.001	<0.001	<0.001	0.006	0.001	<0.001	<0.001	<0.001	0.011	0.0089*	0.81	2.5	OUT
Copper (Cu)	mg/L		<0.015	<0.015	<0.015	0.022	0.016	0.036	<0.015	<0.015	0.004	0.002*	0.087	2.5	OUT
Iron (Fe)	mg/L		0.031	0.230	0.163	6.30	3.73	1.49	0.006	0.039	4.09	0.3*	ncl	5	IN
Potassium (K)	mg/L		2.50	5.07	5.12	1.97	3.03	0.981	<0.193	2.04	20.7	ncl	ncl	ncl	OUT
Lithium (Li)	mg/L		0.002	0.003	0.003	0.006	0.005	<0.001	<0.001	0.002	nvl	ncl	ncl	ncl	OUT
Magnesium (Mg)	mg/L		14.4	17.0	17.1	47.9	21.2	2.77	0.014	14.4	134	ncl	ncl	ncl	OUT
Manganese (Mn)	mg/L		0.003	0.007	0.004	0.301	0.179	0.090	<0.003	0.005	0.717	ncl	ncl	ncl	OUT
Mercury (Hg)	ng/L	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	nvl	26	290	1,000	OUT
Sodium (Na)	mg/L		247	200	201	6.54	47.9	3.29	<0.226	362	489	ncl	2300	ncl	OUT
Nickel (Ni)	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.014	0.025	0.49	2.5	OUT
Phosphorous (P)	mg/L		<0.019	<0.019	<0.019	0.300	0.090	0.047	<0.019	<0.019	7.97	ncl	ncl	5*	OUT
Lead (Pb)	mg/L		<0.004	<0.004	<0.004	0.014	<0.004	<0.004	<0.004	<0.004	0.002	0.001*	0.025	0.5	OUT

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Sample ID			DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation					Duplicate				Blank		[2011]	[2016]	[2011]	[2014]	
Date Sampled			10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	
Strontium (Sr)	mg/L		2.23	6.27	6.31	0.147	0.289	0.041	<0.001	5.80	20.2	ncl	ncl	ncl	OUT
Vanadium (V)	mg/L		<0.001	<0.001	<0.001	0.016	0.004	<0.001	<0.001	0.013	0.003	ncl	0.25	ncl	OUT
Zinc (Zn)	mg/L		0.031	0.082	0.034	0.195	0.265	0.812	0.016	0.046	0.063	0.03*	1.1	2.5	OUT

NOTE: Within analytical results, light grey shading denotes concentrations 10x or more higher than results from effluents with lower concentrations (i.e., relatively high concentrations), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

			Douglas Point							Evaluation Criteria				Evaluation	
Sample ID			DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation					Duplicate				Blank		[2011]	[2016]	[2011]	[2014]	
Date Sampled			10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	
ATG-16	Units	MDL													
1,1,2,2-Tetrachloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1,2-Trichloroethane	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,1-Dichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1-Dichloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,3-Dichlorobenzene	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,4-Dichlorobenzene	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
Bromodichloromethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Bromoform	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Bromomethane	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Carbon tetrachloride	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chloroform	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	24	0.6	2	1.8*	(22) 2.4	0.5*	OUT
cis-1,3-Dichloropropylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Dibromochloromethane	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Ethylene dibromide	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Methylene chloride	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Tetrachloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trans-1,3-Dichloropropylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trichloroethylene	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Trichlorofluoromethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichloroethane	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
1,2-Dichloropropane	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Chloromethane	µg/L	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9					OUT

MEMO / NOTE

CW-511300-FM-001 Rev. 4

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			Douglas Point								Evaluation Criteria				Evaluation
			DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation					Duplicate				Blank		[2011]	[2016]	[2011]	[2014]	
Date Sampled			10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	
Trans-1,2-Dichloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Vinyl chloride	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
1,1,1-Trichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-17															OUT
Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Styrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
o-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
m-Xylene and p-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-18															OUT
Acrolein	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT
Acrylonitrile	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

Sample ID			Douglas Point								Evaluation Criteria				Evaluation
			DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation					Duplicate				Blank		[2011]	[2016]	[2011]	[2014]	
Date Sampled			10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	
ATG-19															
Acenaphthene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
5-Nitro acenaphthene	µg/L	1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2					
Acenaphthylene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
Anthracene	µg/L	0.1	< 0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	< 0.1	nvl	0.012	2.4	0.6	IN
Atrazine	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1					
Benzo(a)anthracene	µg/L	0.2	< 0.2	< 0.2	< 0.2	0.8	0.5	< 0.2	< 0.2	< 0.2	nvl	0.018	4.7	0.5	IN
Benzo(a)pyrene	µg/L	0.3	< 0.3	< 0.3	< 0.3	0.7	0.5	< 0.3	< 0.3	< 0.3	nvl	0.015	0.81	0.6	IN
Benzo(b)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 0.4	0.7	0.6	< 0.4	< 0.4	< 0.4	nvl	ncl	0.75	0.7	IN
Benzo(g,h,i)perylene	µg/L	0.4	< 0.4	< 0.4	< 0.4	0.5	0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	0.2	0.7	IN
Benzo(k)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 0.4	0.7	0.6	< 0.4	< 0.4	< 0.4	nvl	ncl	0.4	0.7	IN
Biphenyl	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
Camphene	µg/L	2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5					
1-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
2-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
Chrysene	µg/L	0.2	< 0.2	< 0.2	< 0.2	0.9	0.8	< 0.2	< 0.2	< 0.2	nvl	ncl	1	0.3	IN

MEMO / NOTE

CW-511300-FM-001 Rev. 4

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	Douglas Point										Evaluation Criteria				Evaluation
	DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out		
QC Designation			Duplicate				Blank		[2011]	[2016]	[2011]	[2014]			
Date Sampled	10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4			
Dibenzo(a,h)anthracene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6							
Fluoranthene	µg/L	0.1	< 0.1	< 0.1	< 0.1	2.4	2.0	0.2	nvl	0.04	130	0.4	IN		
Fluorene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6							
Indeno(1,2,3-c,d)pyrene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6							
Indole	µg/L	0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7							
1-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8							
2-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8							
Naphthalene	µg/L	0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9							
Perylene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8							
Phenanthrene	µg/L	0.1	< 0.1	< 0.1	< 0.1	1.6	1.4	< 0.1	nvl	0.4	580	0.4	IN		
Pyrene	µg/L	0.1	< 0.1	< 0.1	< 0.1	1.8	1.5	0.1	nvl	0.025	68	0.4	IN		
T-butyl phosphate	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	ncl	ncl	ncl	OUT		
Benzyl butyl phthalate	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	ncl	0.6	OUT		
Bis(2-ethylhexyl)phthalate	µg/L	1.0 ¹	< 1.0	< 1.0	< 1.0	1.4	< 1.0	< 1.0	nvl	ncl	140	2.2	OUT		
Di-n-butylphthalate	µg/L	1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5							
Di-n-octylphthalate	µg/L	2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6							
4-Bromophenyl phenylether	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1							
4-Chlorophenyl phenylether	µg/L	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5							
Bis(2-chloroisopropyl)ether	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8							
Bis(2-chloroethyl)ether	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0							
Diphenyl Ether	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4							
2,4-Dinitrotoluene	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4							
2,6-Dinitrotoluene	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2							
Bis(2-chloroethoxy)methane	µg/L	0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9							
Diphenylamine	µg/L	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5							
N-Nitrosodiphenylamine	µg/L	Note	ND	ND	ND	ND	ND	ND							
N-Nitroso-di-n-propylamine	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8							
ATG-20, Extractables, Acids (Phenolics)															
2,3,4,5-Tetrachlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0							
2,3,4,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0	ivl	1	ncl	1.5	OUT		
2,3,5,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0	nvl	1	ncl	1	OUT		
2,3,4-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0							
2,3,5-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 1.0	< 1.0	< 1.0							
2,4,5-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0							
2,4,6-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 1.0	< 1.0	< 1.0	ivl	18	230	1	OUT		
2,4-Dimethylphenol	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0							
2,4-Dinitrophenol	µg/L	0.7	< 0.7	< 0.7	< 0.7	1.1	< 1.0	< 1.0	nvl	ncl	11000	42	OUT		
2,4-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0							

MEMO / NOTE

CW-511300-FM-001 Rev. 4

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	Douglas Point									Evaluation Criteria				Evaluation	
	DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd [2011]	CCME EQG [2016]	MOE Cont [2011]	CNL GLV [2014]	Screen In/Out		
QC Designation			Duplicate				Blank								
Date Sampled	10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4			
2,6-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0	< 0.4	< 0.4					
4,6-Dinitro-o-cresol	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 1.0	< 1.0	< 1.0	< 0.6	< 0.6					
2-Chlorophenol	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 1.0	< 1.0	< 1.0	< 0.8	< 0.8					
4-Chloro-3-methylphenol	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0	< 0.2	< 0.2					
4-Nitrophenol	µg/L	0.1	< 0.1	< 0.1	< 0.1	1.3	< 1.0	< 1.0	< 0.1	< 0.1	nvl	1	ncl	1.4	IN
m-Cresol ¹	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0	< 0.2	< 0.2					
o-Cresol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 1.0	< 1.0	< 1.0	< 0.4	< 0.4					
p-Cresol ¹	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 1.0	< 1.0	< 1.0	< 0.2	< 0.2					
Pentachlorophenol	µg/L	1.2	< 1.2	< 1.2	< 1.2	< 1.0	< 1.0	< 1.0	< 1.2	< 1.2	0.01	0.5*	62*	1*	OUT
Phenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 1.0	< 1.0	< 1.4	< 0.3	< 0.3					
ATG-23, Extractables, Neutral-Chlorinated															
1,2,3,4-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
1,2,3,5-Tetrachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
1,2,4,5-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
1,2,3-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
1,2,4-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
2,4,5-Trichlorotoluene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Hexachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Hexachlorobutadiene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Hexachlorocyclopentadiene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Hexachloroethane	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Octachlorostyrene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
Pentachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	< 0.01	< 0.01					
ATG-24, Dioxins and Furans															
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	pg/L		ND	ND	ND	ND	ND	ND	ND	ND	nvl	ncl	ncl	3.9	OUT
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	pg/L		ND	ND	ND	NDR(2.9)	ND	ND	ND	ND	nvl	ncl	ncl	14	OUT
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	pg/L		ND	ND	ND	2	ND	ND	ND	ND	nvl	ncl	ncl	7	OUT
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L		NDR(0.4)	NDR(0.6)	ND	4.1	NDR(1.2)	0.6	NDR(0.4)	ND	nvl	ncl	ncl	27	OUT
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L		NDR(0.4)	0.8	ND	5.1	1.4	ND	ND	ND	nvl	ncl	ncl	6	OUT
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L		2.5	6.3	5.2	90.7	26.2	5.5	2.1	3	nvl	ncl	ncl	8	OUT
Octachlorodibenzo-p-dioxin	pg/L		11.5	56.1	28.7	696	168	20.7	10.9	14	nvl	ncl	ncl	70	OUT
2,3,7,8-Tetrachlorodibenzofuran	pg/L		ND	ND	ND	1.1 E	NDR(0.5)	ND	NDR(0.3)	NDR(0.4)	nvl	ncl	ncl	6	OUT
2,3,4,7,8-Pentachlorodibenzofuran	pg/L		ND	NDR(0.5) E	ND	1.3	ND	ND	NDR(0.4) E	NDR(0.6)	nvl	ncl	ncl	5	OUT
1,2,3,7,8-Pentachlorodibenzofuran	pg/L		ND	ND	NDR(0.4) E	0.8	ND	ND	ND	ND	nvl	ncl	ncl	10	OUT
1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L		ND	NDR(0.5) E	ND	1.7	NDR(1) E	NDR(0.6)	ND	ND	nvl	ncl	ncl	6	OUT
1,2,3,7,8,9-Hexachlorodibenzofuran	pg/L		ND	ND	ND	2.1	NDR(0.5)	0.5 E	ND	ND	nvl	ncl	ncl	12	OUT
1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L		ND	ND	ND	2.2	0.5	ND	ND	ND	nvl	ncl	ncl	11	OUT
2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L		0.5 E	0.9 E	ND	1.4	0.9	0.7	1	0.9	nvl	ncl	ncl	9	OUT

MEMO / NOTE

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		Douglas Point								Evaluation Criteria				Evaluation Screen In/Out
		DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	
QC Designation				Duplicate				Blank		[2011]	[2016]	[2011]	[2014]	
Date Sampled		10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	1.3	NDR(1.7) E	NDR(1.1) E	17.9	8	1.4 E	1.1 E	NDR(1)	nvl	ncl	ncl	23	OUT
1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/L	0.4 E	0.9	0.9	2.4	0.9	0.5 E	0.3 E	NDR(0.4) E	nvl	ncl	ncl	10	OUT
Octachlorodibenzofuran	pg/L	1	4.2	2.3	30.3	9.7	2.1	1.7	2.2	nvl	ncl	ncl	30	OUT
Total tetrachlorinated dibenzo-p-dioxins	pg/L	ND	ND	ND	ND	ND	ND	ND	ND	nvl	ncl	ncl	3.9	OUT
Total pentachlorodibenzo-p-dioxins	pg/L	ND	ND	ND	NDR(2.9)	ND	ND	ND	ND	nvl	ncl	ncl	8	OUT
Total hexachlorodibenzo-p-dioxins	pg/L	1.1	0.8	ND	37.1	12.6	2.1	NDR(0.4)	1	nvl	ncl	ncl	28	OUT
Total heptachlorodibenzo-p-dioxins	pg/L	4.5	11	8.2	171	62.7	10.2	4	5.6	nvl	ncl	ncl	10	OUT
Total Dioxins	pg/L	17.1	67.9	36.9	905	244	33	14.9	20.6	nvl	ncl	ncl	ncl	OUT
Total tetrachlorinated dibenzofurans	pg/L	ND	ND	ND	1.9 E	0.4	ND	NDR(0.3)	0.4	nvl	ncl	ncl	6	OUT
Total pentachlorinated dibenzofurans	pg/L	ND	NDR(0.5) E	NDR(0.4) E	4.5 E	ND	ND	NDR(0.4) E	NDR(0.6)	nvl	ncl	ncl	7	OUT
Total hexachlorinated dibenzofurans	pg/L	0.5 E	0.9 E	ND	20 E	4.2 E	1.7 E	1	1.2	nvl	ncl	ncl	17	OUT
Total heptachlorinated dibenzofurans	pg/L	1.7 E	2.3 E	1.5 E	39.5	14.8	2.7 E	2.2 E	NDR(1)	nvl	ncl	ncl	28	OUT
Total Furans	pg/L	3.2	7.4	3.8	96.2	29.1	6.5	4.9	3.8	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans	pg/L	20.3	75.3	40.7	1001.2	273.1	39.5	19.8	24.4	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans (Detected)	pgTEQ/L	0.6	0.8	1.1	5.3	1.7	1.1	0.8	0.7	nvl	ncl	(23) 14	ncl	OUT
Total Dioxins/Furans (Maximum Possible)	pgTEQ/L	1.1	1.4	2.1	6.3	2.6	1.9	1.5	1.2	nvl	ncl	ncl	ncl	OUT
ATG-27, PCBs														
Total PCB	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.026	0.001*	(15) 7.8	0.05	OUT

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ivl denotes invalid value listed (insufficient data to derive percentile value), ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

Sample ID		Douglas Point								Evaluation Criteria						Evaluation Screen In/Out
		DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME DWQG	MOE Cont	DRLs (Bq/mo)			
QC Designation				Duplicate				Blank		[2011]	[2014]	[2011]	NPD	DP	G-1	
Date Sampled		10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	4	4	
Tritium (H-3)	Bq/mL	0.51	1.84	1.87	0.77	0.54	0.24	0.05	0.24	nvl	7	ncl	3.61E+16	1.61E+16	9.63E+17	OUT
C-14	Bq/L	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	nvl	200	ncl	3.24E+13	8.48E+12	2.00E+14	OUT
K-40	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Cr-51	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Mn-54	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Co-57	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Fe-59	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Co-60	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Zn-65	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Se-75	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							

MEMO / NOTE

To: M. Vickerd
Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		Douglas Point								Evaluation Criteria						Evaluation
		DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD	MOE Bkgd	CCME DWQG	MOE Cont	DRLs (Bq/mo)			Screen In/Out
QC Designation				Duplicate				Blank		[2011]	[2014]	[2011]	NPD	DP	G-1	
Date Sampled		10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15	1	2	3	4	4	4	
Nb-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Zr-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Mo-99	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Tc-99m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ru-103	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ru-106	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ag-110m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Sb-125	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
I-131	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ba-133	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Cs-134	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Cs-137	Bq/L	<1.75	<1.7	<1.7	<1.04	<1.8	<1.82	<1.73	<1.8	nvl	10	ncl	2.13E+12	3.96E+11	1.46E+13	OUT
Ce-141	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ce-144	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Eu-152x	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Eu-154	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Eu-155	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Tl-208	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Bi-212	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Pb-212	Bq/L	<2.74	<2.37	1.52	1.62	<2.71	<2.63	1.46	3.20	nvl	ncl	ncl	ncl	ncl	ncl	OUT
Bi-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Pb-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ra-226	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Ac-228	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Pa-233	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Th-234	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Am-241	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA							
Total Alpha	Bq/L	<0.41	0.502	<0.32	<0.39	<0.22	<0.18	<0.17	0.636	nv	0.2	ncl	ncl	ncl	8.94E+13	IN
Total Beta	Bq/L	<0.40	0.403	0.627	<0.38	<0.38	<0.38	<0.38	<0.40	nvl	5	ncl	2.13E+12	4.31E+12	1.46E+13	OUT

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

MEMO / NOTE

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To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Table 3
Analytical Results of Effluent Water Samples Collected at the NPD Prototype Reactor Decommissioning (PRD) Site, 2015 Fall

Sample ID			NPD					Evaluation Criteria				Evaluation
			NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EOG	MOE Cont	CNL GLV	Screen In/Out
QC Designation			Blank				Duplicate	[2011]	[2016]	[2011]	[2014]	
Date Sampled			30-Nov-15	30-Nov-15	30-Nov-15	2-Dec-15	2-Dec-15	1	2	3	4	
Alkalinity	mg/L as HCO3-		3.2	34.0	41.2	630	842	550	ncl	ncl	ncl	OUT
pH (lab)	na		5.3	6.08	6.55	9.29	9.35	8.67	ncl	ncl	9.5	OUT
Conductivity	uS/cm @ 25 °C		1.77	149	144	1551	1552	3160	ncl	ncl	ncl	OUT
Dissolved Inorganic Carbon (DIC)	mg/L C		0.45	7.40	6.36	129.41	129.37	131	ncl	ncl	ncl	OUT
Dissolved Organic Carbon (DOC)	mg/L C		0.05	0.98	1.13	19.6	20.4	9.80	ncl	ncl	ncl	OUT
Bromide (Br-)	mg/L	0.064	<0.0638	<0.0638	<0.0638	<0.0638	<0.0638	nvl	ncl	ncl	ncl	OUT
Chloride (Cl-)	mg/L	0.042	0.02	42.87	41.78	13.20	13.63	790	120*	2300	ncl	OUT
Fluoride (F-)	mg/L	0.044	<0.0439	<0.0439	<0.0439	0.50	0.42	2.09	0.12*	ncl	ncl	OUT
Nitrate (NO3-)	mg/L	0.072	1.46	1.60	3.03	25.23	25.83	nvl	13	ncl	ncl	OUT
Nitrite (NO2-)	mg/L	0.054	<0.0534	<0.0534	<0.0534	0.16	0.35	nvl	60	ncl	ncl	OUT
Phosphate (PO43-)	mg/L	0.290	<0.2896	<0.2896	<0.2896	1.09	0.97	nvl	ncl	ncl	ncl	OUT
Sulphate (SO42-)	mg/L	0.091	0.12	8.71	2.65	127.10	128.29	1,070	ncl	ncl	ncl	OUT
Total Cyanide (CN-)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	nvl	ncl	ncl	ncl	OUT
Ammonia (NH3 + NH4+)	mg/L as N	0.05	< 0.05	< 0.05	< 0.05	0.45	0.43	nvl	22	ncl	ncl	OUT
Total Kjeldahl Nitrogen (TKN)	mg/L as N	0.25	< 0.25	< 0.25	0.6	2.8	3.6	5.65	ncl	ncl	ncl	OUT
Phenolics (4AAP)	ug/L Phenol		<1.0	<1.2	<1.6	5.20	6.50	13.7	4*	12000	100	OUT
Metals												
Aluminum (Al)	mg/L		<0.009	0.07	3.02	4.76	4.19	0.869	0.1*	ncl	ncl	OUT
Boron (B)	mg/L		<0.227	<0.227	<0.227	0.509	0.501	1.65	0.15*	45	ncl	OUT

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To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			NPD					Evaluation Criteria				Evaluation
			NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EOG	MOE Cont	CNL GLV	Screen In/Out
QC Designation			Blank				Duplicate	[2011]	[2016]	[2011]	[2014]	
Date Sampled			30-Nov-15	30-Nov-15	30-Nov-15	2-Dec-15	2-Dec-15	1	2	3	4	
Barium (Ba)	mg/L		<0.004	0.100	0.097	0.166	0.140	0.609	ncl	29	ncl	OUT
Calcium (Ca)	mg/L		0.161	37.1	46.2	28.8	28.7	431	ncl	ncl	ncl	OUT
Cadmium (Cd)	mg/L		<0.004	<0.004	<0.004	0.051	0.035	0.0001	0.00009*	0.0027	ncl	IN
Chromium (Cr)	mg/L		<0.001	<0.001	<0.001	0.092	0.093	0.011	0.0089*	0.81	2.5	OUT
Copper (Cu)	mg/L		<0.031	<0.031	0.035	1.37	1.26	0.004	0.002*	0.087	2.5	IN
Iron (Fe)	mg/L		0.011	0.291	7.31	7.45	9.02	4.09	0.3*	ncl	5	IN
Potassium (K)	mg/L		<0.337	7.11	13.44	840	823	20.7	ncl	ncl	ncl	OUT
Lithium (Li)	mg/L		<0.125	<0.125	<0.125	<0.125	<0.125	nvl	ncl	ncl	ncl	OUT
Magnesium (Mg)	mg/L		<0.001	13.5	8.20	1.67	1.66	134	ncl	ncl	ncl	OUT
Manganese (Mn)	mg/L		<0.010	0.012	0.160	0.145	0.164	0.717	ncl	ncl	ncl	OUT
Mercury (Hg)	ng/L	5	< 5	< 5	< 5	647	651	nvl	26	290	1,000	IN
Sodium (Na)	mg/L		<0.314	72.7	73.9	1010	991	489	ncl	2300	ncl	OUT
Nickel (Ni)	mg/L		<0.003	<0.003	<0.003	<0.003	<0.003	0.014	0.025	0.49	2.5	OUT
Phosphorous (P)	mg/L		<0.074	<0.074	0.310	2.62	2.43	7.97	ncl	ncl	5*	OUT
Lead (Pb)	mg/L		<0.018	<0.018	<0.018	1.90	1.55	0.002	0.001*	0.025	0.5	IN
Strontium (Sr)	mg/L		<0.003	0.322	0.205	1.09	1.03	20.2	ncl	ncl	ncl	OUT
Vanadium (V)	mg/L		<0.001	<0.001	0.006	0.022	0.024	0.003	ncl	0.25	ncl	OUT
Zinc (Zn)	mg/L		0.011	0.036	1.78	1.16	0.874	0.063	0.03*	1.1	2.5	IN

NOTE: Within analytical results, light grey shading denotes concentrations 10x or more higher than results from effluents with lower concentrations (i.e., relatively high concentrations), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

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To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			NPD					Evaluation Criteria				Evaluation
			NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation			Blank					Duplicate				
Date Sampled			30-Nov-15	30-Nov-15	30-Nov-15	02-Dec-15	02-Dec-15	1	2	3	4	
ATG-16	Units	MDL										
1,1,2,2-Tetrachloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1,2-Trichloroethane	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,1-Dichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1-Dichloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,3-Dichlorobenzene	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,4-Dichlorobenzene	µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
Bromodichloromethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Bromoform	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Bromomethane	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Carbon tetrachloride	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chloroform	µg/L	0.5	1.0	<0.5	<0.5	<0.5	<0.5	2	1.8*	(22) 2.4	0.5*	OUT
cis-1,3-Dichloropropylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Dibromochloromethane	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Ethylene dibromide	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Methylene chloride	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Tetrachloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trans-1,3-Dichloropropylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trichloroethylene	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Trichlorofluoromethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichloroethane	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
1,2-Dichloropropane	µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chlorobenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			NPD					Evaluation Criteria				Evaluation
			NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation			Blank					Duplicate				
Date Sampled			30-Nov-15	30-Nov-15	30-Nov-15	02-Dec-15	02-Dec-15	1	2	3	4	
Chloromethane	µg/L	0.9	<0.9	<0.9	<0.9	<0.9	<0.9					OUT
Trans-1,2-Dichloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Vinyl chloride	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
1,1,1-Trichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-17												OUT
Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Styrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
o-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
m-Xylene and p-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-18												OUT
Acrolein	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT
Acrylonitrile	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	NPD						Evaluation Criteria				Evaluation
	NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out	
QC Designation	Blank				Duplicate	[2011]	[2016]	[2011]	[2014]		
Date Sampled	30-Nov-15	30-Nov-15		02-Dec-15	02-Dec-15	1	2	3	4		
ATG-19	Units	MDL									
Acenaphthene	µg/L	0.8	< 0.8	< 0.8	< 1.0	< 1.0					
5-Nitro acenaphthene	µg/L	1.2	< 1.2	< 1.2	< 1.0	< 1.0					
Acenaphthylene	µg/L	0.8	< 0.8	< 0.8	< 1.0	< 1.0					
Anthracene	µg/L	0.1	< 0.1	< 0.1	< 1.0	< 1.0	nvl	0.012	2.4	0.6	OUT
Atrazine	µg/L	0.1	< 0.1	< 0.1	< 1.0	< 1.0					
Benzo(a)anthracene	µg/L	0.2	< 0.2	< 0.2	< 1.0	< 1.0	nvl	0.018	4.7	0.5	OUT
Benzo(a)pyrene	µg/L	0.3	< 0.3	< 0.3	< 1.0	< 1.0	nvl	0.015	0.81	0.6	OUT
Benzo(b)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 1.0	< 1.0	nvl	ncl	0.75	0.7	OUT
Benzo(g,h,i)perylene	µg/L	0.4	< 0.4	< 0.4	< 1.0	< 1.0	nvl	ncl	0.2	0.7	OUT
Benzo(k)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 1.0	< 1.0	nvl	ncl	0.4	0.7	OUT
Biphenyl	µg/L	0.6	< 0.6	< 0.6	< 1.0	< 1.0					
Camphene	µg/L	2.5	< 2.5	< 2.5	< 1.0	< 1.0					
1-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0					
2-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0					
Chrysene	µg/L	0.2	< 0.2	< 0.2	< 1.0	< 1.0	nvl	ncl	1	0.3	OUT
Dibenzo(a,h)anthracene	µg/L	0.6	< 0.6	< 0.6	< 1.0	< 1.0					
Fluoranthene	µg/L	0.1	< 0.1	< 0.1	< 1.0	< 1.0	nvl	0.04	130	0.4	OUT
Fluorene	µg/L	0.6	< 0.6	< 0.6	< 1.0	< 1.0					
Indeno(1,2,3-c,d)pyrene	µg/L	0.6	< 0.6	< 0.6	< 1.0	< 1.0					
Indole	µg/L	0.7	< 0.7	< 0.7	< 1.0	< 1.0					
1-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 1.0	< 1.0					
2-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 1.0	< 1.0					
Naphthalene	µg/L	0.9	< 0.9	< 0.9	< 1.0	< 1.0					

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 Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	NPD					Evaluation Criteria				Evaluation		
	NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out		
QC Designation	Blank				Duplicate	[2011]	[2016]	[2011]	[2014]			
Date Sampled	30-Nov-15	30-Nov-15		02-Dec-15	02-Dec-15	1	2	3	4			
Perylene	µg/L	0.8	< 0.8	< 0.8		< 1.0	< 1.0					
Phenanthrene	µg/L	0.1	< 0.1	< 0.1		< 1.0	< 1.0	nvl	0.4	580	0.4	OUT
Pyrene	µg/L	0.1	< 0.1	< 0.1		< 1.0	1.3	nvl	0.025	68	0.4	IN
T-butyl phosphate	µg/L	0.1	< 0.1	< 0.1		< 1.0	< 1.0	nvl	ncl	ncl	ncl	OUT
Benzyl butyl phthalate	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0	nvl	ncl	ncl	0.6	OUT
Bis(2-ethylhexyl)phthalate	µg/L	1.0 ¹	< 1.0	< 1.0		14	15	nvl	ncl	140	2.2	IN
Di-n-butylphthalate	µg/L	1.5	< 1.5	< 1.5		< 1.0	< 1.0					
Di-n-octylphthalate	µg/L	2.6	< 2.6	< 2.6		< 1.0	< 1.0					
4-Bromophenyl phenylether	µg/L	0.1	< 0.1	< 0.1		< 1.0	< 1.0					
4-Chlorophenyl phenylether	µg/L	0.5	< 0.5	< 0.5		< 1.0	< 1.0					
Bis(2-chloroisopropyl)ether	µg/L	0.8	< 0.8	< 0.8		< 1.0	< 1.0					
Bis(2-chloroethyl)ether	µg/L	1.0	< 1.0	< 1.0		< 1.0	< 1.0					
Diphenyl Ether	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
2,4-Dinitrotoluene	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
2,6-Dinitrotoluene	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0					
Bis(2-chloroethoxy)methane	µg/L	0.9	< 0.9	< 0.9		< 1.0	< 1.0					
Diphenylamine	µg/L	0.5	< 0.5	< 0.5		< 1.0	< 1.0					
N-Nitrosodiphenylamine	µg/L	Note	na	na		na	na					
N-Nitroso-di-n-propylamine	µg/L	0.8	< 0.8	< 0.8		< 1.0	< 1.0					
ATG-20, Extractables, Acids (Phenolics)												
2,3,4,5-Tetrachlorophenol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
2,3,4,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0	ivl	1	ncl	1.5	OUT
2,3,5,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0	nvl	1	ncl	1	OUT
2,3,4-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	NPD						Evaluation Criteria				Evaluation	
	NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out		
QC Designation	Blank				Duplicate	[2011]	[2016]	[2011]	[2014]			
Date Sampled	30-Nov-15	30-Nov-15		02-Dec-15	02-Dec-15	1	2	3	4			
2,3,5-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3		< 1.0	< 1.0					
2,4,5-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
2,4,6-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3		< 1.0	< 1.0	ivl	18	230	1	OUT
2,4-Dimethylphenol	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0					
2,4-Dinitrophenol	µg/L	0.7	< 0.7	< 0.7		< 1.0	< 1.0	nvl	ncl	11000	42	OUT
2,4-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
2,6-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
4,6-Dinitro-o-cresol	µg/L	0.6	< 0.6	< 0.6		< 1.0	< 1.0					
2-Chlorophenol	µg/L	0.8	< 0.8	< 0.8		< 1.0	< 1.0					
4-Chloro-3-methylphenol	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0					
4-Nitrophenol	µg/L	0.1	< 0.1	< 0.1		< 1.0	< 1.0	nvl	1	ncl	1.4	OUT
m-Cresol ¹	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0					
o-Cresol	µg/L	0.4	< 0.4	< 0.4		< 1.0	< 1.0					
p-Cresol ¹	µg/L	0.2	< 0.2	< 0.2		< 1.0	< 1.0					
Pentachlorophenol	µg/L	1.2	< 1.2	< 1.2		< 1.0	< 1.0	0.01	0.5*	62*	1*	OUT
Phenol	µg/L	0.3	< 0.3	< 0.3		< 1.0	< 1.0					
ATG-23, Extractables, Neutral-Chlorinated												
1,2,3,4-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					
1,2,3,5-Tetrachlorobenzene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					
1,2,4,5-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					
1,2,3-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					
1,2,4-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					
2,4,5-Trichlorotoluene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0					

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	NPD					Evaluation Criteria				Evaluation	
	NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out	
QC Designation	Blank				Duplicate	[2011]	[2016]	[2011]	[2014]		
Date Sampled	30-Nov-15	30-Nov-15		02-Dec-15	02-Dec-15	1	2	3	4		
Hexachlorobenzene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
Hexachlorobutadiene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
Hexachlorocyclopentadiene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
Hexachloroethane	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
Octachlorostyrene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
Pentachlorobenzene	µg/L	0.01	< 0.01	< 0.01		< 1.0	< 1.0				
ATG-24, Dioxins and Furans											
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	pg/L	ND	ND		10.2	NDR(7.8)	nvl	ncl	ncl	3.9	OUT
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	pg/L	ND	NDR(0.2)		80.8	124	nvl	ncl	ncl	14	OUT
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	pg/L	ND	ND		44.2	51.6	nvl	ncl	ncl	7	OUT
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L	ND	ND		155	141	nvl	ncl	ncl	27	OUT
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L	ND	ND		153	150	nvl	ncl	ncl	6	OUT
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L	3.4	3.3		5090	4070	nvl	ncl	ncl	8	OUT
Octachlorodibenzo-p-dioxin	pg/L	8.8	9.2		30900	26200	nvl	ncl	ncl	70	OUT
2,3,7,8-Tetrachlorodibenzofuran	pg/L	ND	ND		49.8	29.6	nvl	ncl	ncl	6	OUT
2,3,4,7,8-Pentachlorodibenzofuran	pg/L	ND	ND		21.2	13.9	nvl	ncl	ncl	5	OUT
1,2,3,7,8-Pentachlorodibenzofuran	pg/L	ND	ND		42.4	22.7	nvl	ncl	ncl	10	OUT
1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L	ND	0.4 E		33.3	21.5	nvl	ncl	ncl	6	OUT
1,2,3,7,8,9-Hexachlorodibenzofuran	pg/L	ND	0.4 E		15.5	10.9	nvl	ncl	ncl	12	OUT
1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L	ND	0.3 E		21.2	19.4	nvl	ncl	ncl	11	OUT
2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L	ND	NDR(0.5)		4.5 E	NDR(2.5) E	nvl	ncl	ncl	9	OUT
1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	1.5	NDR(1.2) E		155	107	nvl	ncl	ncl	23	OUT
1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/L	ND	0.6		17.1	14.6	nvl	ncl	ncl	10	OUT
Octachlorodibenzofuran	pg/L	ND	1.8		551	471	nvl	ncl	ncl	30	OUT

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 Ref. Procedure CW-511300-PRO-647

To: M. Vickerd
Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID	NPD					Evaluation Criteria				Evaluation	
	NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out	
QC Designation	Blank				Duplicate	[2011]	[2016]	[2011]	[2014]		
Date Sampled	30-Nov-15	30-Nov-15		02-Dec-15	02-Dec-15	1	2	3	4		
Total tetrachlorinated dibenzo-p-dioxins	pg/L	1.2	ND		146	106	nvl	ncl	ncl	3.9	OUT
Total pentachlorodibenzo-p-dioxins	pg/L	ND	0.4		313	357	nvl	ncl	ncl	8	OUT
Total hexachlorodibenzo-p-dioxins	pg/L	0.6	2.2		1550	1460	nvl	ncl	ncl	28	OUT
Total heptachlorodibenzo-p-dioxins	pg/L	5.5	5.2		9140	7110	nvl	ncl	ncl	10	OUT
Total Dioxins	pg/L	16.1	17		42100	35300	nvl	ncl	ncl	ncl	OUT
Total tetrachlorinated dibenzofurans	pg/L	ND	ND		646	537	nvl	ncl	ncl	6	OUT
Total pentachlorinated dibenzofurans	pg/L	ND	ND		249	111	nvl	ncl	ncl	7	OUT
Total hexachlorinated dibenzofurans	pg/L	ND	0.8 E		268 E	216	nvl	ncl	ncl	17	OUT
Total heptachlorinated dibenzofurans	pg/L	1.5	0.6		524	389	nvl	ncl	ncl	28	OUT
Total Furans	pg/L	1.5	3.2		2240	1720	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans	pg/L	17.6	20.2		44340	37020	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans (Detected)	pgTEQ/L	1.6	1.0		204.6	189.1	nvl	ncl	(23) 14	ncl	IN
Total Dioxins/Furans (Maximum Possible)	pgTEQ/L	3.1	1.7		204.6	193.2	nvl	ncl	ncl	ncl	OUT
ATG-27, PCBs											
Total PCB	µg/L	0.1	< 0.1	< 0.1							
					4.9	6.0	0.026	0.001*	(15) 7.8	0.05	IN

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ivl denotes invalid value listed (insufficient data to derive percentile value), ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		NPD					Evaluation Criteria				Evaluation
		NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd [2011]	CCME DWQG [2014]	MOE Cont [2011]	DRLs (Bq/mo) NPD	Screen In/Out
QC Designation		Blank				Duplicate					
Date Sampled		30-Nov-15	30-Nov-15	30-Nov-15	02-Dec-15	02-Dec-15	1	2	3	4	
Tritium (H-3)	Bq/mL	0.04	0.04	2.42	1771	1797	nvl	7	ncl	3.61E+16	IN
C-14	Bq/L	<7.37	<7.37	<7.37	49.9	62.2	nvl	200	ncl	3.24E+13	OUT
K-40	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Cr-51	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Mn-54	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Co-57	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Fe-59	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Co-60	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Zn-65	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Se-75	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Nb-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Zr-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Mo-99	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Tc-99m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ru-103	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ru-106	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ag-110m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Sb-125	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
I-131	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ba-133	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Cs-134	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Cs-137	Bq/L	<1.22	<1.24	<1.44	25.15	51.52	nvl	10	ncl	2.13E+12	IN
Ce-141	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ce-144	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		NPD					Evaluation Criteria				Evaluation
		NPD-FB	NPD-MH2	NPD-MH3	NPD-WAS	NPD-WAS dup	MOE Bkgd	CCME DWQG	MOE Cont	DRLs (Bq/mo)	Screen In/Out
QC Designation		Blank				Duplicate	[2011]	[2014]	[2011]	NPD	
Date Sampled		30-Nov-15	30-Nov-15	30-Nov-15	02-Dec-15	02-Dec-15	1	2	3	4	
Eu-152x	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Eu-154	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Eu-155	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Tl-208	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Bi-212	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Pb-212	Bq/L	1.77	<1.91	<2.14	<2.12	<2.06	nvl	ncl	ncl	ncl	OUT
Bi-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Pb-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ra-226	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Ac-228	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Pa-233	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Th-234	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Am-241	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA					
Total Alpha	Bq/L	<0.12	<0.12	<0.14	<0.30	<0.29	nv	0.2	ncl	ncl	OUT
Total Beta	Bq/L	<0.26	<0.26	<0.29	28.1	53.7	nvl	5	ncl	2.13E+12	IN

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Table 4
Analytical Results of Effluent Water Samples Collected at the Gentilly-1 Prototype Reactor Decommissioning (PRD) Site, 2015 Fall

			G-1								Evaluation Criteria				Evaluation	
Sample ID			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation						Blank				Duplicate		[2011]	[2016]	[2011]	[2014]	
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
Alkalinity	mg/L as HCO3-		257	663	328	3.0	714.5	1068	164	168	232	550	ncl	ncl	ncl	OUT
pH (lab)	na		7.82	8.46	7.86	4.94	10.4	8.69	8.03	7.98	7.18	8.67	ncl	ncl	9.5	IN
Conductivity	uS/cm @ 25 °C		4020	1163	1854	1.5	6210	1924	435	444	8020	3160	ncl	ncl	ncl	OUT
Dissolved Inorganic Carbon (DIC)	mg/L C		39.01	125.62	53.37	0.31	39.3	141	25.7	25.5	37.6	131	ncl	ncl	ncl	OUT
Dissolved Organic Carbon (DOC)	mg/L C		3.39	8.88	0.98	0.01	15.9	19.9	4.00	3.59	0.58	9.80	ncl	ncl	ncl	OUT
Bromide (Br-)	mg/L	0.064	0.29	<0.0638	<0.0638	<0.0638	0.10	<0.0638	<0.0638	<0.0638	<0.0638	nvl	ncl	ncl	ncl	OUT
Chloride (Cl-)	mg/L	0.042	1,270	16.34	549.96	<0.0421	153	116.40	47.69	48.12	3,881	790	120*	2300	ncl	IN
Fluoride (F-)	mg/L	0.044	<0.0439	<0.0439	<0.0439	<0.0439	<0.0439	<0.0439	0.29	0.22	<0.0439	2.09	0.12*	ncl	ncl	OUT
Nitrate (NO3-)	mg/L	0.072	1.99	11.06	8.93	<0.0721	0.11	0.47	15.29	15.18	<0.0721	nvl	13	ncl	ncl	IN
Nitrite (NO2-)	mg/L	0.054	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	<0.0534	nvl	60	ncl	ncl	OUT
Phosphate (PO43-)	mg/L	0.290	<0.2896	<0.2896	<0.2896	<0.2896	0.77	3.55	<0.2896	<0.2896	<0.2896	nvl	ncl	ncl	ncl	OUT
Sulphate (SO42-)	mg/L	0.091	475.27	39.67	68.87	2.32	22.5	19.3	4.95	5.17	77.09	1,070	ncl	ncl	ncl	OUT
Total Cyanide (CN-)	mg/L	0.01	0.002	< 0.001	0.001	< 0.001	0.013	0.003	< 0.001	< 0.001	< 0.001	nvl	ncl	ncl	ncl	OUT
Ammonia (NH3 + NH4+)	mg/L as N	0.05	< 0.05	< 0.05	< 0.05	< 0.05	8.9	4.5	< 0.05	< 0.05	1.18	nvl	22	ncl	ncl	OUT
Total Kjeldahl Nitrogen (TKN)	mg/L as N	0.25	1.7	0.9	< 0.25	< 0.25	12	6.0	0.5	0.5	1.5	5.65	ncl	ncl	ncl	OUT
Phenolics (4AAP)	ug/L Phenol		<1.9	<1.9	<1.9	<1.9	3.6	2.6	2.8	<1.9	<1.9	13.7	4*	12000	100	OUT
Metals																
Aluminum (Al)	mg/L		1.05	3.98	0.074	0.002	1.12	0.321	0.135	0.183	0.376	0.869	0.1*	ncl	ncl	OUT
Boron (B)	mg/L		3.33	0.090	0.182	0.019	0.045	0.078	0.085	0.088	0.207	1.65	0.15*	45	ncl	OUT
Barium (Ba)	mg/L		0.076	0.013	0.167	<0.001	0.039	0.016	0.012	0.012	1.38	0.609	ncl	29	ncl	OUT

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

		G-1									Evaluation Criteria				Evaluation	
Sample ID		S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out	
QC Designation					Blank				Duplicate		[2011]	[2016]	[2011]	[2014]		
Date Sampled		29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4		
Calcium (Ca)	mg/L	101	15.7	96.7	0.025	3.89	15.6	7.99	8.05	474	431	ncl	ncl	ncl	OUT	
Cadmium (Cd)	mg/L	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001	0.00009*	0.0027	ncl	OUT	
Chromium (Cr)	mg/L	0.007	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.011	0.0089*	0.81	2.5	OUT	
Copper (Cu)	mg/L	0.152	0.016	<0.015	<0.015	0.051	0.091	0.023	0.020	<0.015	0.004	0.002*	0.087	2.5	IN	
Iron (Fe)	mg/L	11.4	0.581	0.076	<0.001	0.171	0.267	0.262	0.150	3.01	4.09	0.3*	ncl	5	IN	
Potassium (K)	mg/L	103	178	8.23	<0.193	799	191	35.5	36.3	30.2	20.7	ncl	ncl	ncl	OUT	
Lithium (Li)	mg/L	0.014	0.003	0.019	<0.001	0.076	0.002	0.004	0.004	0.050	nvl	ncl	ncl	ncl	OUT	
Magnesium (Mg)	mg/L	9.94	4.33	14.4	<0.006	0.083	11.2	0.673	0.682	45.3	134	ncl	ncl	ncl	OUT	
Manganese (Mn)	mg/L	9.62	0.023	0.003	<0.003	0.005	0.064	0.024	0.028	3.86	0.717	ncl	ncl	ncl	OUT	
Mercury (Hg)	ng/L	5	35	73	< 5	< 5	39	77	31	32	33	nvl	26	290	1,000	IN
Sodium (Na)	mg/L	598	139	260	<0.226	780	288	58.9	60.4	888	489	ncl	2300	ncl	OUT	
Nickel (Ni)	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.014	0.025	0.49	2.5	OUT	
Phosphorous (P)	mg/L	0.814	0.097	<0.019	<0.019	0.761	1.43	0.046	0.062	<0.019	7.97	ncl	ncl	5*	OUT	
Lead (Pb)	mg/L	0.058	0.006	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.013	0.002	0.001*	0.025	0.5	IN	
Strontium (Sr)	mg/L	0.713	0.250	0.976	<0.001	1.05	0.311	0.178	0.181	6.52	20.2	ncl	ncl	ncl	OUT	
Vanadium (V)	mg/L	<0.001	0.005	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.003	ncl	0.25	ncl	OUT	
Zinc (Zn)	mg/L	0.846	0.103	0.026	<0.004	0.020	0.029	0.033	0.041	0.161	0.063	0.03*	1.1	2.5	OUT	

NOTE: Within analytical results, light grey shading denotes concentrations 10x or more higher than results from effluents with lower concentrations (i.e., relatively high concentrations), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1								Evaluation Criteria				Evaluation	
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation						Blank				Duplicate		[2011]	[2016]	[2011]	[2014]	
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
ATG-16			Units	MDL												
1,1,2,2-Tetrachloroethane			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1,2-Trichloroethane			µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,1-Dichloroethane			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,1-Dichloroethylene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichlorobenzene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,3-Dichlorobenzene			µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
1,4-Dichlorobenzene			µg/L	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4					OUT
Bromodichloromethane			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Bromoform			µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Bromomethane			µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Carbon tetrachloride			µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chloroform			µg/L	0.5	<0.5	<0.5	1.4	<0.5	<0.5	<0.5	<0.5	2	1.8*	(22) 2.4	0.5*	OUT
cis-1,3-Dichloropropylene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Dibromochloromethane			µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Ethylene dibromide			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Methylene chloride			µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Tetrachloroethylene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trans-1,3-Dichloropropylene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Trichloroethylene			µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
Trichlorofluoromethane			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
1,2-Dichloroethane			µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
1,2-Dichloropropane			µg/L	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6					OUT
Chlorobenzene			µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1								Evaluation Criteria				Evaluation	
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd [2011]	CCME EQG [2016]	MOE Cont [2011]	CNL GLV [2014]	Screen In/Out
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
Chloromethane	µg/L	0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9					OUT
Trans-1,2-Dichloroethylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Vinyl chloride	µg/L	0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7					OUT
1,1,1-Trichloroethane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-17																OUT
Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Styrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
o-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
m-Xylene and p-Xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5					OUT
ATG-18																OUT
Acrolein	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT
Acrylonitrile	µg/L	4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0					OUT

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1									Evaluation Criteria				Evaluation
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EOG	MOE Cont	CNL GLV	Screen In/Out
QC Designation						Blank				Duplicate		[2011]	[2016]	[2011]	[2014]	
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
ATG-19	Units	MDL														
Acenaphthene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
5-Nitro acenaphthene	µg/L	1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2					
Acenaphthylene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
Anthracene	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	0.012	2.4	0.6	OUT
Atrazine	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1					
Benzo(a)anthracene	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	nvl	0.018	4.7	0.5	OUT
Benzo(a)pyrene	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	nvl	0.015	0.81	0.6	OUT
Benzo(b)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	0.75	0.7	OUT
Benzo(g,h,i)perylene	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	0.2	0.7	OUT
Benzo(k)fluoranthene ²	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	0.4	0.7	OUT
Biphenyl	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
Camphene	µg/L	2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5					
1-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
2-Chloronaphthalene	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
Chrysene	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	nvl	ncl	1	0.3	OUT
Dibenzo(a,h)anthracene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
Fluoranthene	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	0.04	130	0.4	OUT
Fluorene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
Indeno(1,2,3-c,d)pyrene	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
Indole	µg/L	0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7					
1-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
2-Methyl naphthalene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1									Evaluation Criteria				Evaluation
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd [2011]	CCME EOG [2016]	MOE Cont [2011]	CNL GLV [2014]	Screen In/Out
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
Naphthalene	µg/L	0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9					
Perylene	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
Phenanthrene	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	0.4	580	0.4	OUT
Pyrene	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	0.025	68	0.4	OUT
T-butyl phosphate	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1	< 0.1	nvl	ncl	ncl	ncl	OUT
Benzyl butyl phthalate	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	0.4	< 0.4	< 0.4	< 0.4	< 0.4	nvl	ncl	ncl	0.6	OUT
Bis(2-ethylhexyl)phthalate	µg/L	1.0 ¹	< 1.0	< 1.0	< 1.0	< 1.0	26	1.6	< 1.0	< 1.0	< 1.0	nvl	ncl	140	2.2	IN
Di-n-butylphthalate	µg/L	1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5					
Di-n-octylphthalate	µg/L	2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6	< 2.6					
4-Bromophenyl phenylether	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1					
4-Chlorophenyl phenylether	µg/L	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5					
Bis(2-chloroisopropyl)ether	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
Bis(2-chloroethyl)ether	µg/L	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0					
Diphenyl Ether	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,4-Dinitrotoluene	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,6-Dinitrotoluene	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 1.2	< 1.8	< 0.2	< 0.2	< 0.2					
Bis(2-chloroethoxy)methane	µg/L	0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9					
Diphenylamine	µg/L	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5					
N-Nitrosodiphenylamine	µg/L	Note	ND	ND	ND	ND	ND	ND	ND	ND	ND					
N-Nitroso-di-n-propylamine	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
ATG-20, Extractables, Acids (Phenolics)																
2,3,4,5-Tetrachlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,3,4,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	3.7	< 0.2	< 0.2	< 0.2	< 0.2	ivl	1	ncl	1.5	IN

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1									Evaluation Criteria				Evaluation
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EOG	MOE Cont	CNL GLV	Screen In/Out
QC Designation						Blank				Duplicate		[2011]	[2016]	[2011]	[2014]	
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
2,3,5,6-Tetrachlorophenol ²	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	3.7	< 0.2	< 0.2	< 0.2	< 0.2	nvl	1	ncl	1	IN
2,3,4-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,3,5-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3					
2,4,5-Trichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,4,6-Trichlorophenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	2.5	< 0.3	< 0.3	< 0.3	ivl	18	230	1	IN
2,4-Dimethylphenol	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2					
2,4-Dinitrophenol	µg/L	0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	nvl	ncl	11000	42	OUT
2,4-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
2,6-Dichlorophenol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
4,6-Dinitro-o-cresol	µg/L	0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6					
2-Chlorophenol	µg/L	0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8					
4-Chloro-3-methylphenol	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2					
4-Nitrophenol	µg/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	nvl	1	ncl	1.4	OUT
m-Cresol ¹	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2					
o-Cresol	µg/L	0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4					
p-Cresol ¹	µg/L	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2					
Pentachlorophenol	µg/L	1.2	< 1.2	< 1.2	< 1.2	< 1.2	8.3	< 1.2	< 1.2	< 1.2	< 1.2	0.01	0.5*	62*	1*	OUT
Phenol	µg/L	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3					
ATG-23, Extractables, Neutral-Chlorinated																
1,2,3,4-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
1,2,3,5-Tetrachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
1,2,4,5-Tetrachlorobenzene ¹	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
1,2,3-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID			G-1									Evaluation Criteria				Evaluation
			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd [2011]	CCME EOG [2016]	MOE Cont [2011]	CNL GLV [2014]	Screen In/Out
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
1,2,4-Trichlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
2,4,5-Trichlorotoluene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Hexachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Hexachlorobutadiene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Hexachlorocyclopentadiene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Hexachloroethane	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Octachlorostyrene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
Pentachlorobenzene	µg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01					
ATG-24, Dioxins and Furans																
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	pg/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	nvl	ncl	ncl	3.9	OUT
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	pg/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	nvl	ncl	ncl	14	OUT
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	pg/L		ND	ND	ND	ND	ND	NDR(0.7)	ND	ND	ND	nvl	ncl	ncl	7	OUT
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	pg/L		3	1.3	ND	ND	1.5	0.5	0.4	ND	0.6	nvl	ncl	ncl	27	OUT
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	pg/L		ND	1	ND	ND	0.6	ND	ND	ND	ND	nvl	ncl	ncl	6	OUT
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	pg/L		29.7	16.2	4.5	3.6	35.9	6.5	15.8	19.6	8.7	nvl	ncl	ncl	8	OUT
Octachlorodibenzo-p-dioxin	pg/L		134	90.6	21.1	11.9	257	51.7	176	197	95.7	nvl	ncl	ncl	70	OUT
2,3,7,8-Tetrachlorodibenzofuran	pg/L		7.5	3.9	2.6	3.4	272	1.7	1	1.3	0.8 E	nvl	ncl	ncl	6	OUT
2,3,4,7,8-Pentachlorodibenzofuran	pg/L		ND	ND	ND	0.9	39.8	ND	ND	0.8 E	ND	nvl	ncl	ncl	5	OUT
1,2,3,7,8-Pentachlorodibenzofuran	pg/L		ND	ND	ND	ND	124	ND	ND	ND	NDR(0.3)	nvl	ncl	ncl	10	OUT
1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L		1.9	1.3	0.5 E	ND	194	2.5	1.8	1.7	0.8	nvl	ncl	ncl	6	OUT
1,2,3,7,8,9-Hexachlorodibenzofuran	pg/L		ND	ND	ND	ND	69.4	ND	ND	0.6	ND	nvl	ncl	ncl	12	OUT
1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L		ND	ND	ND	ND	58.2	1.1	ND	ND	ND	nvl	ncl	ncl	11	OUT
2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L		ND	ND	ND	0.9 E	42.4	1.2	0.8	1	1.1	nvl	ncl	ncl	9	OUT
1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L		4.9	5.4	NDR(5.6)	NDR(2.2)	107	2.9	3.5	3.8	2.2	nvl	ncl	ncl	23	OUT

MEMO / NOTE

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

			G-1								Evaluation Criteria				Evaluation	
Sample ID			S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME EQG	MOE Cont	CNL GLV	Screen In/Out
QC Designation						Blank				Duplicate		[2011]	[2016]	[2011]	[2014]	
Date Sampled			29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/L		NDR(1.1)	ND	0.7 E	0.6 E	46.5	0.9	1.1	1	0.6 E	nvl	ncl	ncl	10	OUT
Octachlorodibenzofuran	pg/L		6	8	1	1.1	94.4	2.1	4	4.4	1.8	nvl	ncl	ncl	30	OUT
Total tetrachlorinated dibenzo-p-dioxins	pg/L		8.7	ND	ND	ND	ND	ND	ND	ND	ND	nvl	ncl	ncl	3.9	OUT
Total pentachlorodibenzo-p-dioxins	pg/L		ND	ND	ND	ND	ND	ND	ND	ND	0.9	nvl	ncl	ncl	8	OUT
Total hexachlorodibenzo-p-dioxins	pg/L		2.6	10.1	3.3	1.1	6.6	3.2	3.4	1	3.4	nvl	ncl	ncl	28	OUT
Total heptachlorodibenzo-p-dioxins	pg/L		52.1	27.8	9	7.1	65.7	13.1	29.4	35.4	15.8	nvl	ncl	ncl	10	OUT
Total Dioxins	pg/L		197	128	33.4	20.1	330	68	209	233	116	nvl	ncl	ncl	ncl	OUT
Total tetrachlorinated dibenzofurans	pg/L		7.5	11	4.6 E	5.9	1280	9.4	1.9	2.4	1.6 E	nvl	ncl	ncl	6	OUT
Total pentachlorinated dibenzofurans	pg/L		ND	ND	ND	0.9	744	3.4	ND	1.2 E	ND	nvl	ncl	ncl	7	OUT
Total hexachlorinated dibenzofurans	pg/L		1.9	1.3	1.5 E	0.9 E	618	7.2	2.7	3.4	2.2 E	nvl	ncl	ncl	17	OUT
Total heptachlorinated dibenzofurans	pg/L		7.2	10.8	1.6 E	0.6 E	258	5.2	6.9 E	7.3	3.9 E	nvl	ncl	ncl	28	OUT
Total Furans	pg/L		22.6	31.1	8.7	9.4	3000	27.3	15.5	18.7	9.5	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans	pg/L		219.6	159.1	42.1	29.5	3330	95.3	224.5	251.7	125.5	nvl	ncl	ncl	ncl	OUT
Total Dioxins/Furans (Detected)	pgTEQ/L		3.1	2.3	1.4	1.6	132.6	1.5	1.4	1.7	1.0	nvl	ncl	(23) 14	ncl	IN
Total Dioxins/Furans (Maximum Possible)	pgTEQ/L		4.5	3.6	2.5	2.8	135.0	2.1	2.1	2.5	1.5	nvl	ncl	ncl	ncl	OUT
ATG-27, PCBs																
Total PCB	µg/L	0.1	0.2	0.3	< 0.1	< 0.1	590	1.3	0.2	4.0	< 0.1	0.026	0.001*	(15) 7.8	0.05	IN

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ivl denotes invalid value listed (insufficient data to derive percentile value), ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

MEMO / NOTE

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CW-511300-FM-001 Rev. 4

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Ref. Procedure CW-511300-PRO-647

To: M. Vickerd
Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		G-1									Evaluation Criteria				Evaluation
		S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd [2011]	CCME DWQG [2014]	MOE Cont [2011]	DRLs (Bq/mo) G-1	Screen In/Out
Date Sampled		29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
Tritium (H-3)	Bq/mL	5.09	8.18	0.51	0.04	0.83	0.26	213.34	222.03	0.96	nvl	7	ncl	9.63E+17	IN
C-14	Bq/L	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	13.1	nvl	200	ncl	2.00E+14	OUT
K-40	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Cr-51	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Mn-54	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Co-57	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Fe-59	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Co-60	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Zn-65	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Se-75	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Nb-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Zr-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Mo-99	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Tc-99m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ru-103	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ru-106	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ag-110m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Sb-125	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
I-131	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ba-133	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Cs-134	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Cs-137	Bq/L	19.20	11.96	<1.36	<1.17	<1.25	<1.36	3.21	2.52	<1.58	nvl	10	ncl	1.46E+13	IN
Ce-141	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ce-144	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					

MEMO / NOTE

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 Ref. Procedure CW-511300-PRO-647

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Sample ID		G-1									Evaluation Criteria				Evaluation
		S-001	S-012	P3/P4	FB	T-002	T-004	T-005	T-005D	T-007	MOE Bkgd	CCME DWQG	MOE Cont	DRLs (Bq/mo)	Screen In/Out
QC Designation					Blank				Duplicate		[2011]	[2014]	[2011]	G-1	
Date Sampled		29-Oct-15	29-Oct-15	29-Oct-15	28-Oct-15	28-Oct-15	28-Oct-15	29-Oct-15	29-Oct-15	29-Oct-15	1	2	3	4	
Eu-152x	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Eu-154	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Eu-155	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Tl-208	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Bi-212	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Pb-212	Bq/L	<1.9	<1.92	<1.97	<1.87	<1.8	1.61	1.37	<1.93	<2.17	nvl	ncl	ncl	ncl	OUT
Bi-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Pb-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ra-226	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Ac-228	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Pa-233	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Th-234	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Am-241	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA					
Total Alpha	Bq/L	0.887	<0.33	<0.44	<0.12	<0.81	<0.44	<0.23	<0.19	<0.96	nv	0.2	ncl	8.94E+13	IN
Total Beta	Bq/L	9.77	12.9	<0.30	<0.25	20.9	5.07	3.32	3.34	0.563	nvl	5	ncl	1.46E+13	IN

NOTE: Within analytical results, light grey shading denotes detectable concentrations (anthropogenic compounds), darker grey shading denotes concentrations higher than PGMIS 97.5 percentile values for background groundwater concentrations, bold font denotes exceedance of evaluation criteria

Within Evaluation Criteria, nvl denotes value listed for parameter, ncl denotes no criterion listed for parameter, *Criteria that are lower than the background standard are discounted (deemed overly conservative)

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Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

Table 5
Summary of Anomalous Parameters in Effluent Samples from the Prototype Reactor Decommissioning (PRD) Sites

Douglas Point						NPD			Gentilly-1						
DP-D3	DP-D6	DP-1CB	DP-2CB	DP-5CB	DP-RDD	MH2	MH3	WAS	S-001	S-012	P3/P4	T-002	T-004	T-005	T-007
RB sump	RB sump	C.basin	C.basin	C.basin	Ditch	Mnhole	Mnhole	Sump	SB sump	SB sump	St.swr	TB sump	TB sump	TB sump	TB sump
Physical and Inorganic Parameters															
Cond	Cond	Metals	Metals	Metals	Cond		Metals	Cond	Cond	Cond	Cond	Cond	Cond	Nitrate	Cond
Alk	Alk				Chloride			Alk	Chloride	Alk	Alk	Alk	Alk	Metals	Chloride
Chloride	Chloride				Sodium			pH	Sodium	DIC	Chloride	pH	DIC	Mercury	Sulphate
Sodium	Sodium							DIC/DOC	Sulphate	Nitrate	Nitrate	Sodium	DOC		Sodium
	Nitrate							Nitrate	Metals	Metals		DOC	Sodium		Metals
	Metals							Sulphate	Mercury	Mercury		Ammonia	Phosph		Mercury
								Metals				Mercury	Ammonia		
								Mercury					Nitrogen		
													Metals		
													Mercury		
Volatile Organic Compounds															
Extractable Organic Compounds, PCBs, Dioxins and Furans															
		PAHs	PAHs	PAHs				DEHP				DEHP	PCBs	PCBs	
		OCDD	OCDD					Diox/Fur				Furans			
								PCBs				PCBs			

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Douglas Point						NPD			Gentilly-1						
DP-D3	DP-D6	DP-1CB	DP-2CB	DP-5CB	DP-RDD	MH2	MH3	WAS	S-001	S-012	P3/P4	T-002	T-004	T-005	T-007
RB sump	RB sump	C.basin	C.basin	C.basin	Ditch	Mnhole	Mnhole	Sump	SB sump	SB sump	St.swr	TB sump	TB sump	TB sump	TB sump
Radiological Parameters															
							Tritium	Tritium	Tritium	Tritium		T-beta	T-beta	Tritium	
								C-14	Cs-137	Cs-137				Cs-137	
								Cs-137	T-beta	T-beta				T-beta	
								T-beta							

Note: Bold indicates significantly elevated concentrations (exceedance of evaluation criteria)

DEHP denotes Bis(2-ethylhexyl)phthalate

OCDD denotes octachlorodibenzo-p-dioxin

To: M. Vickerd

Date: 2016/03/28

File No.:	3640-509000-021-000
Non-Standard ID:	ETB-16-038

**Table 6
Parameters of Potential Interest in Effluent Monitoring at the Prototype Reactor Decommissioning (PRD) Sites**

Sampling Location	Parameters	Comment
Douglas Point PRD		
D3	None	
D6	Radiologicals	Trace detection of alpha activity only (questionable significance), but anomalous tritium.
1CB	Metals (iron) EOCs (PAHs),	Catch basin with episodic flow (problematic for routine monitoring). Low EOC concentrations but restrictive criteria.
2CB	EOCs (PAHs)	
5CB	EOCs (PAHs)	
RDD	Radiologicals	Drainage ditch that would be greatly affected by episodic weather events. Trace detection of alpha activity only (questionable significance).
NPD PRD		
MH2	None	
MH3	Metals (iron, zinc)	No flow at time of sampling.
WAS	Nitrate Metals (cadmium, copper, iron, lead) Mercury EOCs (pyrene, bis(2-ethylhexyl)phthalate) Dioxins/Furans PCBs Radiologicals	Periodic sump discharges (not a steady flow to river). Low EOC concentrations but restrictive criteria. Low PCB concentration but restrictive criteria (MISA MDL, not toxicological-based).
Gentilly-1 PRD (note that only P3/P4 is a true effluent; other streams are collected and treated prior to release)		
S-001	Metals (copper, iron, lead) Mercury PCBs Radiologicals	Low PCB concentration but restrictive criteria (MISA MDL, not toxicological-based).
S-012	Mercury PCBs Radiologicals	Low PCB concentration but restrictive criteria (MISA MDL, not toxicological-based).
P3/P4	None	

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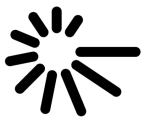
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Sampling Location	Parameters	Comment
T-002	pH Mercury EOCs (bis(2-ethylhexyl)phthalate, tetrachlorophenol) Dioxins/Furans PCBs	Low EOC concentrations but restrictive generic criteria.
T-004	Copper Mercury EOC (trichlorophenol) PCBs Radiologicals	Low EOC and PCB concentrations but restrictive criteria (MISA MDL, not toxicological-based).
T-005	Nitrate Mercury PCBs Radiologicals	Low PCB concentration but restrictive criteria (MISA MDL, not toxicological-based).
T-007	Chloride Mercury	



Report, General

NPD BALANCE OF SITE CHARACTERIZATION REPORT

NPD DECOMMISSIONING

64-509410-REPT-009

Revision 0

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Report, General

NPD Balance of Site Characterisation Report

NPD Decommissioning

64-509410-REPT-009

Revision 0

2018 April

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1. INTRODUCTION

1.1 Acronyms and Abbreviations

AECL	- Atomic Energy of Canada Ltd
Am-241	- americium-241
Bqcm ⁻²	- Becquerel per square centimeter
Bqg ⁻¹	- Becquerel per gram
Bql ⁻¹	- Becquerel per litre
BRA	- Background Reference Area
BTV	- background threshold values
C-14	- carbon-14
CCOC	- conventional contaminant of concern
Cl-36	- chlorine-36
CNL	- Canadian Nuclear Laboratories
CNSC	- Canadian Nuclear Safety Commission
Co-60	- cobalt-60
CoC	- chain-of-custody
COPC	- contaminant of potential concern
Cs-137	- caesium-137
cpm	- counts per minute
CU	- characterisation unit
DCGL	- derived concentration guideline level
DQO	- data quality objectives
DS	- designated substances
Eu-152	- europium-152
EZ	- Exclusion Zone
GPS	- global positioning system
H-3	- tritium
H ₀ and H _A	- Null Hypothesis and Alternate Hypothesis

Ha	- hectare
HC	- Health Canada
HDPE	- high-density polyethylene
HSA	- historical site assessment
HV	- High Voltage
ICPMS	- Inductively Coupled Plasma Mass Spectrometer
IEC	- International Electrotechnical Commission
ISO	- International Organisation for Standardisation
ISR	- International Safety Research Ltd Inc
keV	- thousand electron volts
kg	- kilogram
LBGR	- lower bound of the gray region
LCL	- lower confidence limit
MAC	- maximum acceptable concentration
MARSSIM	- Multi-Agency Radiation Survey and Site Investigation Manual
MDC	- minimum detectable concentration
MDL	- method detection limit
mbgs	- meters below ground surface
MW	- monitoring well
NA	- Nuclear Area
NaI	- Sodium Iodide
Ni-63	- nickel-63
NNA	- Non-Nuclear Area
NORM	- naturally occurring radioactive material
NPD	- Nuclear Power Demonstration
ORAU	- Oak Ridge Associated Universities
PDU	- primary decision unit
PSQ	- principle study question
QA/QC	- quality assurance/quality control
Q-Q plot	- quantile-quantile plot
Ra-226	- radium-226

RoC	- radionuclide of concern
SD	- significant difference
SOP	- Standard Operating Procedure
Sr-90	- strontium-90
Tc-99	- technetium-99
U-235	- uranium-235
U-238	- uranium-238
UCL	- upper confidence limit
UPL	- upper prediction limit
UTL	- upper tolerance limit
USL	- upper simultaneous limit
\bar{X}	- mean
WMW	- Wilcoxon Mann-Whitney

1.2 Overview and Objective

The Nuclear Power Demonstration (NPD) Site comprises a 2.4 hectare (ha) Licensed Area containing the NPD Main building which is bounded by the Ottawa River to the northwest and a ~380 ha Exclusion Zone which surrounds the remainder of the Licensed Area. The Characterisation of NPD involves the execution of the NPD Characterisation Plan [1] which was derived primarily from the Historical Site Assessment [2]. The plan broke the NPD site and facility down into seven Primary Decision Units (PDUs) covering all the structures, systems and land areas. This document is intended to report the findings for three of the seven PDUs listed below along with their general components:

- Land Area: Exclusion Zone – Surface soils, landfills #1 and #2, historic unauthorised surface dumping areas, warehouse/training centre footprints, paved surfaces/roads, sub-surface soils and groundwater.
- Land Area: Licensed Area – Surface and sub-surface soils, septic system, miscellaneous remaining structures, paved surfaces, subsurface systems and groundwater.
- Ottawa River – Sediments.

The four PDUs not covered by this report are the Non-Nuclear and Nuclear area facility structure and both the Nuclear and Non-Nuclear Systems.

For the three PDUs considered in this report, the following Decision Statements were derived from the Principle Study Questions [1];

- Land Area Exclusion Zone:
 1. Radionuclide of Concern (RoC) or Designated Substances (DS) concentration in surface soils are/are not distinguishable from background populations and do/do not satisfy the Class 3/non-impacted designation.
 2. Based on results for surface soils, subsurface soils and groundwater are/are not designated as non-impacted.
 3. For Exclusion Zone surface and subsurface areas that have been impacted by site operations, the RoC or DS concentrations are/are not less than applicable action level thresholds and unrestricted clearance requirements.
- Land Area Licensed Area:
 1. The characterisation data do/do not provide all required inputs for completion of environmental assessments for each PDU component (surface soil, sub-surface soils, groundwater and remaining utilities) and confidence-based decisions for future site use/release.
- Ottawa River – Sediments:
 1. RoC and /or DS concentrations in sediments are/are not distinguishable from background populations and sediments do/do not require further environmental assessments.

For clarification, the classification system for the contamination potential of an area or site comes from the Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) [3], and is as follows:

- Class 1 – Areas known to be contaminated or likely to be contaminated at levels at or above an established action level threshold. Maximum recommended area 2,000 m².
- Class 2 – Areas that are possibly contaminated but where the levels are less than the action level. Maximum recommended area 10,000 m².
- Class 3 – Areas that have a potential for contamination at levels that are a small fraction of the action level. Recommended area unlimited.
- Non-impacted – Areas that have no reasonable potential to have been contaminated by site operations and are based on process knowledge and former site investigations.

MARSSIM acknowledges that not all areas of a site under scrutiny have the same potential to have been contaminated from operations and therefore a graded approach to the survey design, based on Historical Site Assessment (HSA) [2] is employed. In selecting the appropriate classification for study areas the appropriate survey coverage, i.e. the size of a particular unit and/or the density of systematic or random sampling is selected to defensibly support decisions against the release criteria. It should be noted that other than the Background Reference Area (BRA), no area for the NPD was classified as non-impacted. The BRA was selected based

on its geography and negligible potential for residual contamination from historic facility operations and is discussed in more detail in Section 4.5.1 of the Characterisation Plan [1].

The division of the NPD site into area classifications and specific Characterisation Units (CU) are illustrated in Figure 1, Figure 2, Figure 3 and Figure 4 below. These figures are included for context and clarity and are reproduced from the Characterisation Plan [1].

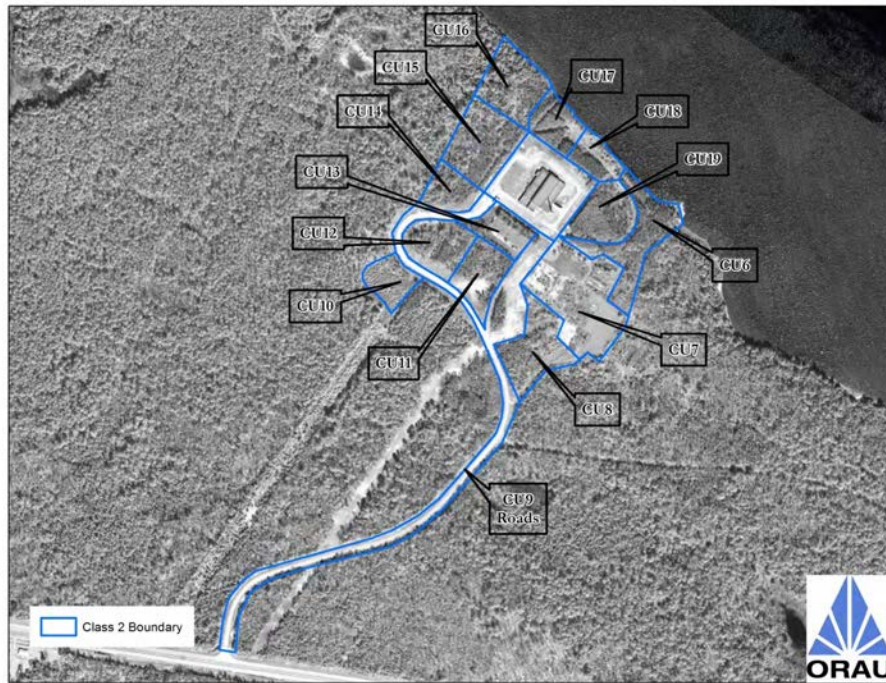


Figure 3, Site Plan Indicating the Boundaries of Class 2 Areas.

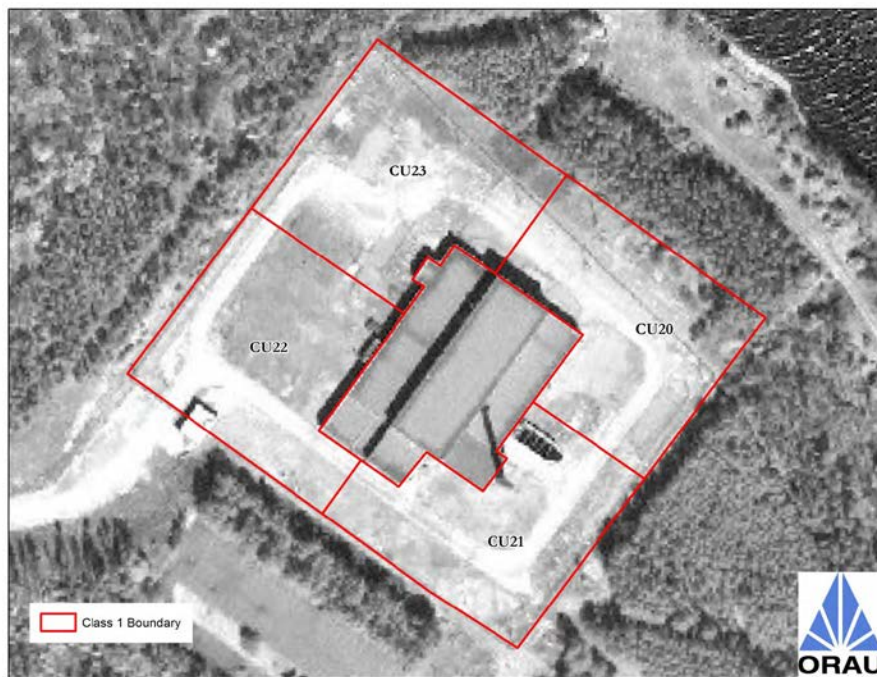


Figure 4, Site Plan Indicating the Boundaries of Class 1 Areas.

1.3 Scope

This report is limited to the 3 PDUs described in Section 1.2 above and their relevant decision statements. It is also concerned only with the radiological aspects of those Principle Study Questions and Decision Statements and final status decision making i.e. the RoCs. The characterisation and investigation into residual Conventional Contaminants of Concern (CCOC)/DS is documented under a separate cover [4].

This report summarises the characterisation activities, results and conclusions that will inform Atomic Energy Canada Ltd (AECL) decision making regarding the release and/or future land use for those areas of the site that are not encompassed by institutional controls, a period estimated to last for a minimum of 100 years from the completion of the NPD Closure Project.

2. METHOD

2.1 Overview

As determined using the Data Quality Objectives (DQO) process to derive decision inputs in the Characterisation Plan [1], all the NPD land areas were subject to both gamma radiation surface scans as well as surface and subsurface soil sampling and analysis by radiochemistry. The density of the scans and sample population is determined as a function of classification, i.e. the potential to have been radiologically impacted and size of area. Additionally, the gamma survey results were used to identify locations where the gamma radiation level was audibly distinguishable from the local ambient background level and thereby supplement the systematic soil sampling investigations with judgemental samples where applicable. Also subject to gamma scanning were the remaining building pads, or concrete foundation slabs which were additionally scanned for alpha plus beta radiation.

The soil sample analysis results, i.e. the characterization data applicable to each PDU, were compared with decommissioning end point criteria on a Characterisation Unit (CU) by CU basis. For these areas, data assessment decision rules included either nonparametric statistical hypothesis testing for the Class 3 and 2 areas and presence/absence results for the Class 1 CUs.

Groundwater sampling was conducted at pre-existing boreholes/monitoring wells for comparison of results against appropriate regulatory limits or comparison criteria.

The following sections outline the method used in all stages for the collection of data, but for a full description of the survey design, the characterisation plan [1] and the HSA [2] should be consulted as these documents remain the primary source of reference for the design rationale and discuss the reasoning and previous data considered.

2.2 Gamma Radiation Surface Scans

Work was undertaken by Canadian Nuclear Laboratories (CNL) staff, consistent with the Sampling Plan [5], to perform Gamma Radiation Surface Scans of all CUs including the BRA. Class 3 CUs along with the BRA received a low density coverage (judgemental), whereas the Class 2 and 1 CUs received medium density (25-100%) coverage and high density (approximately 100%) coverage respectively. Gamma scans took place using Ludlum model 44-10 NaI(Tl) scintillation detectors coupled to a Ludlum 2221 portable scaler ratemeters.

Scans were performed exclusively in pairs for several reasons. One person carried the survey equipment and was able to concentrate on performing the scan, maintaining scan speed at $0.5 - 1 \text{ ms}^{-1}$ with the detector face suspended between 0 – 10 cm of the ground surface. The scan partner was able to make notes, mark any areas of interest for judgemental soil sampling and/or discriminatory monitoring, advise objectively on survey technique and coverage while also able to concentrate on personal safety which was particularly concerning in the dense bush of the Class 3 and 2 CUs which incorporate difficult terrain with many obstacles such as deadfall, wetlands and uneven ground. Geo-referenced position and gamma radiation count

rate data were simultaneously collected and logged at 1 second intervals by a GPS system (Trimble GeoXH). GPS data were used in preference to Cartesian coordinate gridding. The surveyors path was displayed on the handheld GPS units so that both the correct CU was surveyed and to ensure the required coverage of the CUs was achieved. Supplemental to the data logging, the operator, wearing headphones, could hear 2 outputs, an audible beep every second to indicate that data were being collected and the audible output from the radiation detector, i.e. the rise and fall of radioactivity, so that anomalies can be physically recorded/marked or investigated further at the time of collection.

The Minimum Detectable Concentration (MDC) is broken down into two stages for a scan survey, the initial scan by the surveyor followed by a second pass of the detector when a surveyor will re-scan and linger momentarily over an apparent region of elevated activity as indicated by an audible rise in count rate. It follows that the second stage of the scan will have a slightly higher sensitivity based on the surveyor's actions but the first stage MDC is crucial to demonstrate that any potential elevated measurement will not be missed [3]. Based on 1 ms^{-1} scan speed and a background level of 9700 cpm, the MDC was 0.25 Bqcm^{-2} (1,100 cpm) for stage 1 and 0.20 Bqcm^{-2} (880 cpm) for stage 2.

On completion of each CU scan data was downloaded and collated for subsequent post-processing including differential correction, statistical analysis and graphical presentation with the use of mapping software. Results could be overlaid on existing site maps/aerial photographs to identify and display the location of any elevated measurements and to ensure appropriate scan density. This post-processing was performed on behalf of CNL by Oak Ridge Associated Universities (ORAU).

2.3 Alpha-Beta Radiation Surface Scans

A Ludlum 43-37, large area (584 cm^2) gas proportional detector coupled to a Ludlum 2221 scaler/ratemeter, mounted to a model 239-1 floor monitor cart was used to perform additional surface scans of the former building foundation slabs. This data was collected in the same manner as the gamma data above, i.e. using audible indication of elevated radioactivity with data collected and logged with GPS coordinates for visual presentation. Scanning using this method was used for qualitative assessment only in order to locate any areas of elevated activity. The intent was that quantitative measurements would be collected with alternate equipment on identification and delineation of areas of concern. For any quantitative measurements the following equipment was used:

- Alpha - Ludlum model 43-68, rechargeable gas proportional detector coupled to a Ludlum 2221 scaler/ratemeter.
- Beta – Ludlum model 44-142, plastic scintillation detector coupled to a Ludlum 2221 scaler/ratemeter.

2.4 Soil Sampling

Soil sampling was undertaken by Golder Associates in accordance with the survey design requirements from the characterisation plan [1], following their sampling plan [6]. The radiological scanning/screening portion of this work was initially undertaken by International Safety Research Inc (ISR) in accordance with their sampling plan [7] and subsequently carried out by CNL employees during 2017. Soil samples were taken from all the Class 1, 2, 3 and BRA areas in accordance with the sampling plan [6] as follows:

- BRA - 16 shallow test pits were excavated by hand,
- Class 3 CUs (5) - 16 shallow test pits were excavated by hand in each CU,
- Class 2 CUs (14) – 17 shallow test pits were excavated by hand in each CU,
- Class 1 CUs (4) - 17 shallow boreholes were drilled in each CU.

Shallow test pits describe a manual excavation 0 – 0.15 mbgs (meters below ground surface) whereas the shallow boreholes were excavated using a track mounted 9580-VTR PowerProbe taking samples from 0 – 0.15 mbgs and an additional depth sample 0.15 – 0.30 mbgs. Additional samples were retrieved from depths below 1 mbgs in CU 10, a Class 2 unit that incorporated Landfill #1, see Figure 27.

The number of samples required in each CU was derived using the appropriate planning inputs from Section 5.2.2 of the characterisation plan [1]. The number of data points required to satisfy the non-parametric tests are not arbitrarily obtained but are based on the Derived Concentration Guideline Level-(DCGL), in this case the Unconditional Clearance Level (UCL) [8] for Cs-137 was used, the anticipated standard deviation of the contaminant in the CU/BRA, the Lower Bound of the Gray Region-(LBGR) and the acceptable probability of making Type I and II decision errors. These planning inputs are then compared to either table 5.3 or 5.5 of MARSSIM [3] which sets the required minimum number of data points.

Using Trimble Pro GPS equipment, the contractor sampling team proceeded to each of the sample locations as detailed in Appendix B of the characterisation plan [1]. Once confirmed at the correct location, the procedure for retrieving soil samples was as described in Section 2.4.1.

It should be noted that additional screening and sampling in addition to that described below also occurred at each location for the assessment of CCOCs, however, the results of these investigations are covered in a separate report [4].

2.4.1 Surface Soil Samples (BRA, Class 3 and 2 CUs)

The sampling plan [6] documents all aspects of the sampling procedure including scope, work definition, hazard assessment etc. The following is a brief explanation of the most pertinent methodology for information:

- A 1 minute static gamma count of the sample location was performed and recorded in counts per minute (cpm) for screening using Ludlum 44-10 NaI detector and model 2221 scaler/ratemeter,
- 0 – 0.15 mbgs soil sample (min 1 kg) was retrieved using simple sampling equipment, i.e. trowel, shovel, and sample is retained in a suitable container, new Nalgene (HDPE) bottle appropriately labeled.
- A second 1 minute gamma count was then performed in the hole created by the 0-0.15 mbgs sample. Any indication of increasing gamma radiation in the sample hole would initiate the retrieval of a second sample at the same location resulting in a 0.15-0.3 mbgs sample.
- Sampling tools were cleaned and decontaminated at the sample location before proceeding to the next coordinate.

2.4.2 Surface/Subsurface Soil Samples (Class 1 CUs)

In the case of the Class 1 sample locations, soil/overburden cores to a minimum depth of 1.2 mbgs were collected using a track mounted 9580-VTR PowerProbe. From the core, samples were extracted from 0 – 0.15 and 0.15 – 0.3 mbgs and further radiological screening of both the remaining core and the vacated shallow borehole took place. Should initial screening indicate a potential rise in radioactivity, subsequent depths in 0.5 mbgs increments, would be extracted for further screening and any distinct layering indicated would also require a separate sample.

2.4.3 Subsurface Soil Samples Landfill 1 (CU#10)

Landfill 1 was identified in the characterisation plan [1] as potentially impacted and was therefore incorporated in the Class 2 CUs, CU#10 and sampled accordingly. Due to the previously indicated use as a landfill site, subsurface sampling of this CU, using the PowerProbe, was carried out to the lower boundary of the waste layer to ensure appropriate coverage. A waste layer was encountered at 3 separate locations and therefore the samples included additional depths at the following 3 locations and depths in Table 2-1:

Table 2-1, Characterisation Unit 10, Waste Layer Sample Depths

Sample Location	1 st sub-surface (mbgs)	2 nd sub-surface (mbgs)
SA-187	0.5 – 1.0	1.0 – 1.5
SA-189	2.0 – 2.5	2.5 – 3.0
SA-192	1.0 – 1.5	1.5 – 2.0

2.4.4 Judgemental Soil Samples

Based on the results of gamma and alpha/beta radiation surface scans (Sections 2.2 and 2.3) there was an expectation that judgemental soil samples, in addition to those stipulated by the pre-determined locations identified in the characterisation plan [1], would be collected where elevated areas of concern were indicated and noted. The sampling method for the Class 3/2 soil sampling (Section 2.4.1) was employed in this case.

2.5 Groundwater Sampling

Groundwater sampling was undertaken by Golder Associates in accordance with the survey design requirements from the characterisation plan [1] and following their sampling plan [6]. Following previous campaigns undertaken since 1988, 34 boreholes or monitoring wells previously installed were to be redeveloped and/or repaired where necessary and sampled. Wells were located by the contractor, marked, purged and sampled using a peristaltic pump to collect all output water as per the sampling plan description which included the contractors Standard Operating Procedures (SOP) [6].

2.6 Riverbed Sediment Sampling

The sampling and assessment of the Ottawa Riverbed sediments was essentially a simple statistical based assessment to qualitatively distinguish between the sediments sampled immediately downstream and those located upstream of the NPD effluent outfalls. Two CUs were sampled CU-24 (upstream) and CU-25 (downstream) with a total of 8 samples in each. Access to the sample locations, Appendix A of the sampling plan [1], was obtained by a small boat and on arrival at each location, confirmed using Trimble Pro GPS, a sample from the top 0.15 m of sediment was obtained using a Ponar grab sampler. Retrieval and packaging procedure was the same as the soil samples in the land CUs.

2.7 Sample Analysis

All surface/sub-surface, sediment and groundwater samples were screened, collected, packaged, recorded, labeled and shipped in accordance with the appropriate sampling plan [6], [7]. Samples were shipped to Kinetrics Inc, Toronto, ON for the following analyses in accordance with Table 6.2 of the Characterisation Plan [1]:

- Gamma emitting fission/activation products + U-235, U-238, Am-241.
- H-3 (Tritium).
- C-14.
- Sr-90.
- Isotopic Pu-238, Pu-2349/240, Pu-241 (only analysed where Am-241 was present above Minimum Detectable Concentration (MDC)).
- Tc-99.

- Cl-36 (Groundwater only).
- Ni-63 (Groundwater only).

The lab analytical quality assurance and quality control measures are discussed below, Section 2.8.4.

2.8 Quality Assurance and Quality Control Measures

Quality Assurance/Quality Control (QA/QC) steps were implemented to ensure that results produced were accurate and dependable and in some cases suitable for statistical testing. Quality Assurance is a system that ensures quality control procedures are correctly performed and documented. Quality Control refers to the established procedures observed both in the field and in the laboratory designed to ensure that the resulting end data meet intended quality objectives. The QA/QC plan implemented, included the components from the relevant sampling plans [5], [6], [7] that contributed to the collection of data reported by this document.

2.8.1 Gamma Scans

Instrument operating parameters were established at the commencement of characterisation work, i.e. valid calibration certificates were confirmed, threshold set point, operating voltage, operational (site) background and check source reproducibility were determined. Instruments were then checked for functionality at the start and the close of each work day for the following parameters:

- Valid calibration dates on the instrument and detector,
- Physical integrity check of the instrument and all associated equipment,
- Detector and meter connected using the correct cable,
- Instrument powers on and batteries checked (replace if necessary),
- Threshold (if applicable) and High Voltage (HV) settings adjusted to predetermined values if necessary,
- 1 minute background count performed and checked against operational parameters,
- Speaker and headphone functionality checked where required,
- 1 minute count of the check source performed and compared the result with the established response limits,
- Having evaluated any deviations and re-established response or background limits where necessary, information is recorded on a check out sheet unique to the specific instrument. An example of an instrument field check-out record form is included at Appendix M.

2.8.2 Alpha-Beta Scans and Static Counts

Instrument operating parameters were established at the commencement of characterisation work, i.e. detector gas purging, threshold set point, operating voltage, purge check, operational (site) background and check source reproducibility were determined. Instruments were then checked for functionality at the start and the close of each work day for the following parameters:

- Valid calibration dates on the instrument and detector,
- Physical integrity check of the instrument and all associated equipment,
- Detector and meter connected using the correct cable,
- Instrument powers on and batteries checked (replace if necessary),
- Threshold (if applicable) and High Voltage (HV) settings adjusted to predetermined values if necessary,
- Purge check performed and purged until count rate stabilises,
- 1 minute background count performed and checked against operational parameters,
- 1 minute count of the check source performed and compared with the established response limits,
- Speaker and headphone functionality checked where required,
- Purge check to be maintained every 15 min when operating in static mode.

Having evaluated any deviations and re-established response or background limits where necessary, information is recorded on a check out sheet unique to the specific instrument. An example of an instrument field check-out record form is included at NAppendix N.

2.8.3 Soil/Sediment/Groundwater Sampling

Physical sampling was undertaken by Golder Associates in accordance with the sampling plan [6]. The radiological scanning/screening portion of this work was initially undertaken by International Safety Research Inc (ISR) in accordance with their sampling plan [7] and subsequently carried out by CNL employees.

In order to maintain the requisite Quality Assurance/Quality Control (QA/QC), the following Sampling protocol was maintained:

- Sampling equipment was decontaminated between sampling locations following Golders Standard Operating Procedure (SOP) 11 [6].
- Disposable nitrile gloves worn by the samplers were exchanged for new/clean pairs between each sample location. Dedicated tubing was used for the extraction of groundwater samples to minimise potential cross contamination.

- Blind duplicate soil and groundwater samples were collected and submitted for analysis at a ratio of 1:20 and 1:10 respectively.
- GPS coordinates were collected and recorded at each sample location. Additionally field notes were maintained during sampling.
- Groundwater Monitoring wells were purged to remove stagnant water from the bore before sampling and appropriate sampling equipment and adherence to SOPs ensure that agitation and aeration was minimised.
- Lab approved/supplied containers (1 litre HDPE bottles) were used for the retention of collected samples.
- Where required lab supplied containers were charged with appropriate preservative for sample analysis, such as sodium hydroxide for groundwater C-14 analysis.
- Chain of Custody (CoC) was maintained for all samples. CoC forms were accurately maintained and included sample number, matrix, date and time, sampler initials, project number, relinquishment date/time, receiving party name and sample condition on receipt. All CoCs were reviewed by a second staff member for accuracy prior to shipment. CoC seals were used on all coolers/shipping containers.

2.8.4 Analytical Testing

The contracted Lab chosen to perform the analyses of intrusive samples was Kinetrics Inc, Toronto, ON. Kinetrics Inc are an expert provider of lab analytical services operating a Quality Assurance Program that is registered to ISO 9001 and meets the requirements of and is accredited to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories and is registered.

All samples were shipped in accordance with the Packaging and Transport of Nuclear Substances Regs where necessary or were otherwise exempt [9] and under Golder/Kinetrics Chain of Custody (CoC) arrangements.

Kinetrics Inc QA/QC Program involves:

- Monitoring of positive and negative controls.
- Defining variability and reproducibility through duplicates.
- Ensuring the accuracy of test data including calibration and/or continuing calibrations, use of certified reference materials, proficiency test sampling etc.
- Evaluating test performance using method detection limits and quantitation limits or range of applicability such as linearity.
- Selection of the appropriate method of data reduction.

Any judgemental samples obtained, were sent to GEL Laboratories LLC (GEL) in Charleston, SC. GEL meet or exceed the QA/QC requirements of Kinetrics Inc and are equally accredited. Any

samples consigned to GEL for analyses were collected and shipped under GELs specific CoC arrangements.

3. RESULTS

3.1 Gamma Radiation Surface Scans

3.1.1 BRA and Assessment

The BRA was scanned using the same equipment and procedures as the subsequent CUs. This was necessary to collect a representative data population upon which to compare the CUs and assess results. The gamma radiation background reading for the site was expected to vary based on the differing geology identified as well as historical disturbance of land areas during construction of the facility. Additionally a wide variance in background was seen between the areas that were densely forested and had high organic content in surface soils, contained wetlands or prominent bedrock outcroppings. As discussed in Section 4.5.1 of the plan [1], the BRA was selected to represent the background conditions for the land area surface conditions. Using the collected scan data Figure 5 and Figure 6 below illustrate the distribution of data and show a right skewed data set. The right tail of both the Q Plot and the histogram represent the rocky outcroppings and/or formerly disturbed land areas, i.e. rocky soil, and the left hand tail shows data collected in undisturbed forested areas or wetlands. Gamma count rates ranged from <1000 to >28,000 cpm with a median of 6,500 and a mean of 6,700 cpm.

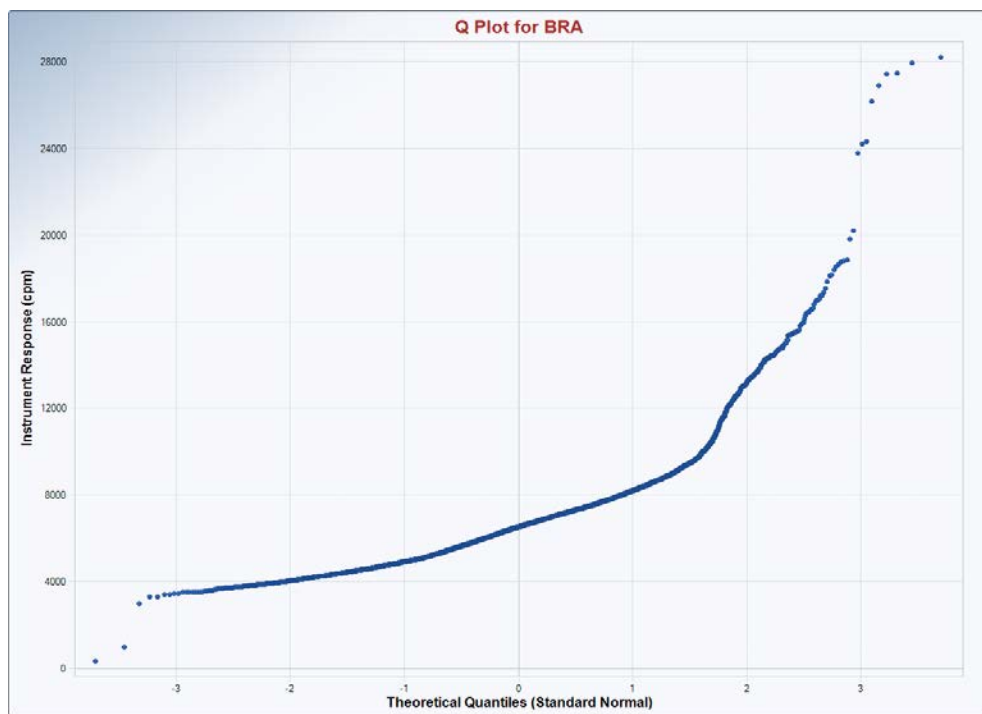


Figure 5, BRA Gamma Scan Data Quantile Plot.

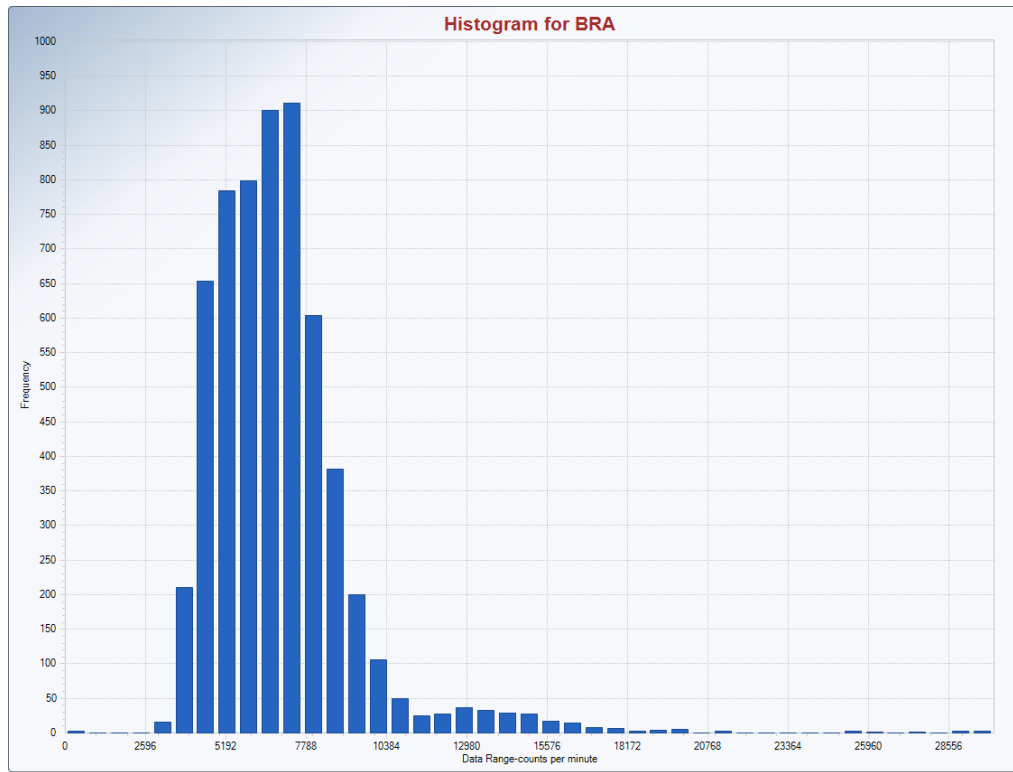


Figure 6, BRA Gamma Scan Data Histogram.

Careful use of the collected data was required to ensure that the scans were representative and correctly displayed for interpretation and appropriate decision making. The basis for the binning or colour contouring of the scan data is included below in Table 3-1 and Table 3-2. It follows standard percentile ranges at the lower levels and more specific statistical ranges for the upper regions based on the use of upper prediction, simultaneous and tolerance limits (UPL), (USL), (UTL) [10]. Some further explanation of these terms should provide the insight into the colour contouring and the elevated levels seen in the gamma scan results and how they relate to the data collected from the BRA;

- **Upper Confidence Limit (UCL):** The upper boundary (or limit) of a confidence interval of a parameter of interest such as the population mean, e.g. a 95% UCL means that 95% of the time the true mean will fall within the 95% interval of the sample mean.
- **Upper Prediction Limit (UPL):** The upper boundary of a prediction interval for an independently obtained observation. Similar to the UCL of the mean, however, a larger interval is obtained because we are now predicting the result of a single random variable, in our case the radioactivity of a yet to be taken sample.
- **Upper Tolerance Limit (UTL):** A confidence limit on a percentile of the statistical population rather than a confidence limit on the mean. For example, a 95% UTL for 95% coverage represents the value below which 95% of the population values are expected










to fall with 95% confidence. In other words, a 95% UTL with coverage coefficient 95% represents a 95% UCL for 95% of the population.

- Upper Simultaneous Limit (USL):** The upper boundary of the largest value in the population so that a 95% USL means that all observations are less than this limit with 95% confidence.

The processing of this data collected by CNL, was performed by ORAU. The summary results [11] for the CUs, as supplied by ORAU follow in Sections 3.1.2, 3.1.3 and 3.1.4. Reference [12] includes the technical basis for the binning ranges and assessment but is summarised below. The output of the BRA scan data, as an aerial photograph with scan data and area boundaries overlaid, is illustrated in Figure 7.

In summary, the objective behind the technical basis for binning for the less than 25th and greater than 75th percentiles was to clearly indicate when a CU background distribution was consistent with either the lower or upper percentiles of the BRA data and by doing so minimise the false positive and false negative decision errors due to the background variability discussed previously but maximise true positive decisions.

Table 3-1, Land Area Gamma Scan Bin Ranges

Bin Range	Range Description
 28201 - 92809	95% USL of BRA to Max observed count rate ^a
 16201 - 28200	95% Chebyshev UPL to 95% USL of BRA
 15001 - 16200	99 th percentile to 95% Chebyshev UPL of BRA
 10401 - 15000	UTL 95-95 to 99 th percentile of BRA
 7501 - 10400	75 th percentile to UTL 95-95 of BRA
 6501 - 7500	50 th - 75 th percentile of BRA
 5301 - 6500	25 th - 50 th percentile of BRA
 4601 - 5300	10 th -25 th percentile of BRA
 <4600	<10 th percentile of BRA

^aMaximum value shown is an illustrative example.

Displaying much less variation than the surface soils, the data for the paved/concrete background areas were handled separately. While using the same Background Threshold Values (BTVs) to set the binning ranges the numerical range differs as shown in Table 3-2 below.

Table 3-2, Concrete/Asphalt Gamma Scan Bin Ranges

Bin Range	Range Description
18001 - 187893	95% Chebyshev UPL to Max observed count rate ^a
13821 - 18000	95% USL of BRA distribution to 95% Chebyshev UPL
11801 - 13820	99 th percentile to 95% USL BRA distribution
11371 - 11800	UTL 95-95 to 99 th percentile of BRA
10721 - 11370	75 th percentile to UTL 95-95 of BRA
10151 - 10720	50 th – 75 th percentile of BRA
9401 - 10150	25 th – 50 th percentile of BRA
8901 - 9400	10 th -25 th percentile of BRA
<8900	<10 th percentile of BRA

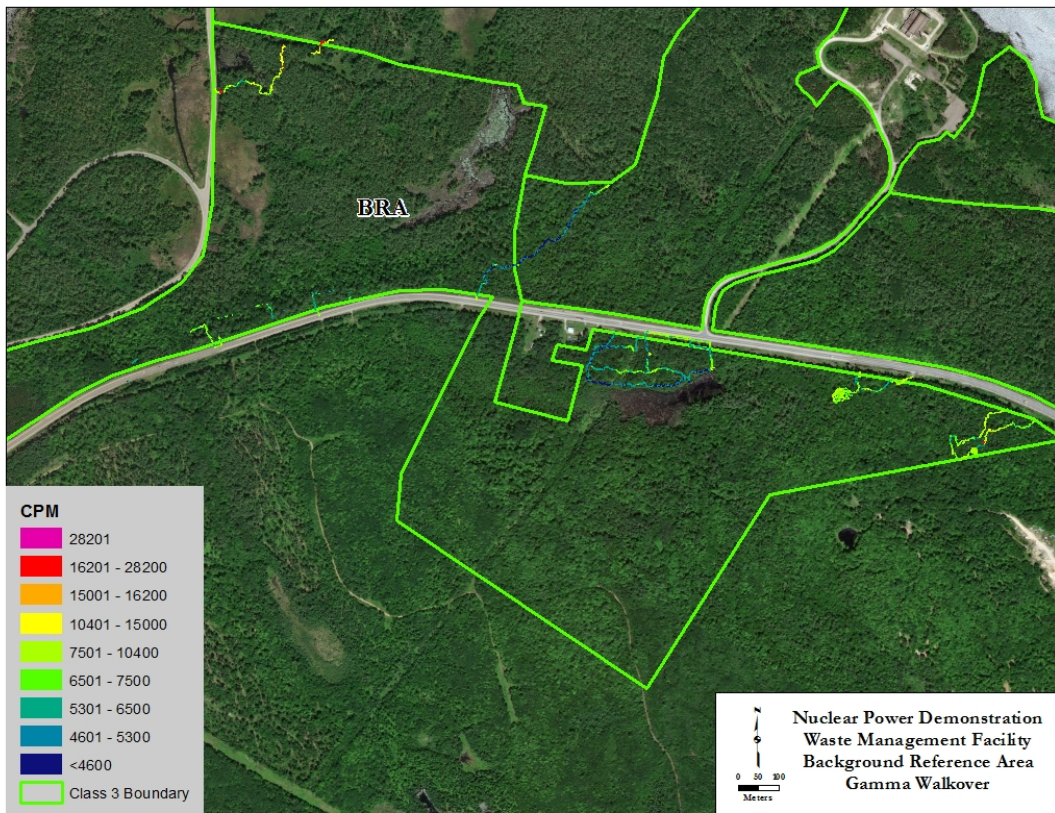


Figure 7, Background Reference Area (BRA) Gamma Scan Results

3.1.2 Class 3 Characterisation Units (CU)

The Class 3 CUs comprise CUs numbers 1 through 5. The results of the walkover gamma scans are illustrated in Figure 9 through Figure 18 below. For each CU the 1st image shows the results of the scan which invariably depicts a winding route through the heavily wooded area and incorporates the soil sample locations overlaid for an illustration of the sample coverage. The 2nd image for each CU displays the same information, however, the elevated areas of gamma radiation have been isolated, i.e. those areas or data points that exceeded the 95% Upper Tolerance Limit-95% coverage (UTL 95-95), 10401 cpm for soil and 11371 cpm for paved areas.

For all areas where the images show discrete elevated scan results the readings were determined, at the time of monitoring, to be due to obviously distinct rock outcroppings, or in the case of the highest readings, attributable to specific rocks/boulders. Either, definite elevated readings were isolated in visibly stratified patterns or, where rocks were small enough to be manipulated, the surveyor was able to determine that the reading would follow the rock when moved and cleaned of soil debris. The Canberra InSpector™ 1000 is a handheld NaI spectrometer that, when used in Nuclear Identification mode can readily analyse the energy peaks of gamma emitting radionuclides. An InSpector™ 1000 was used for confirmatory purposes on several rocks/boulders exhibiting audibly high radiation levels, one of which was retrieved and brought out of the CU for closer examination, see Figure 8. This examination confirmed that Ra-226 was the contributing radionuclide elevating the scan measurements, a Naturally Occurring Radioactive Material (NORM) and part of the natural uranium decay series. As all elevated scans were attributable to rocks, no markers were set for elevated areas that warranted judgementsal soil samples.

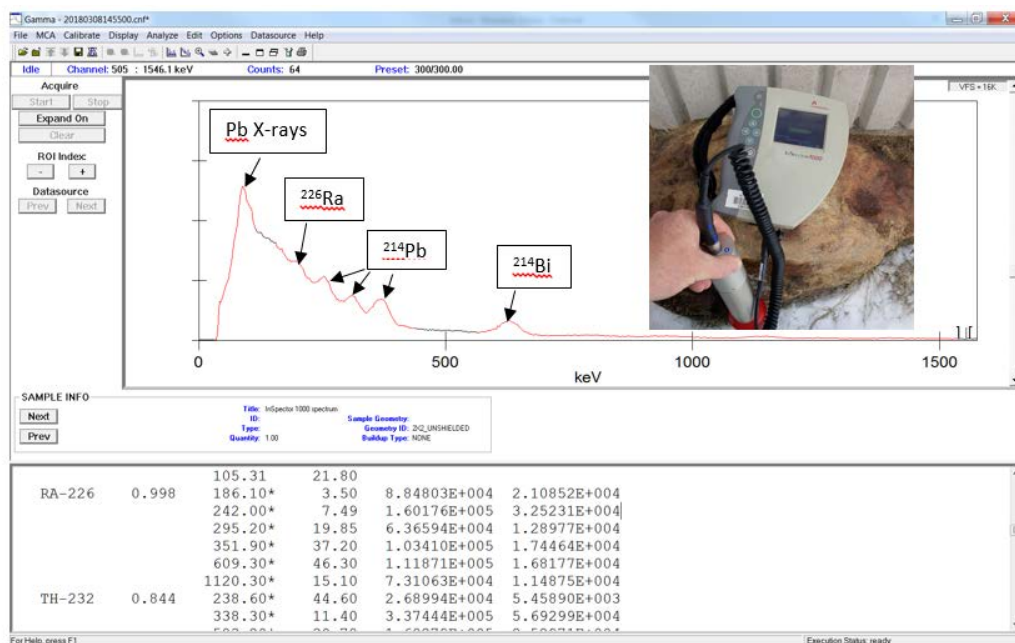


Figure 8, Use of the InSpector™ 1000 on a CU Scanning Anomaly

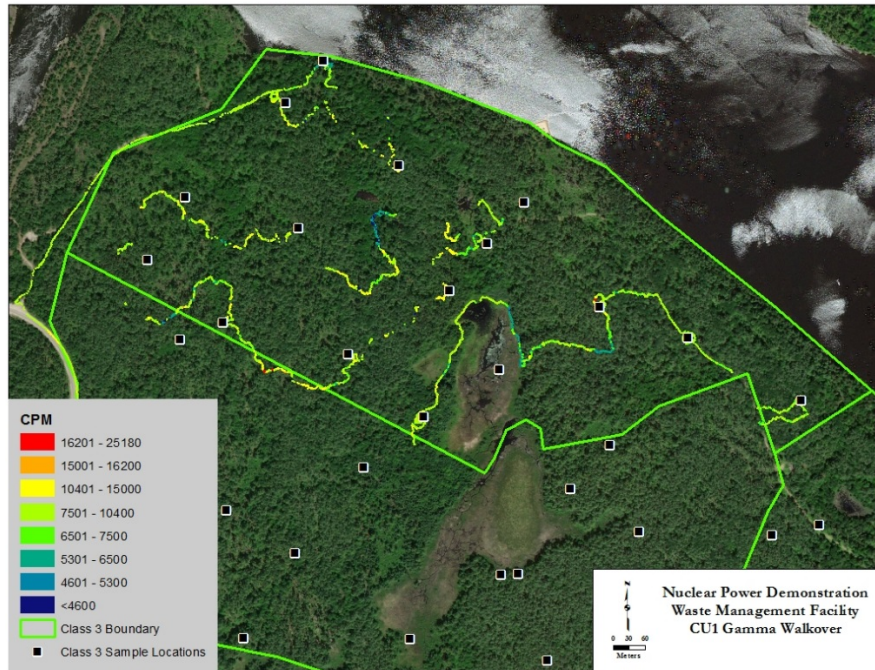


Figure 9, CU 1 Gamma Scan Results + Soil Sample Locations

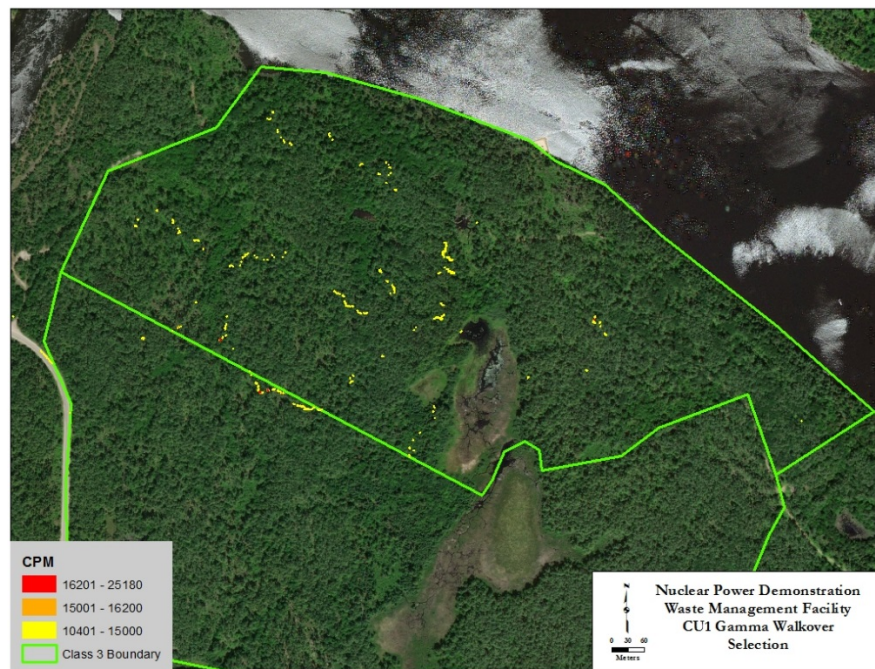


Figure 10, CU 1 Gamma Scan Results Isolating Elevated Readings

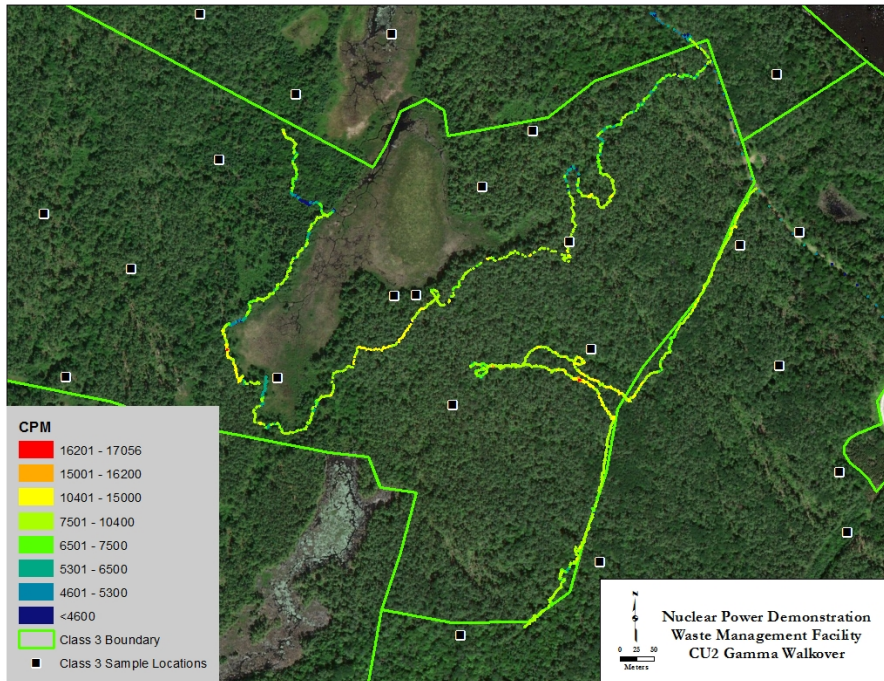


Figure 11, CU 2 Gamma Scan Results + Soil Sample Locations

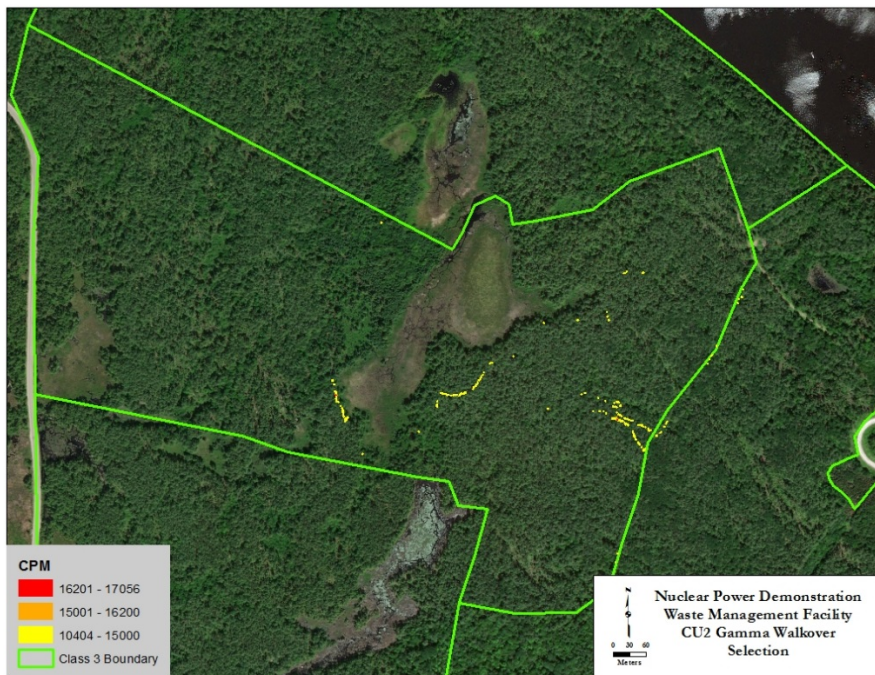


Figure 12, CU 2 Gamma Scan Results Isolating Elevated Readings

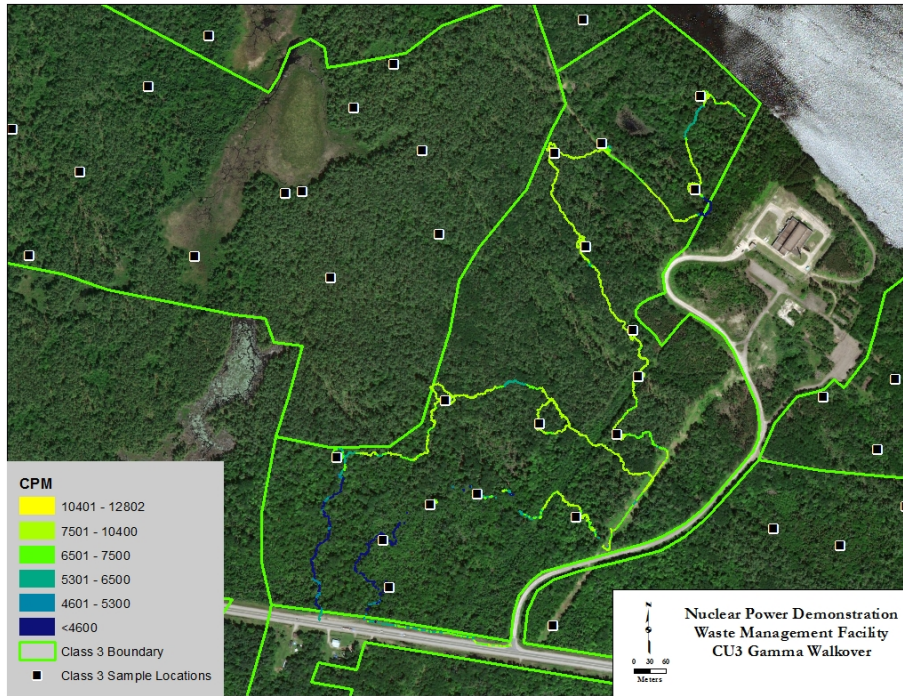


Figure 13, CU 3 Gamma Scan Results + Soil Sample Locations

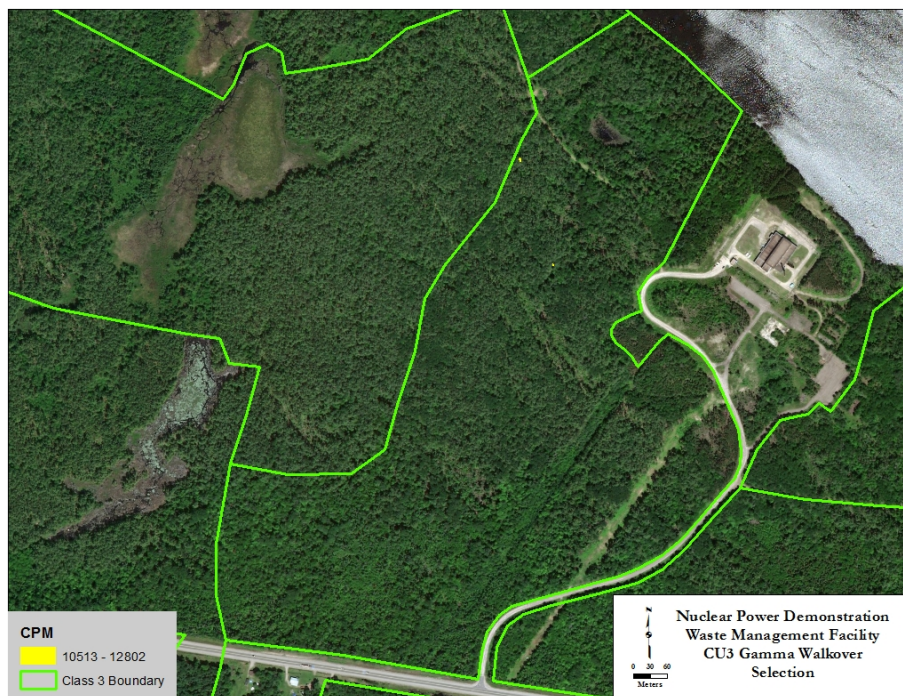


Figure 14, CU 3 Gamma Scan Results Isolating Elevated Readings

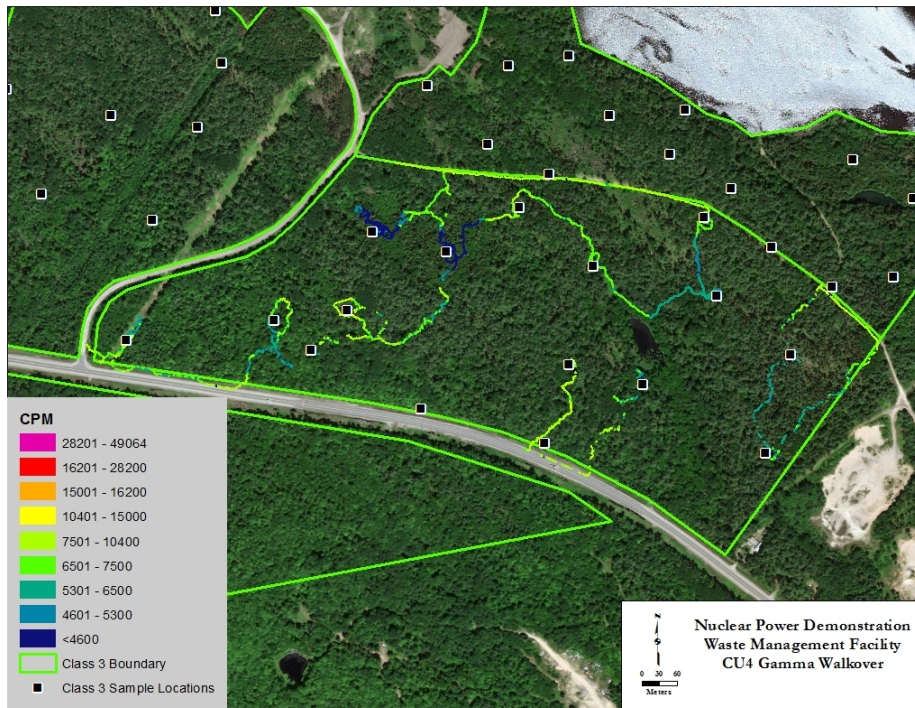


Figure 15, CU 4 Gamma Scan Results + Soil Sample Locations

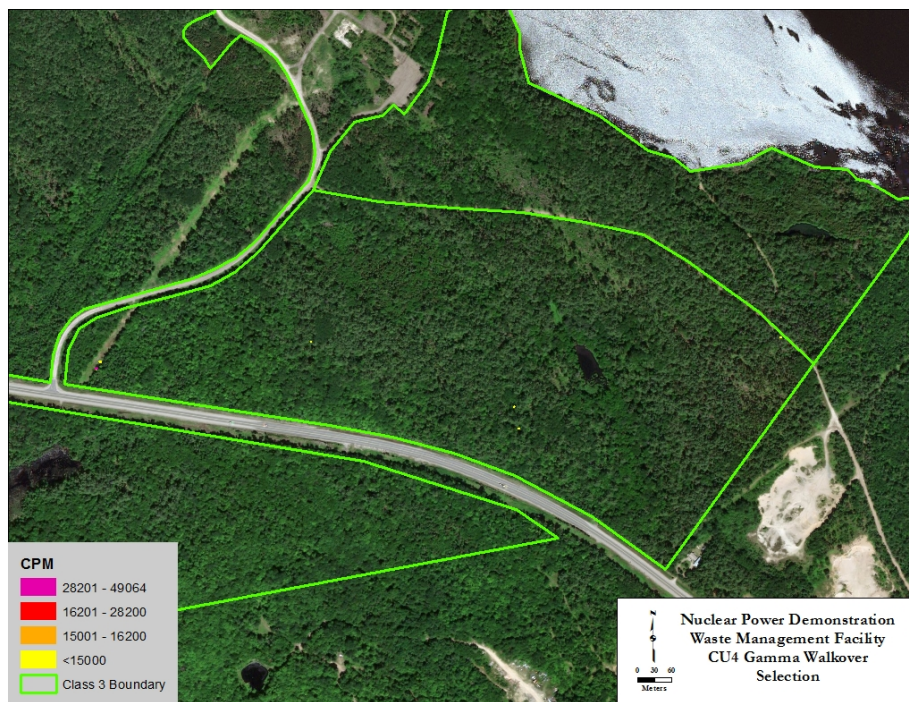


Figure 16, CU 4 Gamma Scan Results Isolating Elevated Readings

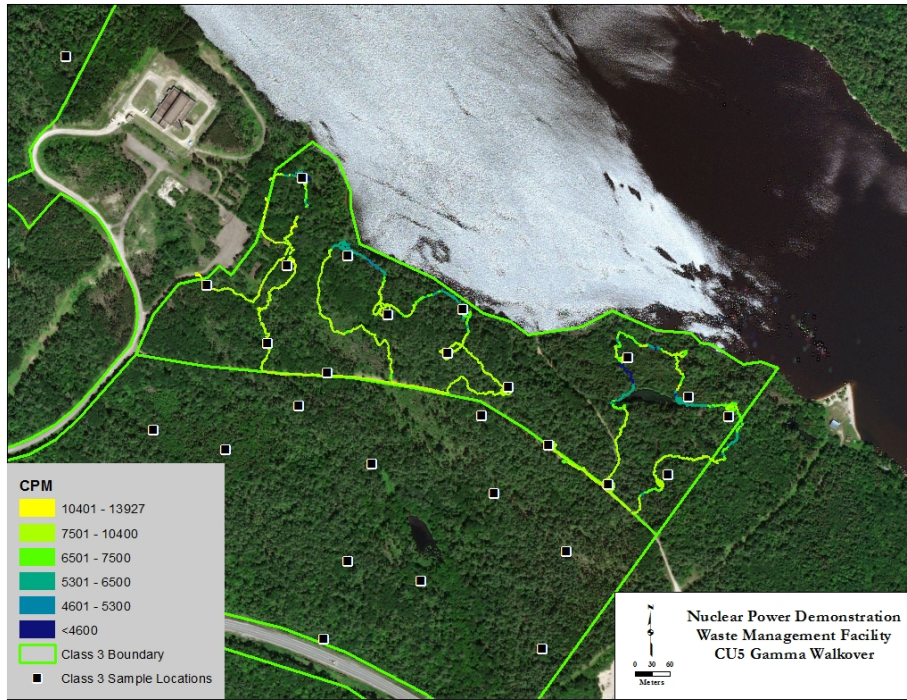


Figure 17, CU 5 Gamma Scan Results + Soil Sample Locations



Figure 18, CU 5 Gamma Scan Results Isolating Elevated Readings

3.1.3 Class 2 Characterisation Units (CU)

The Class 2 CUs comprise CUs numbers 6 through 19. The results of the walkover gamma scans are illustrated in Figure 19 through Figure 46 below. The first image for each CU shows the results of the scan which very clearly depicts a much higher density of results, i.e. the required medium coverage of 25-100% for the Class 2 CUs. Where the density is greater in some areas than in others, this is due to areas that have been maintained to be minimally overgrown, i.e. cutback periodically, road ways or former building concrete foundation pads. The soil sample locations are again overlaid to illustrate the sample density. The second image for each CU displays the same information, however, the elevated areas of gamma radiation have been highlighted, i.e. those areas or data points that exceeded the UTL 95-95, 10401 cpm for surface soil and 11371 cpm for paved areas.

As in the case of the Class 3 CUs, all elevated gamma scan readings were associated with NORM found in local geology and no markers were placed for obtaining judgemental soil samples. As described in Section 2.3 concrete pads, i.e. former building foundations were also scanned for alpha/beta radiations to look for elevated readings that may not have been seen during gamma scanning. The North warehouse pad, indicated in Figure 21, did indicate 2 distinct areas of elevated beta radiation levels that were very confined to localised spots <10 cm². These areas were sampled – a process that effectively removed all apparent contamination – and analysed for specific RoCs [13]. The results returned demonstrated that the contamination was due to random elevated activity from naturally occurring radionuclides as well as Cs-137 from global fallout. All RoCs detected were below the relevant Exemption level [8].

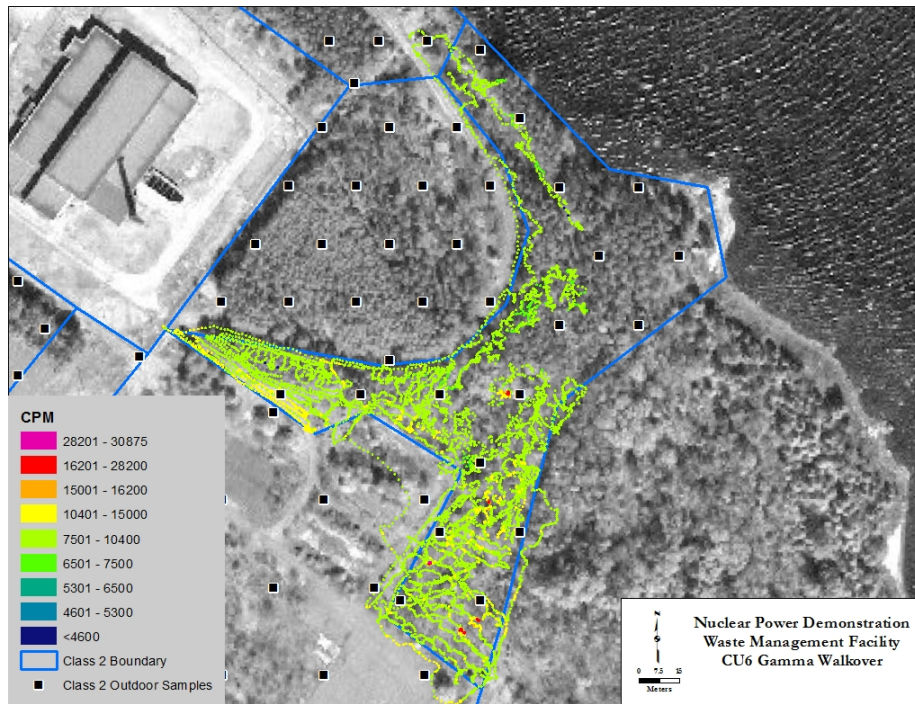


Figure 19, CU 6 Gamma Scan Results + Soil Sample Locations

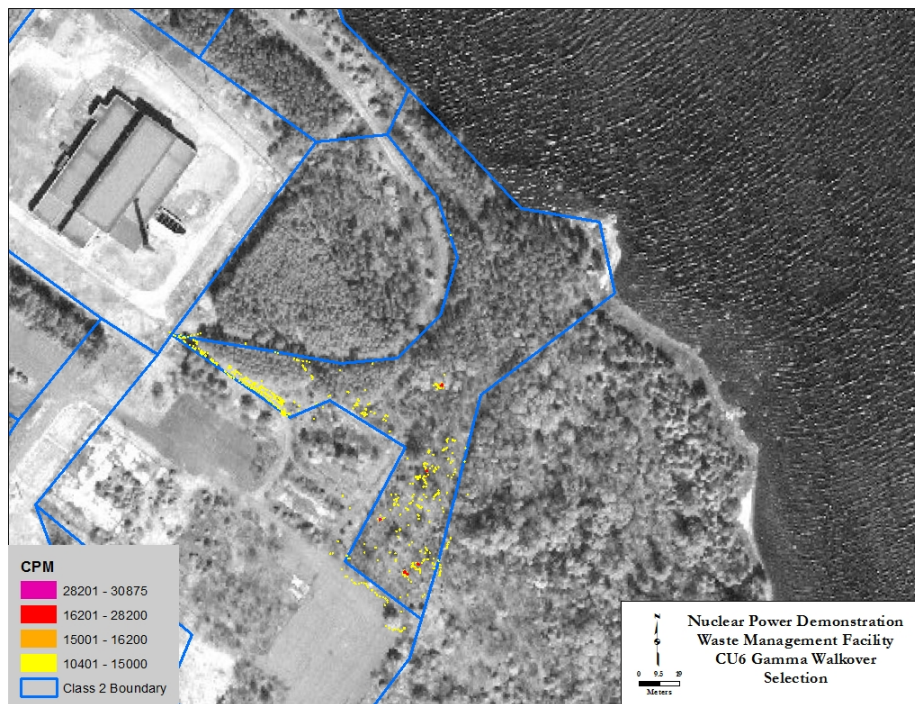


Figure 20, CU 6 Gamma Scan Results Isolating Elevated Readings

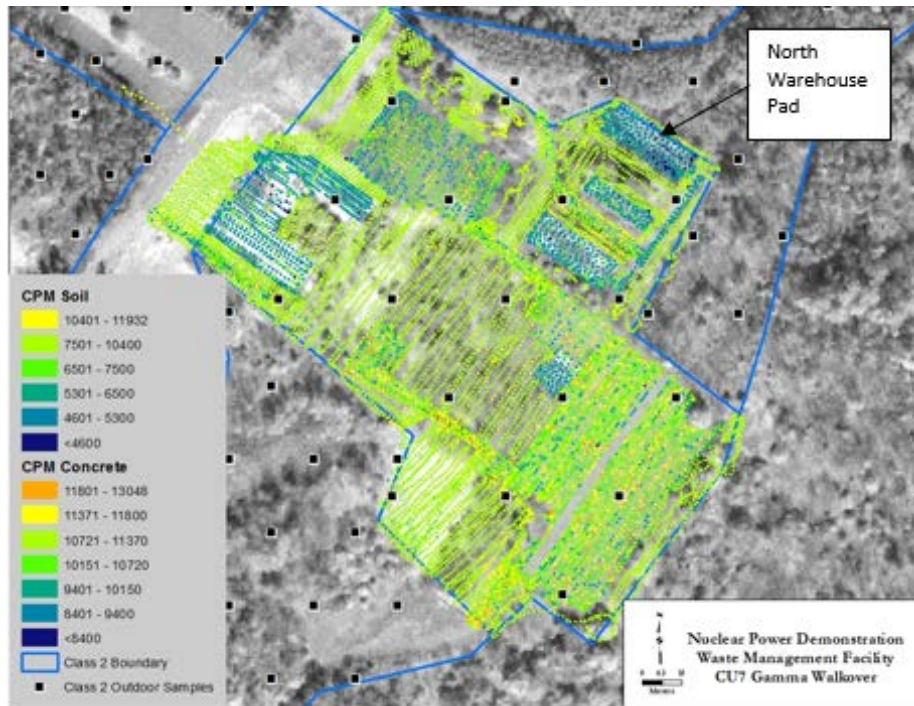


Figure 21, CU 7 Gamma Scan Results + Soil Sample Locations

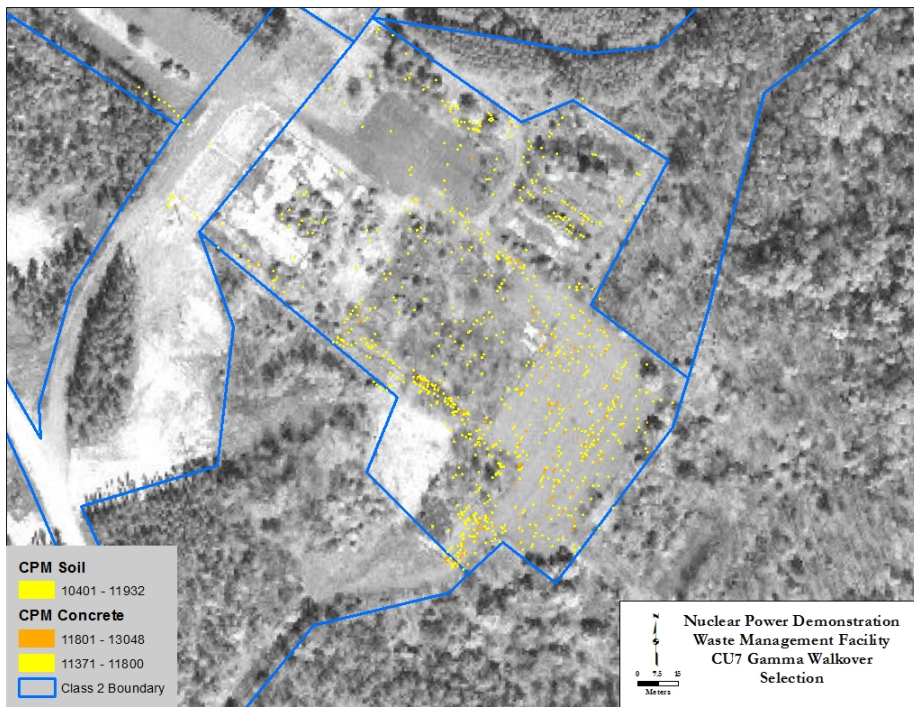


Figure 22, CU 7 Gamma Scan Results Isolating Elevated Readings

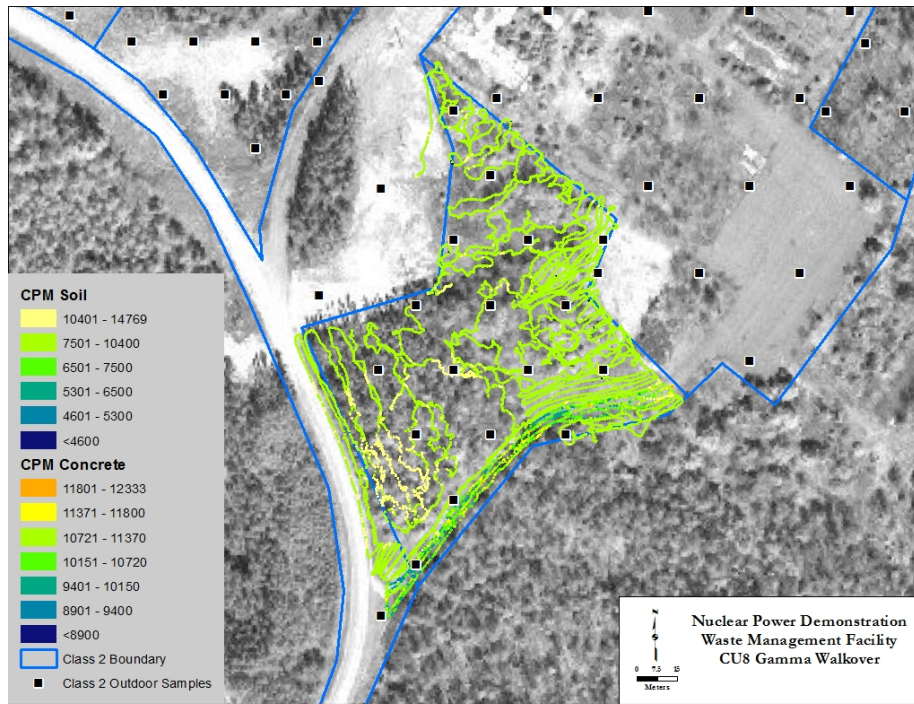


Figure 23, CU 8 Gamma Scan Results + Soil Sample Locations

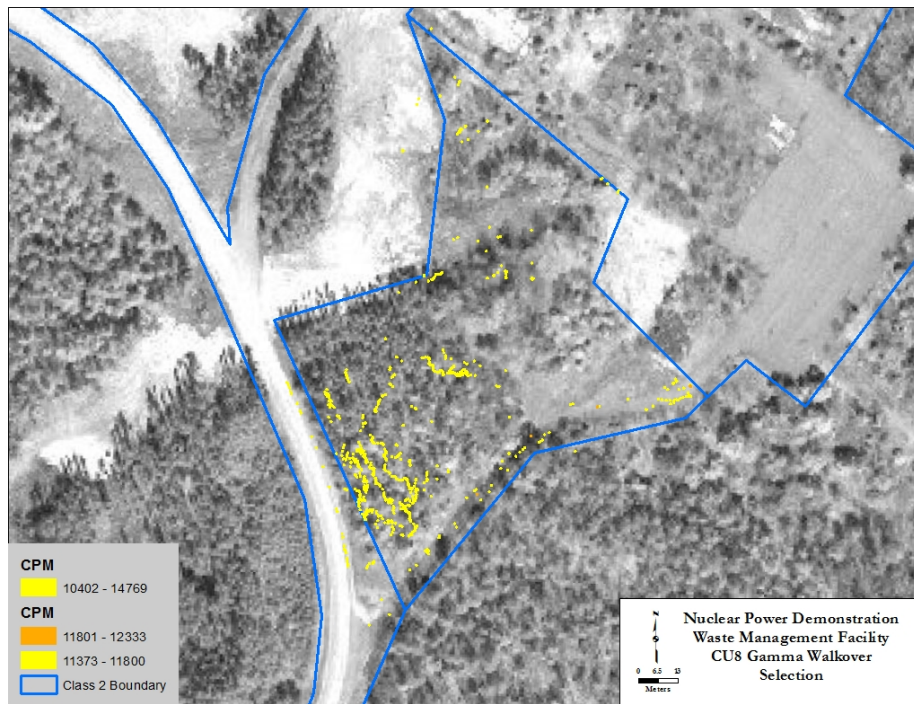


Figure 24, CU 8 Gamma Scan Results Isolating Elevated Readings

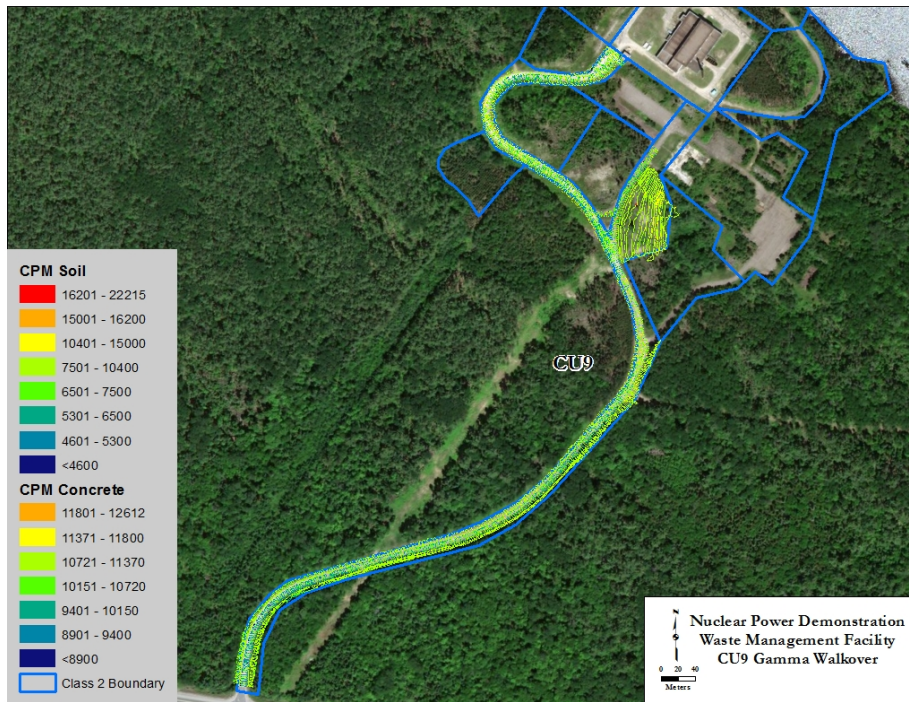


Figure 25, CU 9 Gamma Scan Results + Soil Sample Locations

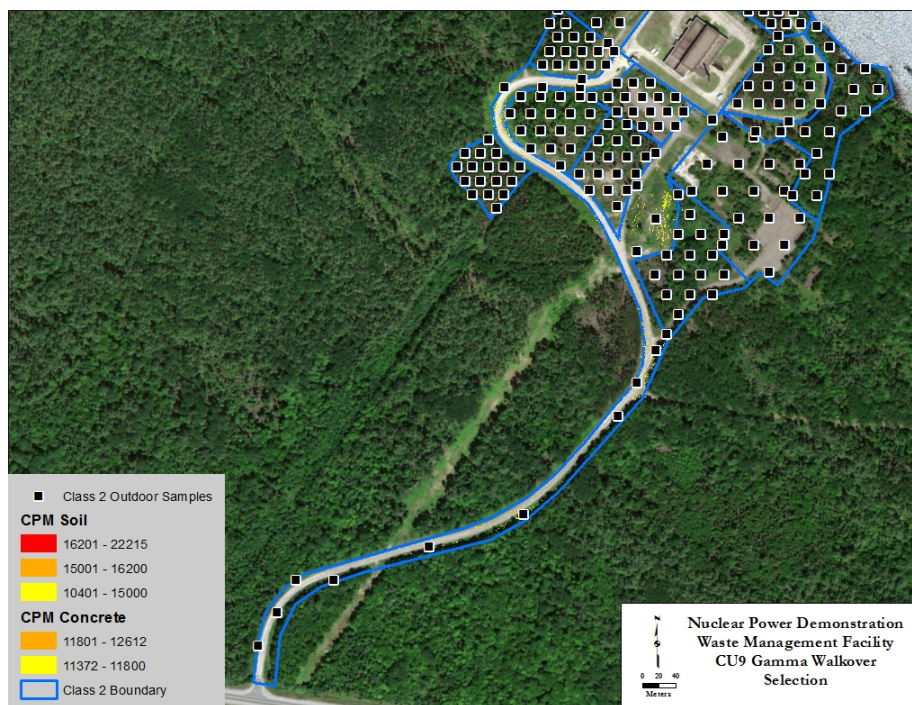


Figure 26, CU 9 Gamma Scan Results Isolating Elevated Readings

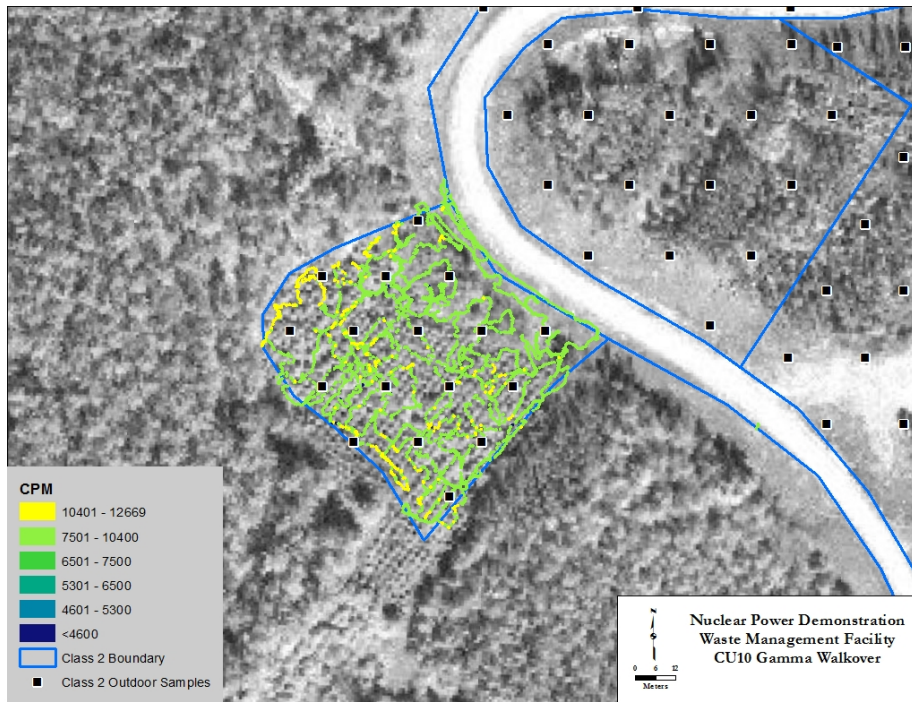


Figure 27, CU 10 Gamma Scan Results + Soil Sample Locations

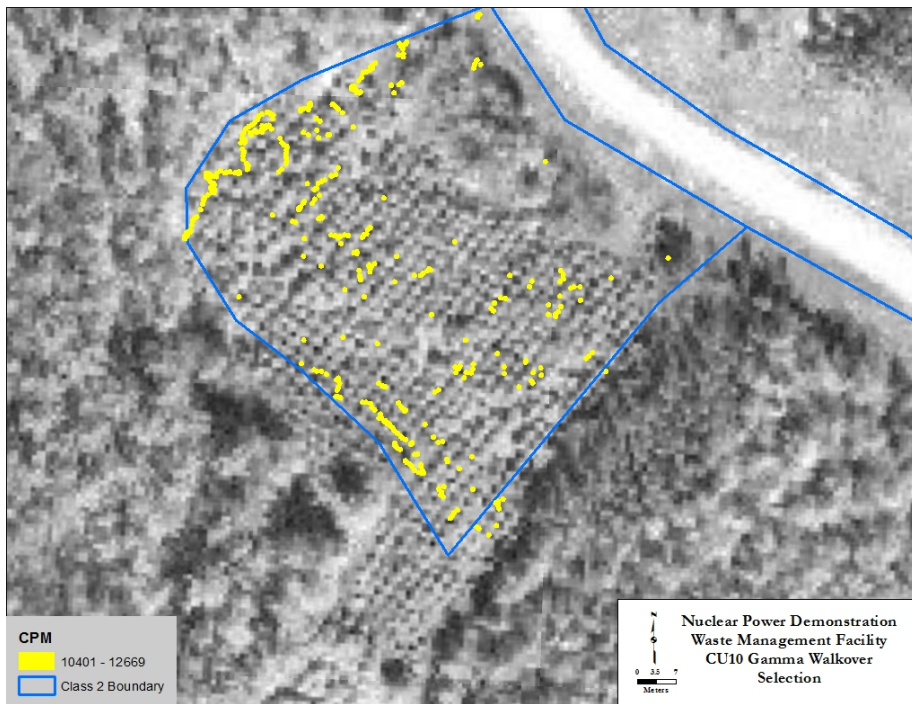


Figure 28, CU 10 Gamma Scan Results Isolating Elevated Readings

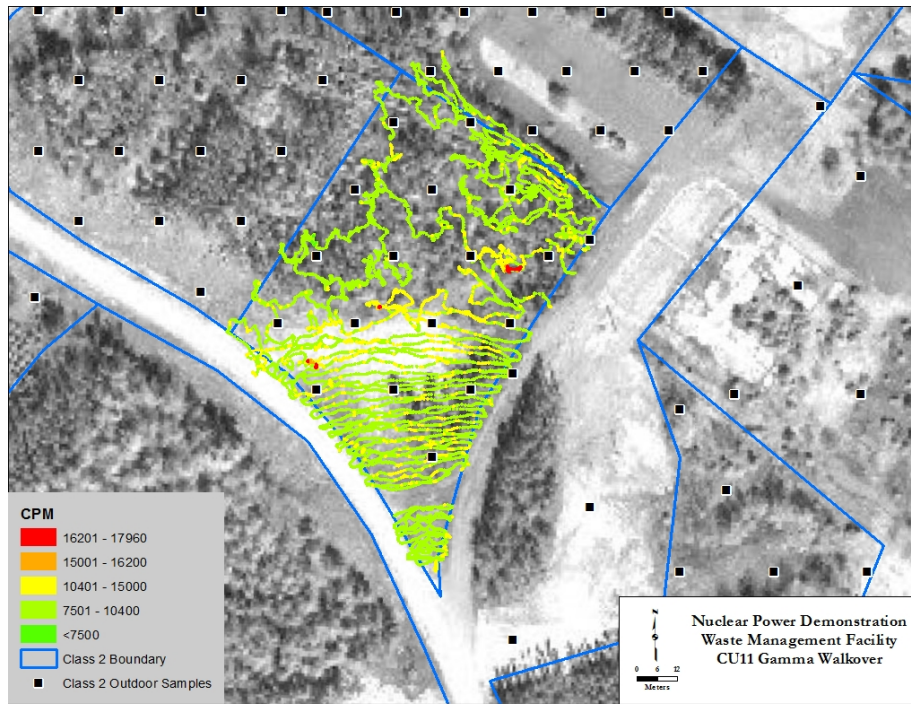


Figure 29, CU 11 Gamma Scan Results + Soil Sample Locations

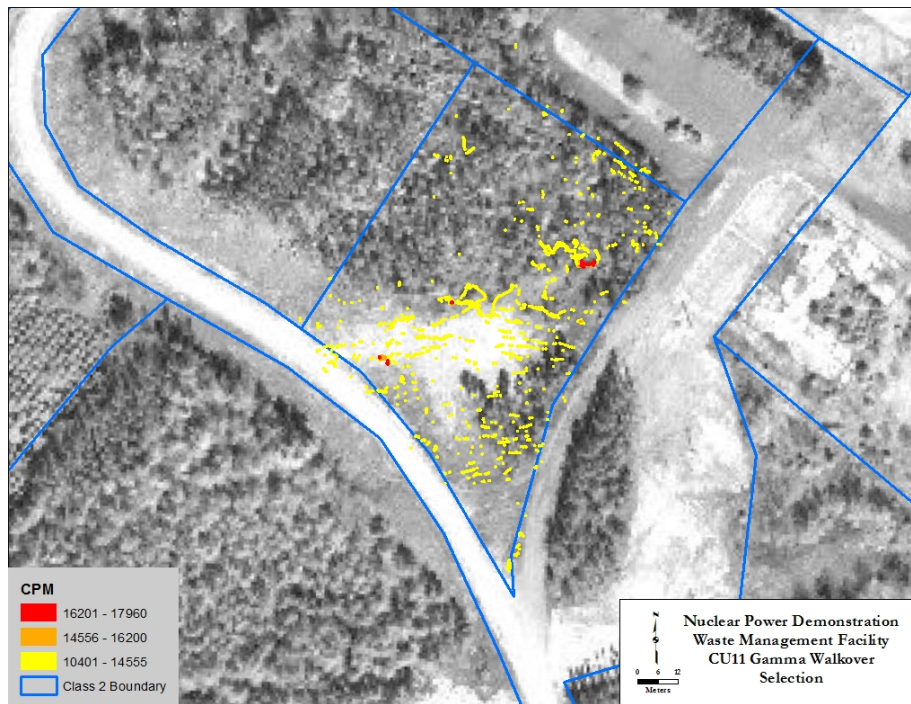


Figure 30, CU 11 Gamma Scan Results Isolating Elevated Readings

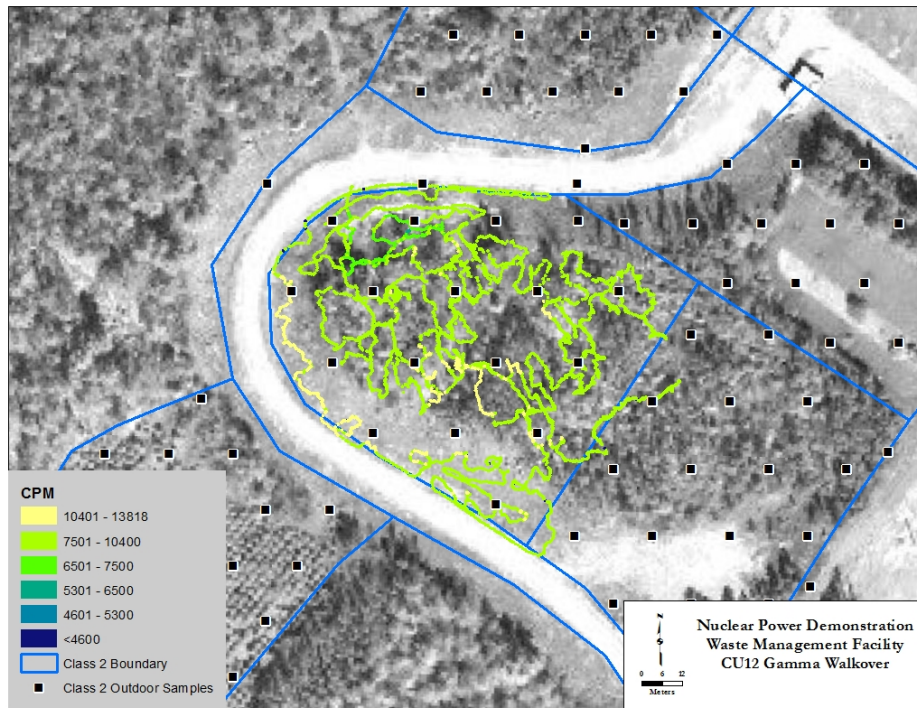


Figure 31, CU 12 Gamma Scan Results + Soil Sample Locations

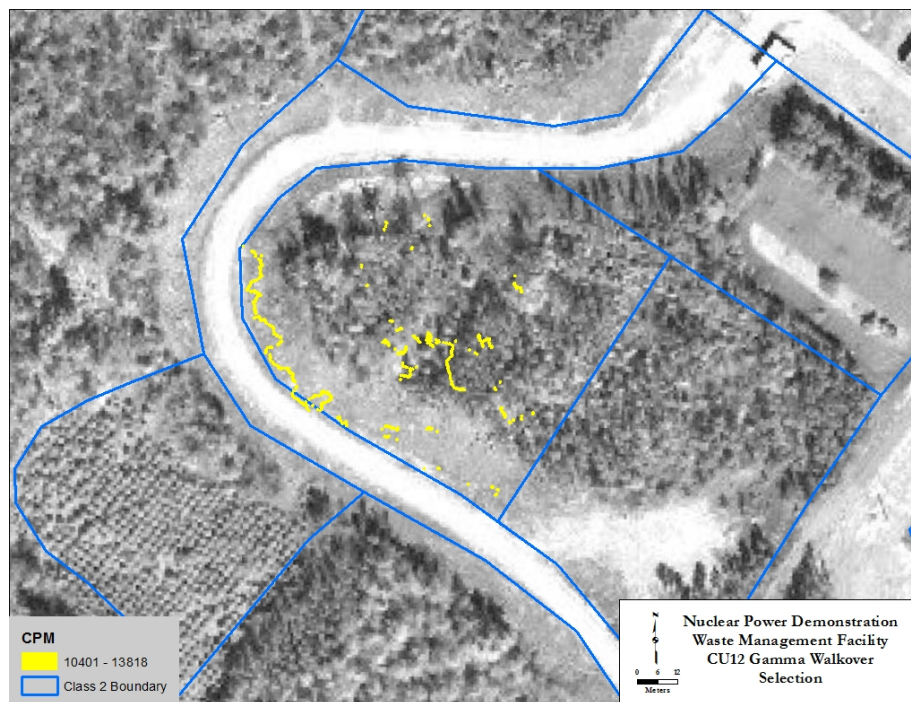


Figure 32, CU 12 Gamma Scan Results Isolating Elevated Readings

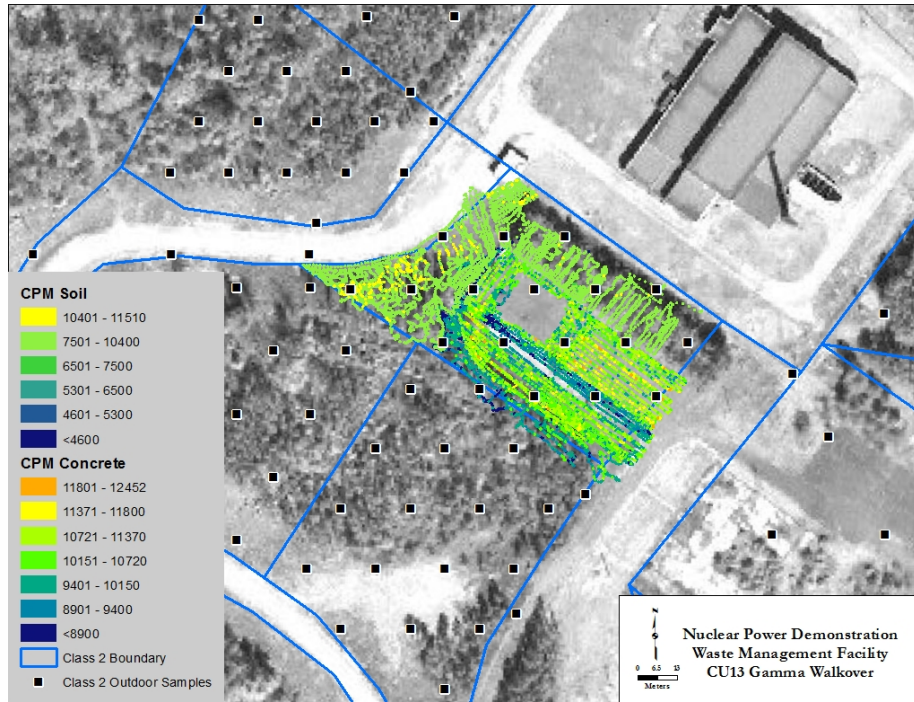


Figure 33, CU 13 Gamma Scan Results + Soil Sample Locations

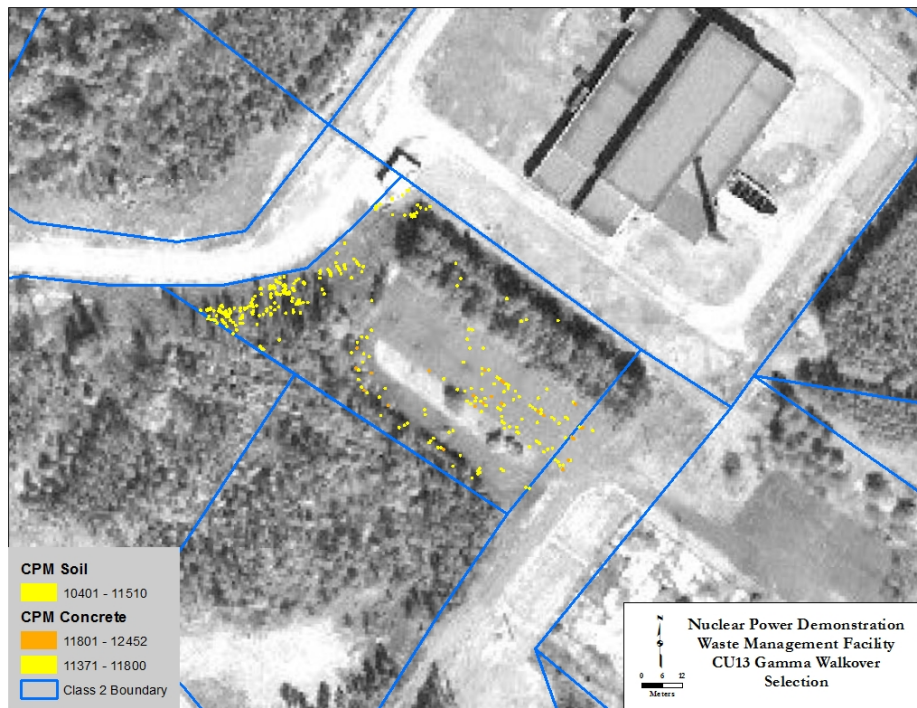


Figure 34, CU 13 Gamma Scan Results Isolating Elevated Readings

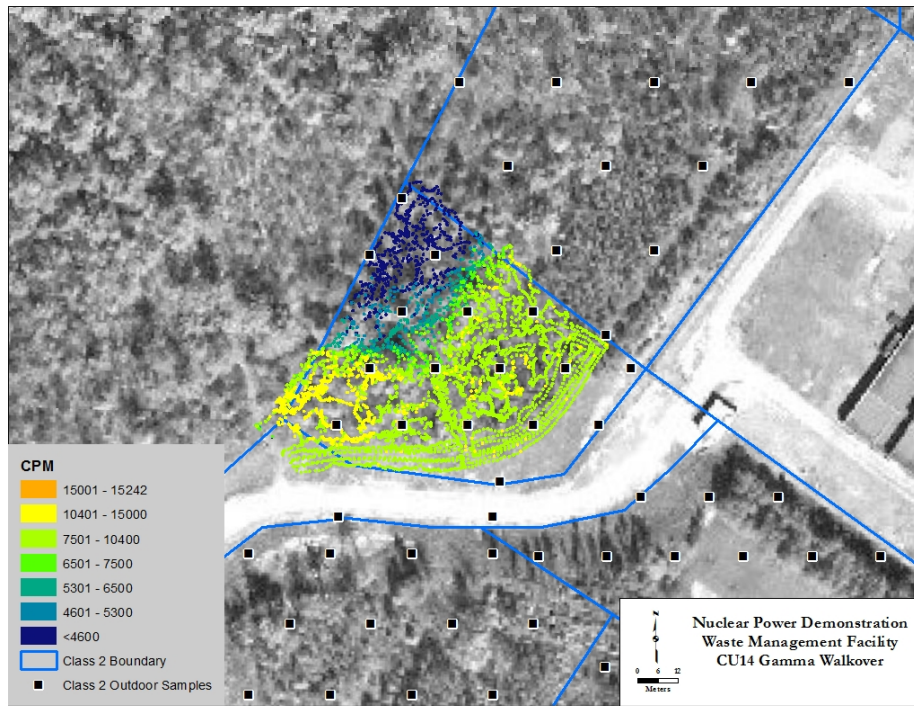


Figure 35, CU 14 Gamma Scan Results + Soil Sample Locations

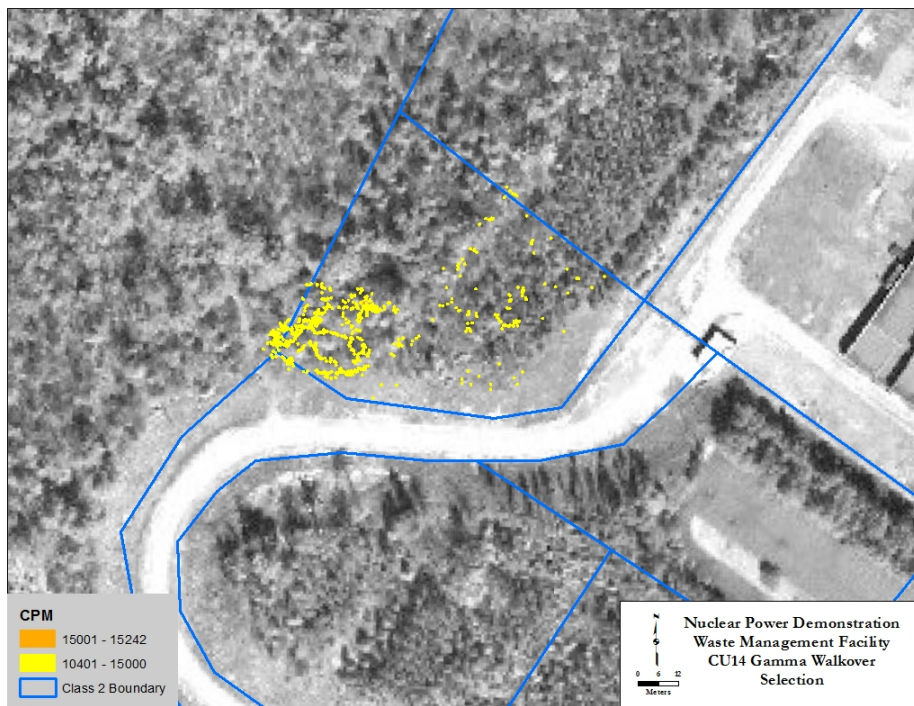


Figure 36, CU 14 Gamma Scan Results Isolating Elevated Readings

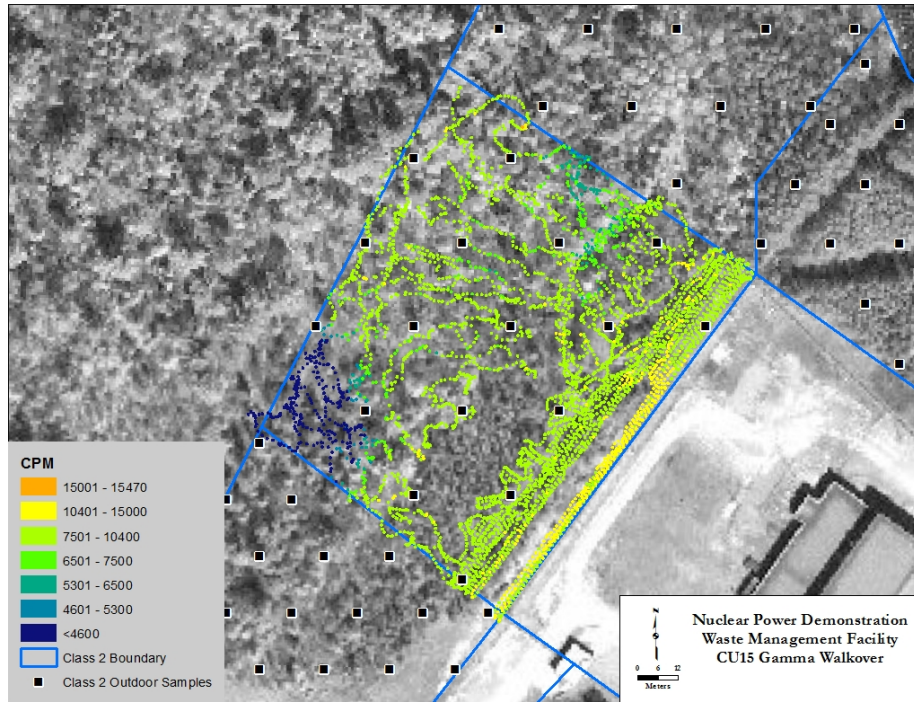


Figure 37, CU 15 Gamma Scan Results + Soil Sample Locations

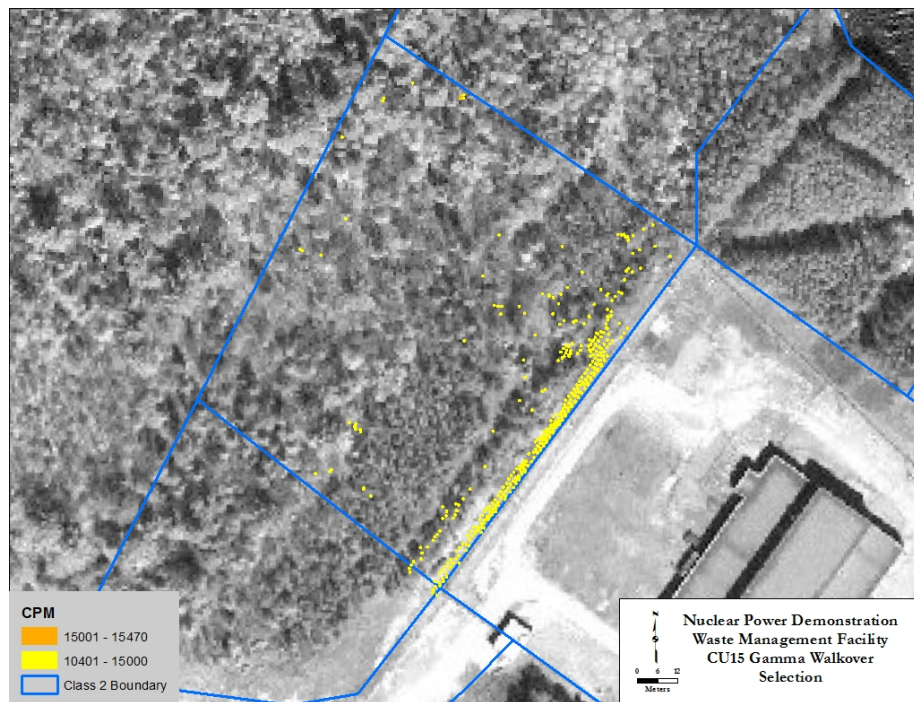


Figure 38, CU 15 Gamma Scan Results Isolating Elevated Readings

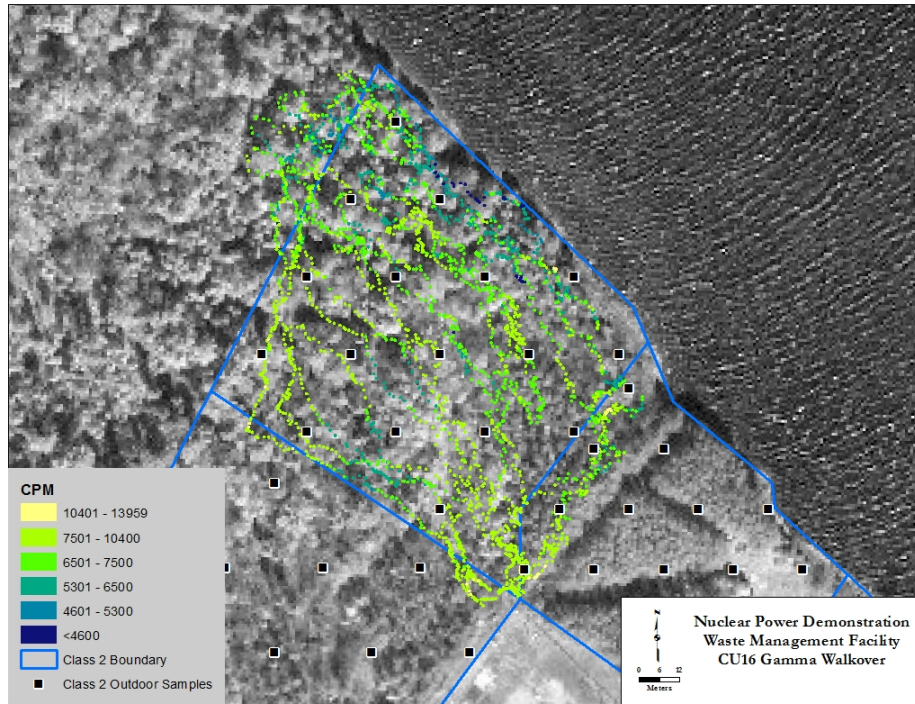


Figure 39, CU 16 Gamma Scan Results + Soil Sample Locations

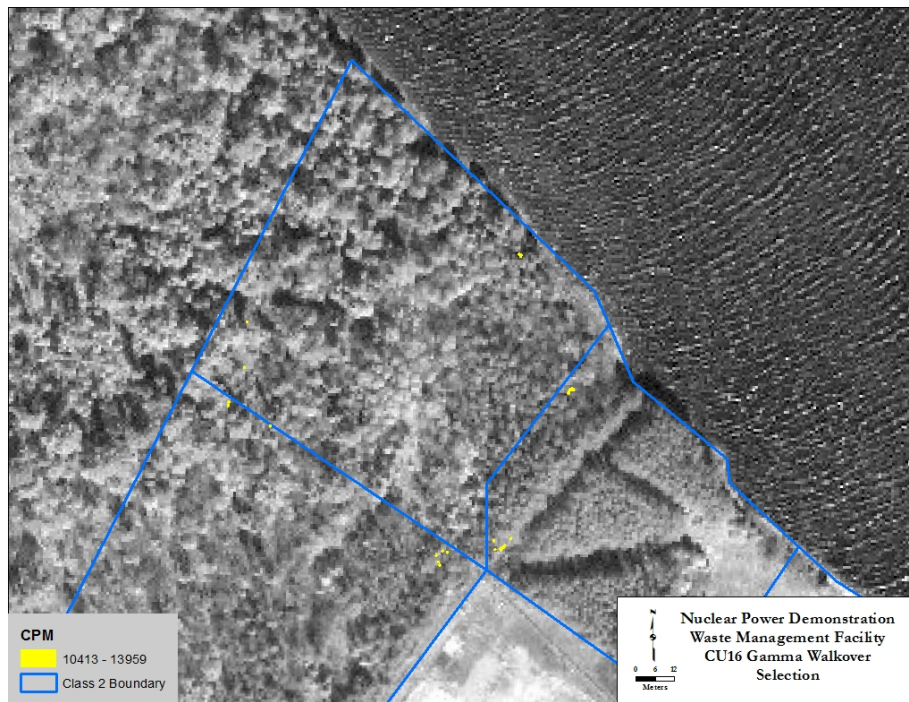


Figure 40, CU 16 Gamma Scan Results Isolating Elevated Readings

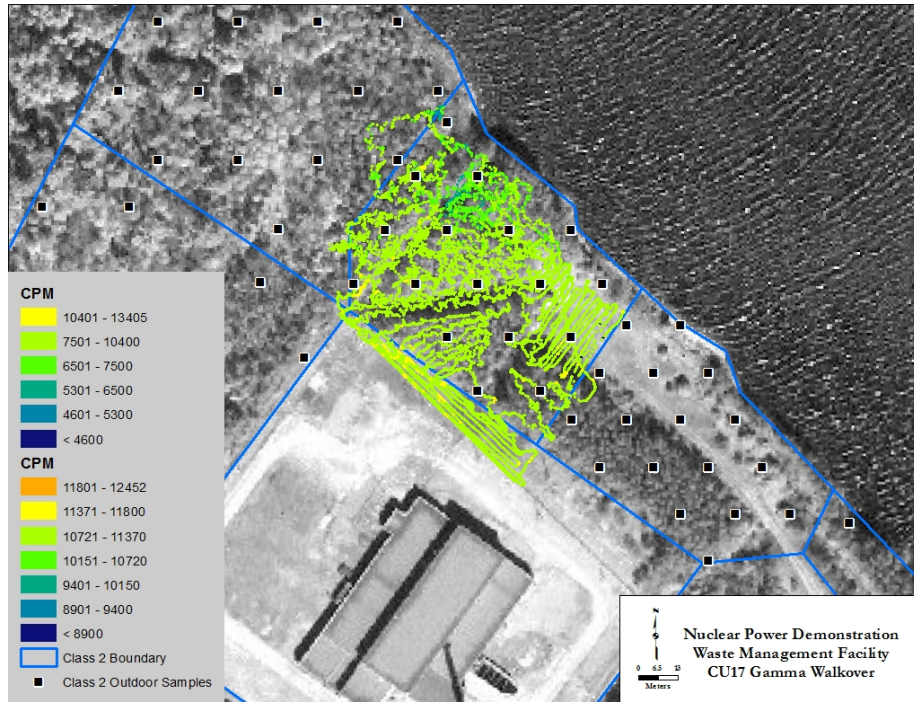


Figure 41, CU 17 Gamma Scan Results + Soil Sample Locations



Figure 42, CU 17 Gamma Scan Results Isolating Elevated Readings

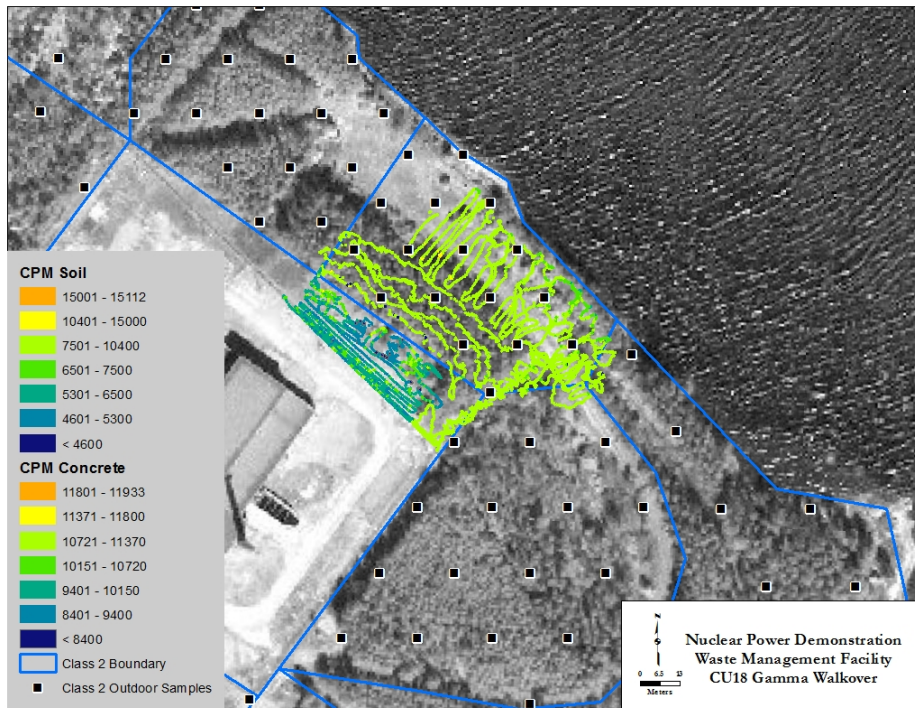


Figure 43, CU 18 Gamma Scan Results + Soil Sample Locations



Figure 44, CU 18 Gamma Scan Results Isolating Elevated Readings

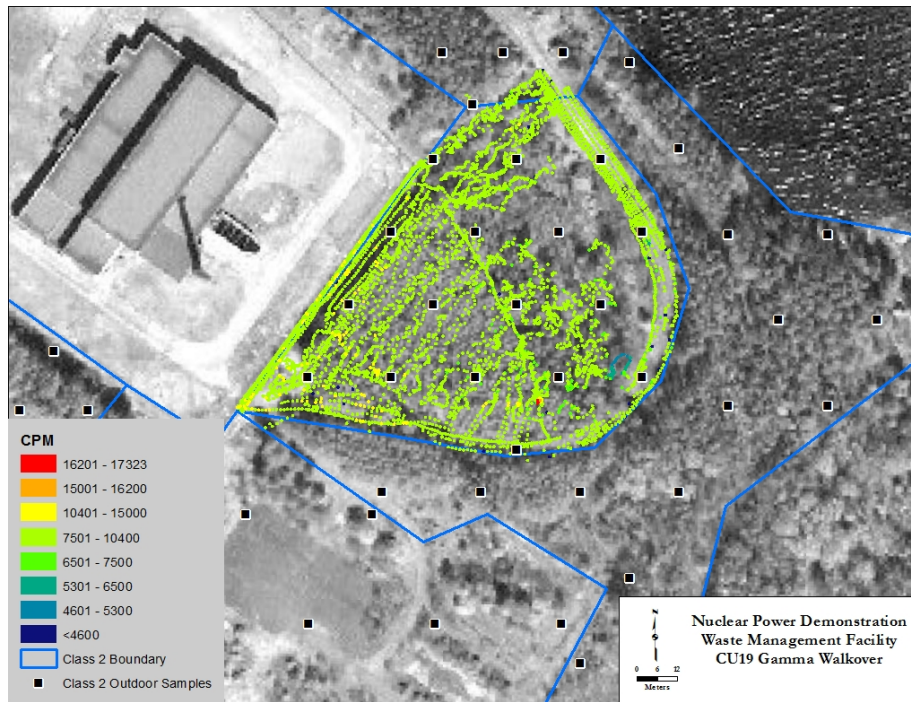


Figure 45, CU 19 Gamma Scan Results + Soil Sample Locations

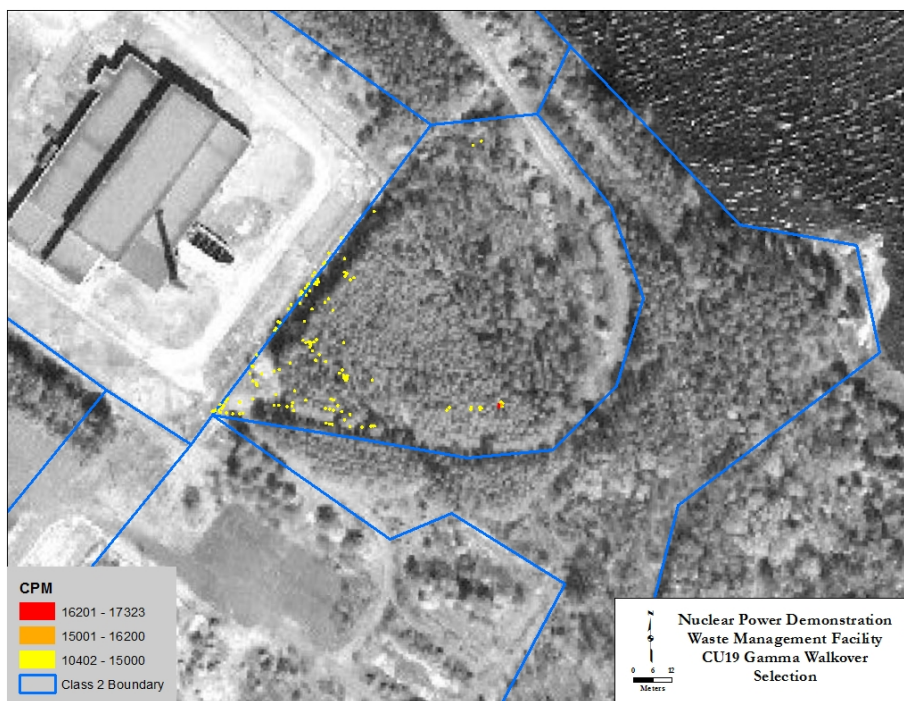


Figure 46, CU 19 Gamma Scan Results Isolating Elevated Readings

3.1.4 Class 1 Characterisation Units (CU)

The Class 1 CUs comprise CUs numbers 20 through 23. The results of the walkover gamma scans are illustrated in Figure 47 through Figure 54 below. For each CU the first image shows the results of the scan and highlights the approximately 100% scan coverage that was achieved for Class 1 CUs. The second image for each CU displays the same information, however, the elevated areas of gamma radiation have been highlighted i.e. those areas or data points that exceeded the UTL 95-95, 10401 cpm for surface soil and 11371 cpm for paved areas.

As can be very clearly seen in the Class 1 CU images the radiation levels were often higher in these areas. The CUs 20-23 represent the facility licensed area and enclose the NPD Main Building and all the ancillary Nuclear and Non-Nuclear building elements. Temporary storage of Low Level Radioactive waste is permitted in this area and this can be seen in Figure 53 which represents CU 23, the North West quadrant of the area where the surveyors scanning path around the waste container footprints is evident. Additionally in CU 23 a section of roadway was elevated relative to the surrounding road as evident in the west of the CU, Figure 54. This was likely due to the repair or excavation and subsequent relaying of this section of road using aggregate material below the asphalt which, depending on its origin, will have contained levels of NORM at higher activity levels than the rest of the site. There were no elevated surface or sub-surface soil samples associated with this section of the CU. Four judgemental soil samples were retrieved in the Class 1 CUs all of which came from CU 21 in the South East quadrant of the licensed area. The coordinates correspond to the elevated readings visible in Figure 49 and Figure 50.

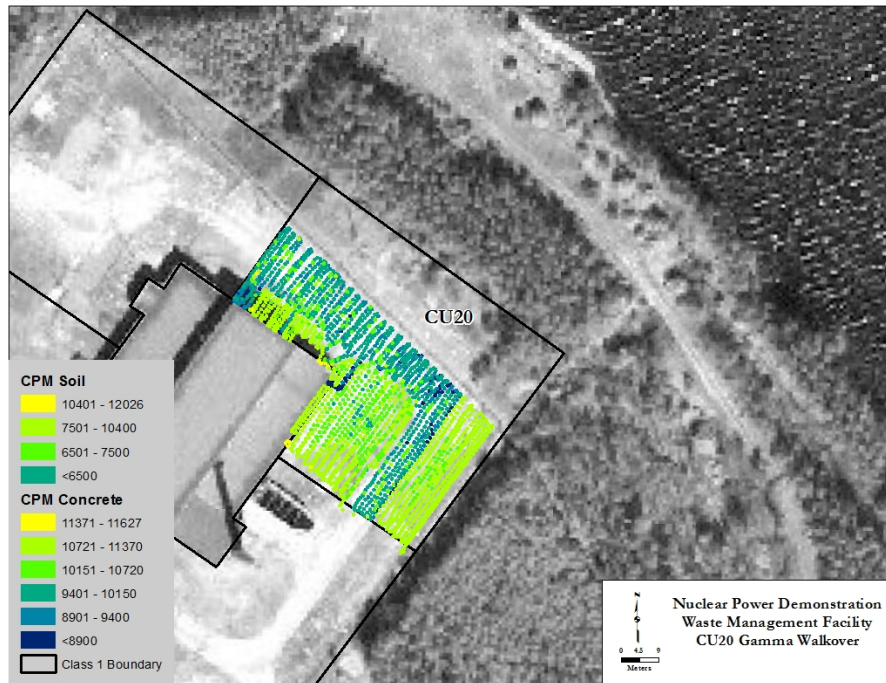


Figure 47, CU 20 Gamma Scan Results

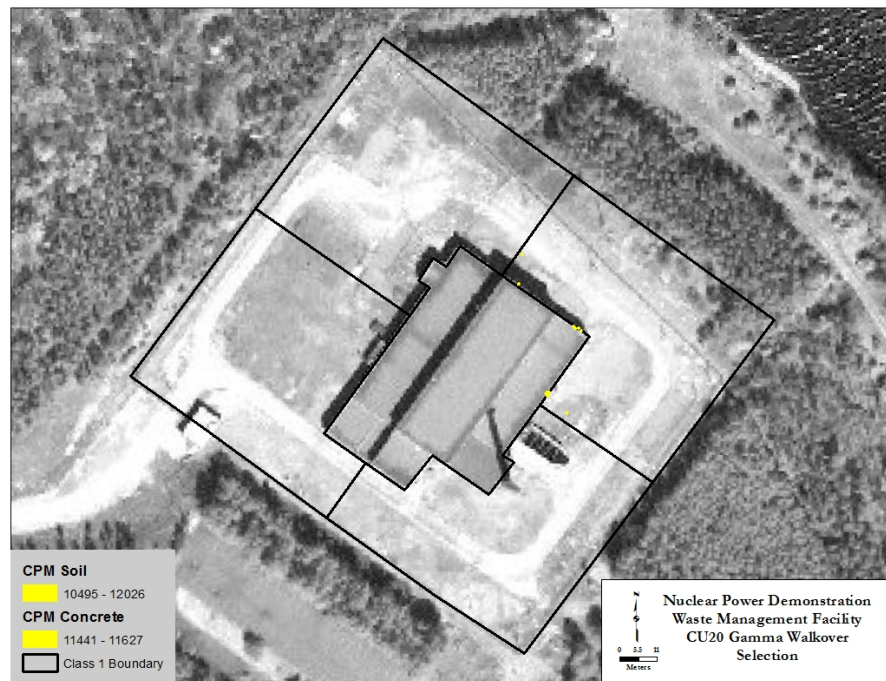


Figure 48, CU 20 Gamma Scan Results Isolating Elevated Readings

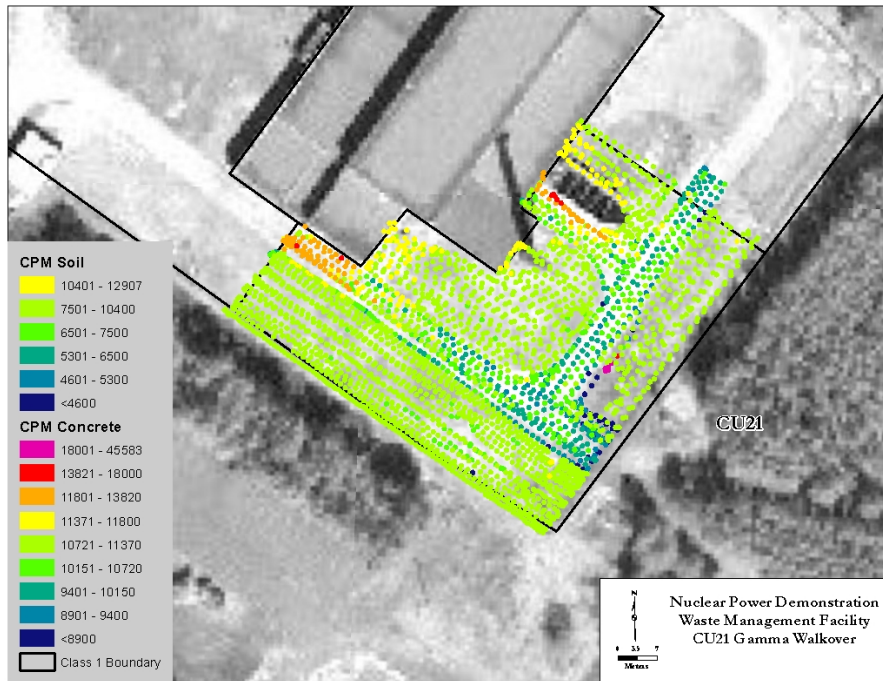


Figure 49, CU 21 Gamma Scan Results

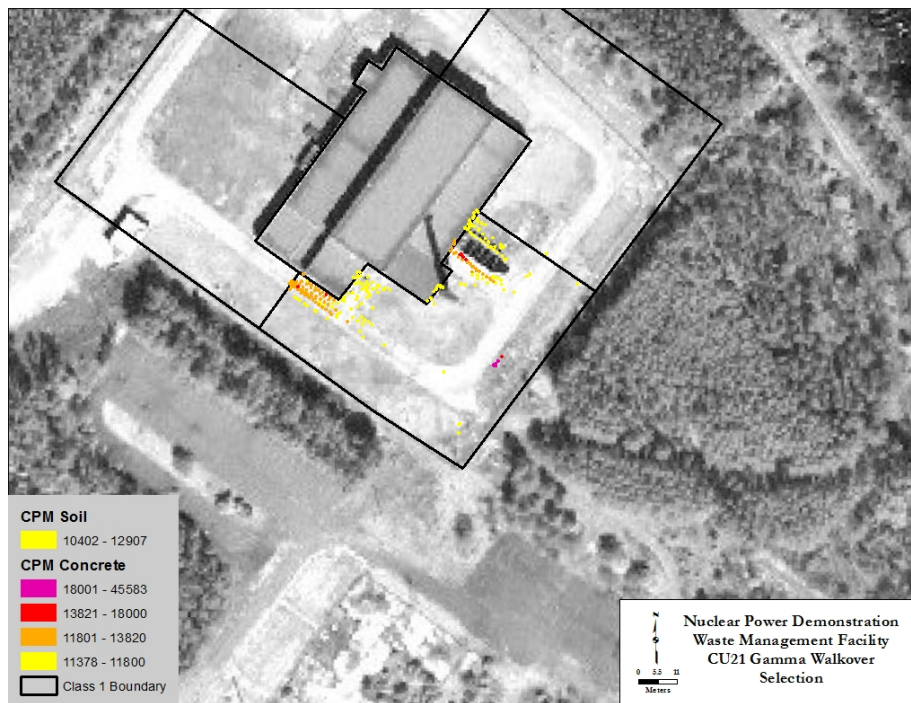


Figure 50, CU 21 Gamma Scan Results Isolating Elevated Readings



Figure 51, CU 22 Gamma Scan Results

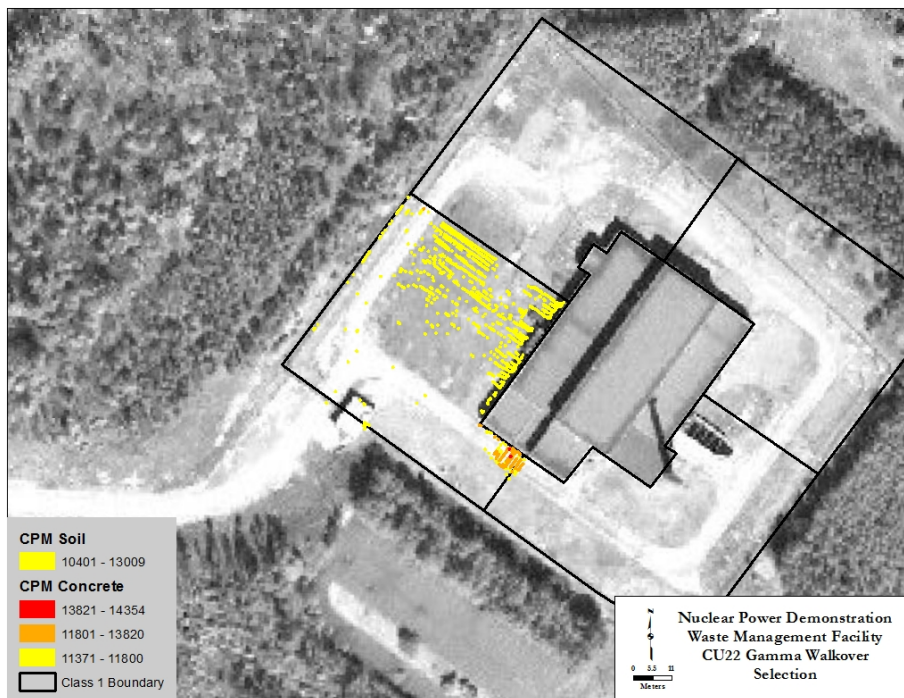


Figure 52, CU 22 Gamma Scan Results Isolating Elevated Readings

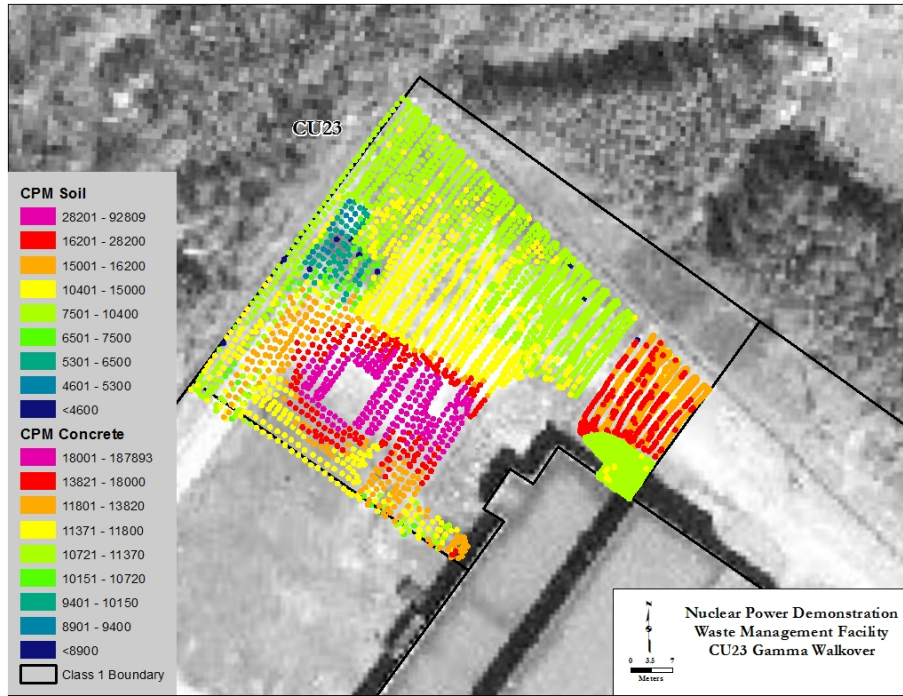


Figure 53, CU 23 Gamma Scan Results



Figure 54, CU 23 Gamma Scan Results Isolating Elevated Readings

3.2 Soil Sampling and Analysis

Surface and sub-surface soil samples were retrieved in accordance with the method described in Section 2.4. Subsequent analyses were undertaken by Kinetrics Inc as described in Section 2.7 and analytical reports provided to CNL for acceptance and interpretation [14]. Results were collated by CU, descriptive statistics generated and compiled and the appropriate statistical testing [1] applied using statistical software.

The hypothesis is a statement about the population parameter of concern, in this case the sample mean (\bar{x}), that may be supported or rejected by examining the data set. There are two hypotheses, a null hypothesis, (H_0), representing the assumption to be tested which is set up to be rejected or accepted based upon the result, and an alternative hypothesis (H_A), representing the logical opposite of the null hypothesis. In the event that H_0 is rejected, then H_A is adopted.

The output reporting of the testing is compiled for reference [15] and is summarised in the working spreadsheet used for all CUs under scrutiny [16].

Analyses results are summarised below and additionally the results of the statistical tests applied are also included. It should be noted that due to a communicative error between the analytical lab and the contracted sampler the test specified for analysis of technetium-99 was Inductively Coupled Plasma Mass Spectrometry (ICPMS) and the required MDL quoted was 1 Bqg^{-1} . With the test specified the standard reporting methodology is to report less than the MDL, which, although the results are all well below the clearance criteria, mean they are essentially unusable for carrying out certain statistical tests.

3.2.1 Background Reference Area (BRA)

The BRA analyses data were examined for any indications that the assumptions made as to its representativity of local background were flawed. As well as tests for distribution assumptions, Q-Q plots and outliers (Appendix A), and comparison with the UCLs [8] or the DCGL, (Appendix B), results were compared with available published data for local and/or global background levels, Table 3-4. Given the large variability associated with published background levels worldwide, the levels seen were not dissimilar to those of CRL. Four outliers [17] were identified in the BRA using the ProUCL software [18] at varying significance levels.

- 16-NPD006-16, SA-112, Co-60 (-0.001 Bqg^{-1}).
- 16-NPD006-09, SA-105, Eu-152 (-0.0033 Bqg^{-1}).
- 16-NPD006-09, SA-105, U-235 (-0.0167 Bqg^{-1}).
- 16-NPD006-09, SA-105, H-3 (0.175 Bqg^{-1}).

To ensure that results were not distorted unduly, these results were removed from the background data for the purpose of hypothesis testing but it should be noted that tests were also performed with the samples included to ensure results were not subject to their inclusion/exclusion. When testing was performed excluding the outliers, test results remained

unchanged with the exception that the p -value, or probability value increased thereby lowering the significance of the results.

Table 3-3 shows the results of the soil sample analyses for the BRA. Although the sample mean (\bar{x}) is shown for each RoC the mean result for the sample using the Unity rule is 0.57 which means that although it can be clearly shown that each individual RoC mean does not exceed the relevant DCGL, using the Sum of the Ratios also demonstrates that the sum of all the RoCs does not exceed the release criterion, i.e. 1.

The concentration and proportion of uranium isotopes fits the expectation for NORM and the apparently elevated levels of caesium-137, is attributable to fall out from global nuclear weapons testing during the latter half of the 20th Century. Tritium and carbon-14 levels are difficult to compare and subject to large variability depending on the sample matrix, water content, organic material, however the levels observed were low and in any case well below the UCLs [8]. It should also be noted that with the exception of Cs-137, Uranium, H-3 and C-14 none of the other RoCs returned any results that exceeded the labs MDL, see Section 2.8.4.

The analyses were deemed appropriate and the results determined to represent a non-impacted conclusion for the BRA. This is important as the classification of the BRA forms the basis of the statistical decision making for the Class 3 and 2 CUs

Table 3-3, BRA Soil Analyses Results

Radionuclide of Concern (RoC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00336	0.00037	0.04583	0.00185	0.00360	0.03409	0.07951	0.02560	0.03000	0.2000	0.72085
\bar{x}	0.00256	0.00026	0.03085	0.00126	0.00259	0.02138	0.05544	0.01751	0.03000	0.2000	0.57063
95% LCL	0.00176	0.00014	0.01587	0.00067	0.00157	0.00867	0.03137	0.00942	0.03000	0.2000	0.42040
Median	0.00295	0.00020	0.02010	0.00130	0.00240	0.01830	0.04280	0.01340	0.03000	0.2000	0.4782
Std Dev	0.00096	0.00015	0.02812	0.00064	0.00132	0.01777	0.04346	0.01204	0.0	0.0	0.28192
Std Err	0.00034	0.00005	0.00703	0.00024	0.00044	0.00562	0.01122	0.00363	0.0	0.0	0.07048
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	100	0	0	31	19	6	0	0	

1. The Unity Rule, also sometimes referred to as the "Sum of the Ratios".

Table 3-4, BRA Surface Soil Analyses Results Compared with UCLs.

RoC	\bar{X} (Bqg ⁻¹)	Derived Concentration Guideline Limit ^a (DCGL) (Bqg ⁻¹)	Variation with DCGL (%)	Local Background \bar{X} (Bqg ⁻¹)	COPC Screening Limit ^b (Bqg ⁻¹)
Am-241	0.00256	0.1	2.5	4.3E-4 ^{[19],[20]}	220
Co-60	0.00026	0.1	0.3	<i>Not Provided or zero</i>	2.63E1
Cs-137	0.03085	0.1	30	2.38E-2 ^{[19],[20]}	9.27E1
Eu-152	0.00126	0.1	1.3	<i>Not Provided or zero</i>	<i>Not Provided</i>
U-235	0.00259	1	0.3	9.0E-4 ^{[19],[20]}	<i>Not Provided</i>
U-238	0.02138	1	2.1	1.8E-2 ^{[19],[20]}	<i>Not Provided</i>
H-3	0.05544	100	<0.1	3.0E-4 ^[21]	2.0E3
C-14	0.01751	1	1.8	5.1E-2 ^[21]	4.67E3
Sr-90	0.03000	1	3	<i>Not Provided or zero</i>	2.84E1
Tc-99	<0.2000	1	<20	<i>Not Provided or zero</i>	<i>Not Provided</i>

a. DCGL = Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations [8].

b. COPC Screening Limit is included for reference only. This limit is defined as the contaminant environmental media concentration above which there are possible organism-level effects to environmental biota [20].

3.2.2 Class 3 CUs

The Class 3 CUs descriptive statistics are summarised below from [16] in Table 3-5 and additionally compared with the UCLs in Table 3-6. In the case of the Class 3 CUs the decision is based on the outcome of a statistical hypothesis test applied on an RoC by RoC basis. The appropriate test determined in the characterisation planning stage comprised two forms of the Wilcoxon Mann-Whitney test or Rank Sum test as it requires no assumption of the sample distribution. Initially, form 1 of the test was used for all data.

Null hypothesis (H_0): Exclusion Zone CU population mean is less than or equal to the BRA mean:

$$H_0: \bar{\mu}_{EZ} \leq \bar{\mu}_{BRA}$$

The alternative hypothesis (H_A) being: Exclusion Zone CU population mean is greater than the BRA mean:

$$H_A: \bar{\mu}_{EZ} > \bar{\mu}_{BRA}$$

Form 2 is used to evaluate the CU in the event that the form 1 H_0 is rejected.

Null Hypothesis (H_0): Exclusion Zone CU population mean is greater than or equal to the BRA mean plus a significant difference (SD):

$$H_0: \bar{\mu}_{EZ} \geq \bar{\mu}_{BRA} + SD$$

Alternative Hypothesis (H_A): Exclusion Zone CU population mean is less than the BRA mean plus a significant difference (SD):

$$H_A: \bar{\mu}_{EZ} < \bar{\mu}_{BRA} + SD$$

In the case of the Class 3 CUs the null hypothesis was held up for all RoCs [15] (Table 3-6) meaning that the release decision could be made confidently, against the relevant criteria. A decision based solely on the outcome of hypothesis testing can be faulty therefore in order to supplement the decision graphically, the Q-Q plots for sample distribution comparison with the BRA as well as the scatterplots for comparison with UCLs that were produced are included for the Class 3 CUs at Appendix C and Appendix D. No sub-surface (0.15-0.3 mbgs) samples were obtained while sampling the Class 3 area.

Table 3-5, Class 3 CUs, Surface Soil Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00373	0.00039	0.02671	0.00190	0.00455	0.02117	0.03560	0.02494	0.03685	0.2000	0.53433
\bar{x}	0.00306	0.00028	0.02317	0.00152	0.00355	0.01722	0.02749	0.02073	0.03160	0.2000	0.49552
95% LCL	0.00238	0.00017	0.01964	0.00115	0.00255	0.01327	0.01937	0.01651	0.02635	0.2000	0.45671
Median	0.00280	0.00010	0.01800	0.00110	0.00260	0.01340	0.02570	0.01750	0.03400	0.2000	0.45562
Std Dev	0.00202	0.00035	0.01578	0.00128	0.00319	0.01418	0.02400	0.01715	0.01407	0.0	0.17440
Std Err	0.00033	0.00005	0.00178	0.00019	0.00049	0.00197	0.00400	0.00211	0.00257	0.0	0.01950
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	99	0	0	18	3	21	0	0	

1. The Unity Rule, also sometimes referred to as the "Sum of the Ratios".

Table 3-6, Class 3 CUs, Surface Soil Analyses Results Compared with UCLs Including Hypothesis Testing (Wilcoxon Mann-Whitney).

Radionuclide of Concern (RoC)	BRA \bar{X} (Bqg ⁻¹)	\bar{X} (Bqg ⁻¹)	DCGL ^a (Bqg ⁻¹)	Variation with DCGL (%)	Hypothesis Test Result (Form 1)	Hypothesis Test Result (Form 2)
Am-241	0.00256	0.00306	0.1	3	<i>Do Not Reject H_o</i>	N/A
Co-60	0.00026	0.00028	0.1	0.2	<i>Do Not Reject H_o</i>	N/A
Cs-137	0.03085	0.02317	0.1	23	<i>Do Not Reject H_o</i>	N/A
Eu-152	0.00126	0.00152	0.1	1.5	<i>Do Not Reject H_o</i>	N/A
U-235	0.00259	0.00355	1	0.4	<i>Do Not Reject H_o</i>	N/A
U-238	0.02138	0.01722	1	1.7	<i>Do Not Reject H_o</i>	N/A
H-3	0.05544	0.02749	100	<0.1	<i>Do Not Reject H_o</i>	N/A
C-14	0.01751	0.02073	1	2	<i>Do Not Reject H_o</i>	N/A
Sr-90	0.03000	0.03160	1	3.2	<i>Do Not Reject H_o</i>	N/A
Tc-99	<0.2000 ^b	<0.2000^b	1	<20	<i>Unable to perform test as all observations were identical.</i>	

a. Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations.

b. Concentration level reported for Tc-99 represents the Method Minimum Detection Limit (MDL) achieved.

3.2.3 Class 2 CUs

The Class 2 CUs descriptive statistics are summarised below from [16] in Table 3-8 and additionally compared with the UCLs in Table 3-10. As with the Class 3 CUs, the Class 2 CUs decision is based on the outcome of a statistical hypothesis test applied on an RoC by RoC basis. The appropriate test determined in the characterisation planning stage comprised two forms of the Wilcoxon Mann-Whitney test as it requires no assumption of the sample distribution. Initially, form 1 of the test was used for all data.

Null hypothesis (H_0): Exclusion Zone CU population mean is less than or equal to the BRA mean:

$$H_0: \bar{\mu}_{EZ} \leq \bar{\mu}_{BRA}$$

The alternative hypothesis (H_A) being: Exclusion Zone CU population mean is greater than the BRA mean:

$$H_A: \bar{\mu}_{EZ} > \bar{\mu}_{BRA}$$

Form 2 is used to evaluate the CU in the event that the form 1 H_0 is rejected.

Null Hypothesis (H_0) : Exclusion Zone CU population mean is greater than or equal to the BRA mean plus a significant difference (SD):

$$H_0: \bar{\mu}_{EZ} \geq \bar{\mu}_{BRA} + SD$$

Alternative Hypothesis (H_A) : Exclusion Zone CU population mean is less than the BRA mean plus a significant difference (SD):

$$H_A: \bar{\mu}_{EZ} < \bar{\mu}_{BRA} + SD$$

In the case of the Class 2 CUs the null hypothesis was held up for all RoCs [15] (Table 3-10) meaning that the release decision could be made confidently, against the relevant criteria. The results show that form 2 of the WMW test was performed in the case of 2 RoCs, Eu-152 and U-238. The significant difference used for this form was 3 standard deviations of the background mean concentration for the 2 RoCs in question. The figures used for SD were derived from the standard deviation of the mean BRA concentrations prior to removal of the non-detect results, Eu-152 (4.11E-3) and U-238 (6.6E-2). The Quantile plots for distribution comparison are attached at Appendix E and the scatterplots comparing the RoC concentration with the UCL are attached at Appendix F. Additional to the surface samples, 28 sub-surface samples were retrieved from the Class 2 CUs, Appendix G, either because gamma count rate screening indicated a potential rise in activity on removal of the surface sample, in accordance with the method discussed in Section 2.4.4 for judgemental sampling, or because the sampling plan [6] had specified samples at depth. As an example, CU 10 which encompassed the site of

the Landfill #1 but which otherwise would have been classified within the Class 3 CUs, Section 2.4.3. The results of the samples are summarised separately in Table 3-9. Results support the expectation that there is no elevated activity due to buried waste and no reason for further investigation. In reviewing the results for caesium-137 using both the Q-Q plots for distribution and the scatterplots for concentration, some further scrutiny was justified. The slightly elevated caesium levels did not challenge the hypothesis test results for the Class 2 CUs and although not a concern in comparison to the UCL of 0.1 Bqg⁻¹ [8], it was decided to look at three of the CUs in more detail. CUs 14, 15 and 16 lay immediately to the Northwest of the facility adjacent to the two Class 1 CUs 22 and 23 and Figure 36, Figure 38 and Figure 40 illustrate their relative position and provide a visual confirmation of any anomalies. The mean concentrations of the RoCs in each of the 3 CUs are included below in Table 3-7. Wilcoxon Mann-Whitney tests were performed on the 3 CUs for the results using the Unity Rule against the BRA results and H₀ was rejected, i.e. the mean of each CU was shown to be less than or equal to that of the BRA. The Quantile Plots were examined for the various RoCs and as a result WMW tests were performed for several individual RoCs, again H₀ was “not rejected” in the case of form 1 or was “rejected” where form 2 was applied, meaning the CU was either less than the BRA concentration or was less than the BRA + significant difference. The RoCs with questionable distributions in relation to the BRA were Co-60, Eu-152, U-235, U-238 and C-14.

Table 3-7, Class 2 CUs 14, 15 and 16 Mean Concentrations.

	Radionuclide of Concern Mean (Bqg ⁻¹)										Unity Value
	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	
CU14	0.00273	0.00025	0.02072	0.00236	0.00304	0.01716	0.07796	0.03657	0.01871	0.1	0.39403
CU15	0.00298	0.00027	0.01538	0.00319	0.00309	0.02778	0.03480	0.02205	0.01529	0.1	0.34470
CU16	0.00380	0.00038	0.03325	0.00224	0.00310	0.01971	0.04323	0.02640	0.01982	0.1	0.53045

Table 3-8, Class 2 CUs Surface Soil Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00320	0.00024	0.00990	0.00275	0.00282	0.02246	0.02407	0.02342	0.02984	0.1000	0.28942
\bar{x}	0.00284	0.00021	0.00777	0.00246	0.00241	0.02099	0.01880	0.01952	0.02719	0.1000	0.26751
95% LCL	0.00247	0.00019	0.00564	0.00218	0.00200	0.01951	0.01353	0.01561	0.02454	0.1000	0.24559
Median	0.00250	0.00020	0.00280	0.00210	0.00190	0.02010	0.01050	0.01140	0.02300	0.1000	0.22626
Std Dev	0.00210	0.00017	0.01634	0.00205	0.00213	0.01082	0.03585	0.02076	0.02021	0.0	0.17161
Std Err	0.00018	0.00001	0.00108	0.00014	0.00021	0.00075	0.00267	0.00197	0.00134	0.0	0.011124
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	69	5	3	58	3	16	24	0	

1. The Unity Rule, also sometimes referred to as the "Sum of the Ratios".

Table 3-9, Class 2 CUs Sub-Surface Soil Analyses Results.

Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00252	0.00022	0.00363	0.00254	0.00260	0.02405	0.01344	0.02011	0.03307	0.1000	0.22696
\bar{x}	0.00216	0.00019	0.00150	0.00226	0.00219	0.02257	0.00817	0.01620	0.03042	0.1000	0.20505
95% LCL	0.00180	0.00017	-0.00062	0.00198	0.00178	0.02109	0.00289	0.01229	0.02777	0.1000	0.18313
Median	0.00195	0.00010	0.00090	0.00215	0.00160	0.02310	0.00551	0.00855	0.02500	0.1000	0.19685
Std Dev	0.00182	0.00017	0.00192	0.00076	0.00174	0.00917	0.00732	0.02022	0.02452	0.0	0.04098
Std Err	0.00046	0.00004	0.00038	0.00014	0.00047	0.00183	0.00173	0.00640	0.00481	0.0	0.00774
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	50	0	4	68	4	0	25	0	

Table 3-10, Class 2 CUs, Surface Soil Analyses Results Compared with UCLs Including Hypothesis Testing (Wilcoxon Mann-Whitney).

Radionuclide of Concern (RoC)	BRA \bar{X} (Bqg ⁻¹)	\bar{X} (Bqg ⁻¹)	DCGL ^a (Bqg ⁻¹)	Variation with DCGL (%)	Hypothesis Test Result (Form 1)	Hypothesis Test Result (Form 2)
Am-241	0.00256	0.00284	0.1	2.8	<i>Do Not Reject H_o</i>	N/A
Co-60	0.00026	0.00021	0.1	0.2	<i>Do Not Reject H_o</i>	N/A
Cs-137	0.03085	0.00777	0.1	7.8	<i>Do Not Reject H_o</i>	N/A
Eu-152	0.00126	0.00246	0.1	2.5	<i>Reject H_o</i>	<i>Reject H_o</i>
U-235	0.00259	0.00241	1	0.2	<i>Do Not Reject H_o</i>	N/A
U-238	0.02138	0.02099	1	2.1	<i>Reject H_o</i>	<i>Reject H_o</i>
H-3	0.05544	0.01880	100	<0.1	<i>Do Not Reject H_o</i>	N/A
C-14	0.01751	0.01952	1	2	<i>Do Not Reject H_o</i>	N/A
Sr-90	0.03000	0.02719	1	2.7	<i>Do Not Reject H_o</i>	N/A
Tc-99	<0.2000 ^b	<0.1000^b	1	<10	<i>Unable to perform test as all observations were identical.</i>	

a. Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations.

b. Concentration level reported for Tc-99 represents the Method Minimum Detection Limit (MDL) achieved.

3.2.4 Class 1 CUs

The Class 1 CUs descriptive statistics are summarised below from [16] in Table 3-11 for the surface soil results and Table 3-13 for the sub-surface results. The Class 1 CUs survey design required surface (0-0.15 mbgs) and sub-surface (0.15-0.3 mbgs) samples to be collected at each sample location. A large portion, if not the entire extent, of the currently Licensed Area will not be released before the end of the period of institutional control, a period anticipated to last for at least 100 years. The aim of this part of the characterisation survey was to understand and document the current level of contamination within the Licensed Area to provide inputs for completion of environmental assessments and allow confidence based decisions for future site

use/release. The criteria applied for the Class 1 CUs was firstly to test the CUs using the Sign Test as per the hypothesis settings below;

Null Hypothesis (H_0): Licensed Area surface soil CU RoC population mean is greater than or equal to the clearance level:

$$H_0: \bar{\mu}_{LA} \geq \bar{\mu}_{CL}$$

Alternative Hypothesis (H_A): Licensed Area surface soil CU RoC population mean is less than the clearance level:

$$H_A: \bar{\mu}_{LA} < \bar{\mu}_{CL}$$

Secondly the same CUs were tested using the same criteria (WMW Test) as the Class 3 and 2 CUs.

Null hypothesis (H_0): Licensed Area CU population mean is less than or equal to the BRA mean:

$$H_0: \bar{\mu}_{EZ} \leq \bar{\mu}_{BRA}$$

The alternative hypothesis (H_A) being: Licensed Area CU population mean is greater than the BRA mean:

$$H_A: \bar{\mu}_{EZ} > \bar{\mu}_{BRA}$$

Form 2 is used to evaluate the CU in the event that the form 1 H_0 is rejected.

Null Hypothesis (H_0): Licensed Area CU population mean is greater than or equal to the BRA mean plus a significant difference (SD):

$$H_0: \bar{\mu}_{EZ} \geq \bar{\mu}_{BRA} + SD$$

Alternative Hypothesis (H_A): Licensed Area CU population mean is less than the BRA mean plus a significant difference (SD):

$$H_A: \bar{\mu}_{EZ} < \bar{\mu}_{BRA} + SD$$

The results of the hypothesis testing are summarised below in Table 3-12 and Table 3-14. In the case of the Class 1 CUs the null hypothesis was held up for all RoCs [15] meaning that the release decision could be made confidently, against the relevant criteria. The results show that

form 2 of the WMW test was performed in the case of 2 RoCs, Eu-152 and U-238 for the surface sample evaluation and just Eu-152 for the sub-surface samples. The significant difference used for this form was 3 standard deviations of the background mean concentration for the 2 RoCs in question as used previously for the Class 2 evaluation in Section 3.2.3. Quantile Plots examining RoC distribution are attached (Appendix H) for the surface results and scatterplots comparing RoC concentration to UCLs are attached at Appendix I and Appendix J. During gamma scanning, as noted in Section 3.1.4, 4 judgemental soil samples were retrieved due to suspect elevated gamma count rates. Their analyses [22] were reviewed on a quantitative basis. All 4 soil samples contained some indications of anthropogenic radionuclides mixed with NORM, however;

- S-CU21-170511-TV-001, was very clearly a confined and discrete area of contamination showing very obvious indicators of fission products, 7.3 Bqg⁻¹ Cs-137, 4 Bqg⁻¹ Sr-90, 0.5 Bqg⁻¹ Am-241.
- S-CU21-170511-TV-002, showed minimal elevated activity except 1 Bqg⁻¹ H-3 and 0.01 Bqg⁻¹ C-14.
- S-CU21-170511-TV-003, showed minimal elevated activity except 0.4 Bqg⁻¹ H-3 and 0.1 Bqg⁻¹ C-14 and some elevated NORM.
- S-CU21-170511-TV-004, showed minimal elevated activity except 26 Bqg⁻¹ H-3 and 0.2 Bqg⁻¹ C-14 0.2 Bqg⁻¹ Co-60 and 0.3 Bqg⁻¹ Cs-137.

In at least 1 of these locations the sampling effectively remediated the area as elevated gamma readings followed the sample container and the area affected was confined to approximately 50 cm², however, in 2 of the 4 areas scanning did not reveal the extent of the affected area precisely. In the final area sampled, the gamma field screening carried out while sampling led staff to believe that the source of the contamination was located in a concrete footing/buttress forming the side wall of the Pressure Relief Pit. Although there are signs of discrete contaminated areas within the 4 Class 1 CUs, the Licensed Area, this area will eventually be designated as the NPD Waste Disposal Facility as a result of the successful In-Situ decommissioning approach which will not only involve the placement of a concrete cap over the facility but will also incorporate an engineered barrier over the area which would isolate any contamination from further precipitation/leaching or escape. Alternatively, these few areas could be remediated further and the source of the contamination and any waste soil/concrete debris be containerised and placed within the NPD facility for In-Situ disposal

Table 3-11, Class 1 CUs Surface Soil Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00336	0.00031	0.00603	0.00288	0.00371	0.02558	0.04009	0.02460	0.01660	0.1000	0.23047
\bar{x}	0.00272	0.00026	0.00381	0.00238	0.00296	0.02223	0.03058	0.01620	0.01413	0.1000	0.20994
95% LCL	0.00207	0.00021	0.00160	0.00189	0.00220	0.01888	0.02107	0.00780	0.01167	0.1000	0.18942
Median	0.00260	0.00020	0.00090	0.00200	0.00220	0.02220	0.01690	0.00830	0.01700	0.1000	0.19574
Std Dev	0.00191	0.00017	0.00865	0.00188	0.00223	0.01331	0.03450	0.02122	0.00859	0.0	0.08479
Std Err	0.00032	0.00002	0.00111	0.00025	0.00037	0.00168	0.00474	0.00408	0.00123	0.0	0.01028
Results > Method Minimum Detection Limit (MDL) (%)											
	0	2	47	4	4	57	28	9	0	0	

Table 3-12, Class 1 CUs, Surface Analyses Results Compared with UCLs Including Hypothesis Testing (One Sample Sign Test).

Radionuclide of Concern (RoC)	BRA \bar{X} (Bqg ⁻¹)	\bar{X} (Bqg ⁻¹)	DCGL ^a (Bqg ⁻¹)	Variation with DCGL (%)	Hypothesis Test Result Sign Test	Hypothesis Test Result WMW (Form 1)	Hypothesis Test Result WMW (Form 2)
Am-241	0.00256	0.00272	0.1	2.8	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Co-60	0.00026	0.00026	0.1	0.3	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Cs-137	0.03085	0.00381	0.1	3.8	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Eu-152	0.00126	0.00238	0.1	2.4	<i>Reject H₀</i>	<i>Reject H₀</i>	<i>Reject H₀</i>
U-235	0.00259	0.00296	1	0.3	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
U-238	0.02138	0.02223	1	2.2	<i>Reject H₀</i>	<i>Reject H₀</i>	<i>Reject H₀</i>
H-3	0.05544	0.03058	100	<0.1	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
C-14	0.01751	0.01620	1	1.6	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Sr-90	0.03000	0.01413	1	1.4	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Tc-99	<0.2000 ^b	<0.1000^b	1	<10	<i>Reject H₀</i>	<i>Unable to perform test as all observations were identical.</i>	

a. Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations.

b. Concentration level reported for Tc-99 represents the Method Minimum Detection Limit (MDL) achieved.

Table 3-13, Class 1 CUs Sub-Surface Soil Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00338	0.00021	0.00196	0.00254	0.00239	0.01974	0.03173	0.02073	0.01909	0.1000	0.18577
\bar{x}	0.00290	0.00018	0.00127	0.00213	0.00180	0.01707	0.02369	0.01506	0.01648	0.1000	0.17622
95% LCL	0.00213	0.00014	0.00058	0.00172	0.00121	0.01440	0.01565	0.00940	0.01386	0.1000	0.16667
Median	0.00250	0.00010	0.00040	0.00190	0.00014	0.01570	0.01330	0.01300	0.02100	0.1000	0.17000
Std Dev	0.00219	0.00012	0.00265	0.00164	0.00169	0.01025	0.02889	0.01341	0.00910	0.0	0.04034
Std Err	0.00038	0.00002	0.00035	0.00020	0.00029	0.00133	0.00401	0.00274	0.00130	0.0	0.00479
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	29	6	1	44	19	10	0	0	

Table 3-14, Class 1 CUs, Sub-Surface Analyses Results Compared with UCLs Including Hypothesis Testing (One Sample Sign Test).

Radionuclide of Concern (RoC)	BRA \bar{X} (Bqg ⁻¹)	\bar{X} (Bqg ⁻¹)	DCGL ^a (Bqg ⁻¹)	Variation with DCGL (%)	Hypothesis Test Result Sign Test	Hypothesis Test Result WMW (Form 1)	Hypothesis Test Result WMW (Form 2)
Am-241	0.00256	0.00290	0.1	2.9	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Co-60	0.00026	0.00018	0.1	0.2	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Cs-137	0.03085	0.00127	0.1	1.3	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Eu-152	0.00126	0.00213	0.1	<0.1	<i>Reject H₀</i>	<i>Reject H₀</i>	<i>Reject H₀</i>
U-235	0.00259	0.00180	1	0.2	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
U-238	0.02138	0.01707	1	1.7	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
H-3	0.05544	0.02369	100	<0.1	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
C-14	0.01751	0.01506	1	1.5	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Sr-90	0.03000	0.01648	1	1.6	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>	N/A
Tc-99	<0.2000 ^b	<0.1000^b	1	<10	<i>Reject H₀</i>	<i>Unable to perform test as all observations were identical.</i>	

a. Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations.

b. Concentration level reported for Tc-99 represents the Method Minimum Detection Limit (MDL) achieved.

3.3 Groundwater Analysis

Groundwater samples were retrieved in accordance with the method described in Section 2.5 following Golder Associates sampling plan [6]. Subsequent RoC analyses were undertaken by Kinetics Inc as described in Section 2.7 and the analytical reports were provided to CNL for acceptance and interpretation [14]. Results were collated, descriptive statistics generated and compiled and the appropriate statistical testing applied using statistical software [18].

Groundwater samples were to be taken from 34 existing monitoring wells/boreholes as specified in the plan [1] and illustrated below in Figure 55, however, only 24 samples were

retrieved, either because the well was dry or could not be located. Although difficult to see from this illustration, in the configuration that the wells existed, of the 24 sampled they are broadly grouped into 4 distinct areas as follows;

- Landfill #1 – **NPD-1, NPD-2, NPD-4, NPD-5, NPD-7, NPD-8**
- Landfill #2 – 2" PVC, **NPD-9, NPD-10, NPD-11, NPD-12, NPD-13, NPD-14**
- NPD Adjacent – MT-8, MT-9, BH-06-01, BH-07-01, BH-09-01, BH-10-01
- Ottawa River Shoreline – MT-5, BH-12-01, BH-13-01, BH-14-01, BH-16-01

Those wells that are highlighted in red above were selected to best represent the background condition as they were sited up-gradient of all potentially impacted areas, subject to soil sample results.

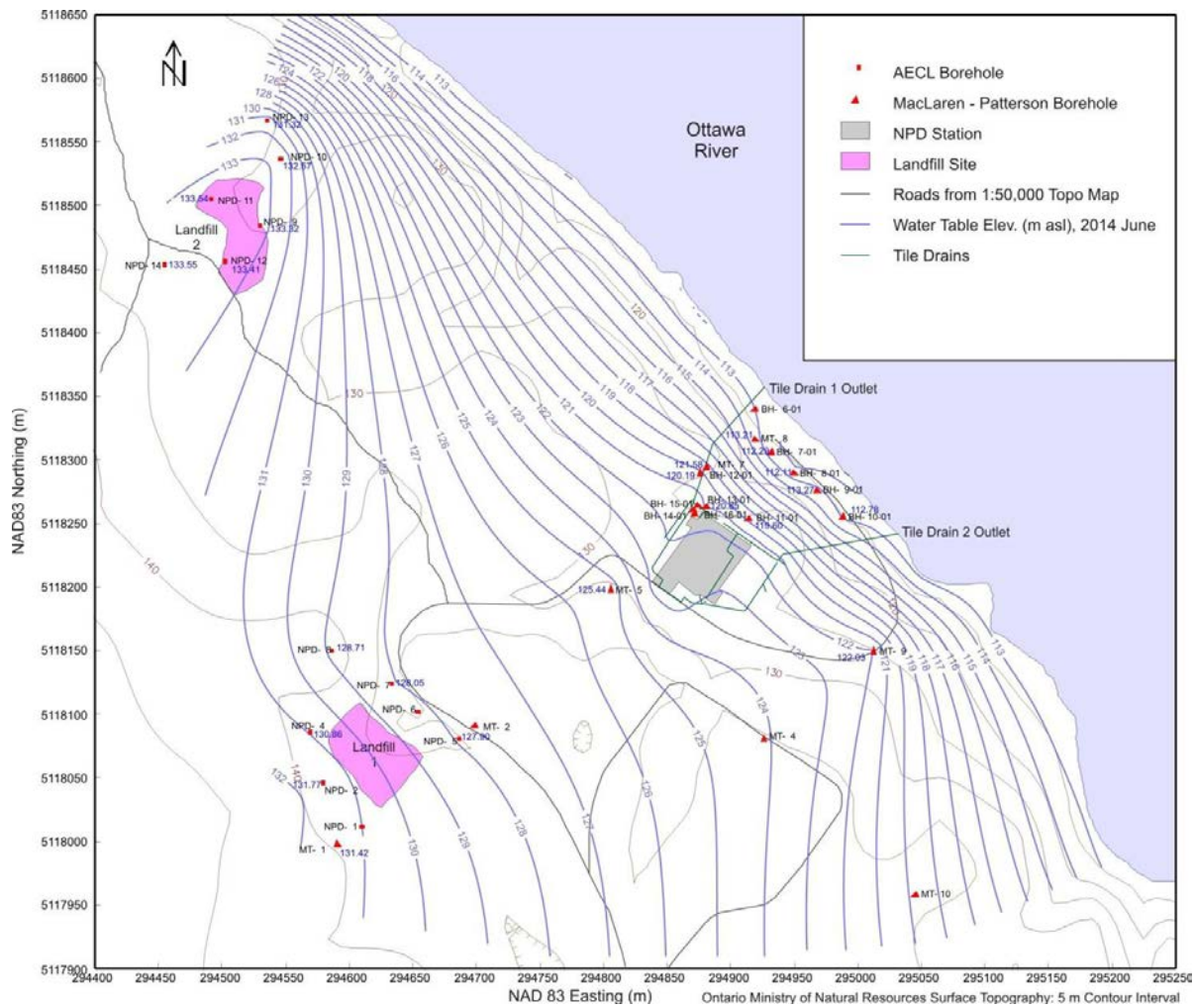


Figure 55 , Planned Groundwater Sampling Locations, Existing Wells.

The aim of the groundwater monitoring decision rule was to establish the 95% and 99% UTL, see Section 3.1.1, at the 90% confidence level for the Background Reference Wells (BRW) sample analysis thereby providing a set of RoC comparators for use against the downgradient samples for both the present decision rule as well as for any future compliance monitoring that may take place, for instance during the period of facility institutional control upon closure. Additionally mean RoC concentrations that exceeded the 99% UTL were compared to appropriate Maximum Acceptable Concentrations (MACs) for drinking water. Table 3-15 below summarises the analyses results providing the mean concentrations and the 99% UTL established for the BRWs, the mean concentrations for the remaining 20 monitoring wells grouped and averaged accordingly, the appropriate MACs and a qualitative comparison column against the MACs for each RoC. The most conservative MACs were obtained from relevant publications in this case, Ontario’s Drinking Water Quality Standards [23], Health Canada’s drinking water quality guideline criteria [24] and for Eu-152, Cl-36 and Ni-63, for which data was not available in Canadian publications, World Health Organisation [25]. Monitoring well results are also considered in Unity using the relevant RoC specific MACs in Table 3-16.

Table 3-15, Groundwater Analysis Results Comparison with Maximum Acceptable Concentrations (MACs).

	BRW (\bar{X})	BRW 99% UTL 90%	Landfill #1 (\bar{X})	Landfill #2 (\bar{X})	Ottawa River Shoreline (\bar{X})	NPD Adjacent (\bar{X})	MAC	Exceeds MAC
RoC	(BqL ⁻¹) ^d							(Y/N)
Am-241	0.058	0.062	0.040	0.032	0.041	0.032	0.2 ^a	X
Co-60	0.352	0.841	0.242	0.226	0.134	0.520	2 ^a	X
Cs-137	0.010	0.143	0.019	0.022	0.015	0.026	10 ^{a,b}	X
Eu-152	0.019	0.019	0.027	0.001	0.053	0.055	100 ^c	X
U-235	0.115	0.115	0.090	0.046	0.109	0.234	4 ^a	X
U-238	0.159	0.234	0.129	0.218	0.123	0.130	4 ^a	X
H-3	7.645	16.700	9.347	16.283	65.600	63.740	7000 ^{a,b}	X
C-14	0.038	0.038	0.038	0.069	0.072	0.035	200 ^a	X

Sr-90	0.0001	0.0001	0.004	0.010	0.009	0.004	5 ^{a,b}	X
Tc-99	0.100	N/A	0.100	0.100	0.100	0.100	200 ^a	X
Cl-36	0.200	0.300	0.460	1.200	1.100	0.600	100 ^c	X
Ni-63	0.486	1.510	0.467	0.325	0.204	0.488	1000 ^c	X

- a. Ontario Reg 169/03 Schedule 3 Radiological Standards [23].
- b. Health Canada, Guidelines for Canadian Drinking Water Quality, Maximum Acceptable Concentrations (MACs) [24].
- c. World Health Organisation (WHO), Guidance Levels for Radionuclides in Drinking Water [25].
- d. For a quick indication, table cells are colour coded green where no benchmark is exceeded or red where either the BRW mean or 95% UTL is exceeded.

Table 3-16, Groundwater Monitoring Results Unity Values.

	Landfill #1	Unity Value ^a	Landfill #2	Unity Value ^a	Ottawa River Shoreline	Unity Value ^a	NPD Facility Adjacent	Unity Value ^a
Monitoring Well Number	NPD-1	0.48	2" PVC	0.12	MT-8	0.02	MT-5	0.09
	NPD-2	0.02	NPD-9	0.23	MT-9	0.59	BH-12-01	0.41
	NPD-4	0.46	NPD-10	0.20	BH-06-01	0.20	BH-13-01	0.41
	NPD-5	0.19	NPD-11	0.54	BH-07-01	0.27	BH-14-01	0.23
	NPD-7	0.03	NPD-12	0.28	BH-09-01	0.29	BH-16-01	1.10
	NPD-8	0.31	NPD-13	0.20	BH-10-01	0.22		
			NPD-14	0.48				

- a. For a quick indication, table cells are colour coded green where the result is below 1 and red where the result exceeds the unity value of 1.

3.4 Riverbed Sediment Sampling and Analysis

The Riverbed characterisation survey was effectively treated in the same manner as the Class 3 and 2 CUs. The CU located upstream of the river outfalls was treated as the Background Reference Area, i.e. not likely impacted by facility operations and the downstream CU then

compared statistically. The Riverbed sediment sample CUs descriptive statistics are summarised below from [16] in Table 3-17 and Table 3-18 and additionally compared with the UCLs in Table 3-19. The outcome of a statistical hypothesis test applied on an RoC by RoC basis was applied as for Class 2 and 3 CUs. The appropriate test determined in the characterisation planning stage comprised two forms of the Wilcoxon Mann-Whitney test as it requires no assumption of the sample distribution. Initially, form 1 of the test was used for all data.

Null hypothesis (H_0): Downstream river sediment population mean is less than or equal to the Upstream sediment concentration mean:

$$H_0: \bar{\mu}_{DS} \leq \bar{\mu}_{US}$$

The alternative hypothesis (H_A) being: Downstream concentration mean is greater than the Upstream concentration mean:

$$H_A: \bar{\mu}_{DS} > \bar{\mu}_{US}$$

Form 2 is used to evaluate the CU in the event that the form 1 H_0 is rejected.

Null Hypothesis (H_0) : Downstream population concentration mean is greater than or equal to the Upstream mean plus a significant difference (SD):

$$H_0: \bar{\mu}_{DS} \geq \bar{\mu}_{US} + SD$$

Alternative Hypothesis (H_A) : Downstream population concentration mean is less than the Upstream mean plus a significant difference (SD):

$$H_A: \bar{\mu}_{DS} < \bar{\mu}_{US} + SD$$

In the case of the Riverbed CUs the null hypothesis was held up for all RoCs [15] (Table 3-19) meaning that the release decision could be made confidently, against the relevant criteria, or in this case that there has not been significant impact on the Ottawa Riverbed sediments from NPD outfall effluents. The results show that form 2 of the WMW test was performed in the case of Co-60, however, the levels were extremely low. The significant difference used for this form was 3 standard deviations of the mean concentration for Co-60 which were derived from the standard deviation of the mean concentrations prior to removal of the non-detect results. Quantile Plots examining RoC distribution are attached at Appendix K for the surface results and scatterplots comparing RoC concentration to UCLs are attached at Appendix L.

Table 3-17, Ottawa River Upstream Sediment Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00535	0.00157	0.02180	0.00307	0.02683	0.02274	0.00697	0.02797	0.04980	0.2000	0.507948
\bar{x}	0.00307	0.00030	0.01398	0.00107	0.00205	0.01525	0.00310	0.01400	0.04175	0.2000	0.43378
95% LCL	0.00078	-0.00097	0.00615	-0.00094	-0.02273	0.00776	-0.00077	0.00003	0.03370	0.2000	0.35961
Median	0.00300	0.00030	0.01600	0.00060	0.00210	0.01200	0.00300	0.01400	0.04000	0.2000	0.43951
Std Dev	0.00218	0.00014	0.00936	0.00081	0.00276	0.00896	0.00243	0.01125	0.00963	0.0	0.08872
Std Err	0.00089	0.00010	0.00331	0.00047	0.00195	0.00317	0.00122	0.00503	0.00341	0.0	0.03137
Results > Method Minimum Detection Limit (MDL) (%)											
	0	0	100	0	0	24	0	6	0	0	

Table 3-18, Ottawa River Downstream Sediment Analyses Results.

Radionuclide of Concern (ROC)											
Statistic	Am-241	Co-60	Cs-137	Eu-152	U-235	U-238	H-3	C-14	Sr-90	Tc-99	Unity ¹
95% UCL	0.00677	0.00074	0.02317	0.00250	0.01329	0.03248	0.00457	0.00851	0.08048	0.2000	0.53208
\bar{x}	0.00257	0.00048	0.01900	0.00110	0.00675	0.02075	0.00242	0.00203	0.05789	0.2000	0.48892
95% LCL	-0.00164	0.00021	0.01483	-0.00030	0.00021	0.00902	0.00026	-0.00445	0.03530	0.2000	0.44576
Median	0.00300	0.00050	0.02000	0.00100	0.00650	0.01650	0.00200	0.00100	0.06600	0.2000	0.49600
Std Dev	0.00169	0.00032	0.00543	0.00113	0.00411	0.01403	0.00206	0.00261	0.02939	0.0	0.05615
Std Err	0.00098	0.00011	0.00181	0.00050	0.00206	0.00496	0.00084	0.00151	0.00980	0.0	0.01872
Results > Method Minimum Detection Limit (MDL)											
(%)											
	0	0	100	0	0	24	0	0	12	0	

Table 3-19, Ottawa River Sediment Analyses Results Compared with UCLs Including Hypothesis Testing (Wilcoxon Mann-Whitney).

Radionuclide of Concern (RoC)	Upstream \bar{X} (Bqg ⁻¹)	Downstream \bar{X} (Bqg ⁻¹)	DCGL ^a (Bqg ⁻¹)	Up'St Var with DCGL (%)	Dn'St Var with DCGL (%)	Hypothesis Test Result (Form 1)	Hypothesis Test Result (Form 2)
Am-241	0.00307	0.00257	0.1	3.1	2.6	<i>Do Not Reject H₀</i>	N/A
Co-60	0.00030	0.00048	0.1	0.3	0.5	<i>Reject H₀</i>	<i>Do Not Reject H₀</i>
Cs-137	0.01398	0.01900	0.1	14	19	<i>Do Not Reject H₀</i>	N/A
Eu-152	0.00107	0.00110	0.1	1.1	1.1	<i>Do Not Reject H₀</i>	N/A
U-235	0.00205	0.00675	1	0.2	0.7	<i>Do Not Reject H₀</i>	N/A
U-238	0.01525	0.02075	1	1.5	2.1	<i>Do Not Reject H₀</i>	N/A
H-3	0.00310	0.00242	100	<0.1	<0.1	<i>Do Not Reject H₀</i>	N/A
C-14	0.01400	0.00203	1	1.4	0.2	<i>Do Not Reject H₀</i>	N/A
Sr-90	0.04175	0.05789	1	4.2	5.8	<i>Do Not Reject H₀</i>	N/A
Tc-99	<0.2000^b	<0.2000^b	1	<20	<20	<i>Unable to perform test as all observations were identical.</i>	

a. Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations.

b. Concentration level reported for Tc-99 represents the Method Minimum Detection Limit (MDL) achieved.

4. CONCLUSION

The characterisation of the NPD Exclusion and Licensed area has been carried out with vigorous scrutiny in an honest and transparent manner. The examination of the data collected, its presentation and interpretation has been completed exhaustively. The data handling was reviewed and verified for technical accuracy and suitability by members of CNL's Environmental Remediation Projects team and the results of their review summarised in a memo [26]. The memo documents any findings, omissions and errors that were minor but duly corrected. It concluded that data handling was in line with the intent of the characterisation plan [1] and met the Data Quality Objectives laid out.

4.1 Class 3 Areas

The Class 3 area of site represents the largest area and arguably the most sensitive to the final decision on release and re-use. Both the results of the gamma scanning and the subsequent soil sampling analysis and statistical testing show that a non-impacted decision can be made with great confidence (95% confidence coefficient). No anomalies were detected that were not easily attributable to a prevalence of NORM and no RoC means approached any concerning levels. The visual output of the scanning surveys are very useful and due to the effective and meaningful way in which the colour contouring was established are of great benefit in demonstrating the results obtained. The Exclusion Zone, the majority of the 380 ha NPD site, has been shown to be free of RoCs in excess of the relevant Unconditional Clearance Levels [8] and in most cases approximately 10 times (or greater) lower. The exception is Cs-137 results which can be attributed to a variation in global distribution due to fallout of fission products from weapons testing. On this basis the radiological impact of the NPD site on the Class 3 Exclusion Zone has been negligible and in any case confined to areas immediately adjacent to the facility.

4.2 Class 2 Areas

The Class 2 area comprised a large area, but one that surrounded the NPD facility intimately, i.e. it was classified Class 2 for greater scrutiny due to the potential for contamination due to activities such as waste storage or equipment maintenance, as well as the potential for leakage and escape of radioactive material from within the Licensed Area. In this way the characterisation of the Class 2 CUs forms an assessment buffer between the Exclusion Area and the Licensed Area, or the areas considered to have the lowest and highest potential risk respectively. The same rigour was applied to the Class 2 CUs, however the reduced physical size of each CU means that the sample density is greater and therefore the level of investigation suits areas of higher potential risk of contamination. Effectively the results of the Class 2 areas match the non-impacted conclusion, with a 95% confidence coefficient, of the Class 3 area. Although 28 sub-surface samples were retrieved, there was no indication of buried radioactive waste or potential radioactive residues/plumes. Except in the cases where the sub-surface samples were specified in the sampling plan [6], it is likely that the elevated gamma scan

readings that initiated their retrieval were due to slightly increased exposure of the detector to NORM, i.e. buried rocks or shallow rock outcroppings. Although the CUs 14, 15 and 16 did warrant further scrutiny they still passed the requirements demanded of the characterisation plan [1] and the criteria for release. Although classified as Class 2, these CUs were still representative of the Exclusion Zone. As concluded for the Class 3 areas, the radiological impact of the NPD site operations on the Exclusion Zone has been negligible and in any case confined to areas immediately adjacent to the facility. The Class 2 portions of the Exclusion Zone, have been shown to be free of RoCs in excess of the relevant Unconditional Clearance Levels [8] and in most cases approximately 10 times (or greater) lower.

4.3 Class 1 Areas

The decision for the Class 1 areas, i.e. the Licensed Area is potentially less onerous than the other areas as some portion at least will remain under Institutional Control for a period of a minimum 100 years post-closure. The statistical testing of the surface/sub-surface sample data was based around this simpler "Presence/Absence" approach but when the results were seen the more rigorous WMW test was applied for speculative interest and to aid decision making should the need arise to minimise the footprint of this area and its impact if at all possible. The scanning coupled with the sample testing located 4 anomalous areas from which positive results for facility contamination were identified, Section 3.2.4. Although there are signs of discrete contaminated areas within the 4 Class 1 CUs, the Licensed Area, this area will eventually be designated as the NPD Waste Disposal Facility as a result of the successful In-Situ decommissioning approach which will not only involve the placement of a concrete cap over the facility but will also incorporate an engineered barrier over the area which would isolate any contamination from further precipitation/leaching or escape. Alternatively, these few areas could be remediated further and the source of the contamination and any waste soil/concrete debris be containerised and placed within the NPD facility for in-situ disposal. The final release of this area is effectively a deferred decision on completion of the period of Institutional Controls but the scanning and sampling results undertaken in the Licensed Area and hence the area covered by the proposed engineered barrier provide good baseline characterisation data.

4.4 Groundwater Monitoring

The assessment of the groundwater monitoring results shows that there is negligible apparent contamination of groundwater at any of the 4 main areas monitored. Although the 99% UTL has been exceeded for several RoCs at several locations the numerical significance is low and all results are at least a single order below the relevant Maximum Acceptable Concentration.

One elevated result of note is that of well BH-16-01 where the results exceeded 1 in unity mainly due to a high result for Co-60, 1.62 Bq l^{-1} which although within 2-sigma of the mean result (0.51 Bq l^{-1}) for the facility adjacent wells, is an anomalous result which should be used for trending.

The highest tritium result (171 Bq l^{-1}) was seen in BH-10-01 although the average result across the shoreline wells was 65 Bq l^{-1} . The previously identified result of 300 Bq l^{-1} seen in BH-13-01 in 2014 [27] was not repeated and the well returned a result of 73 Bq l^{-1} which could be interpreted in several ways, for instance it was a spurious result or a minor tritium plume has passed. The RoC specific results are all summarised in the working spreadsheet [16] and provide a good basis for benchmarking future monitoring results.

4.5 Ottawa Riverbed Sediment

The conclusion for the Ottawa Riverbed Sampling is a fairly simple comparison between the section of the river which lies upstream of the NPD effluent outfalls and the section immediately downstream. The sample analyses show that the effect of the operational output of the facility has been minimal leaving a negligible detectable residual impact.

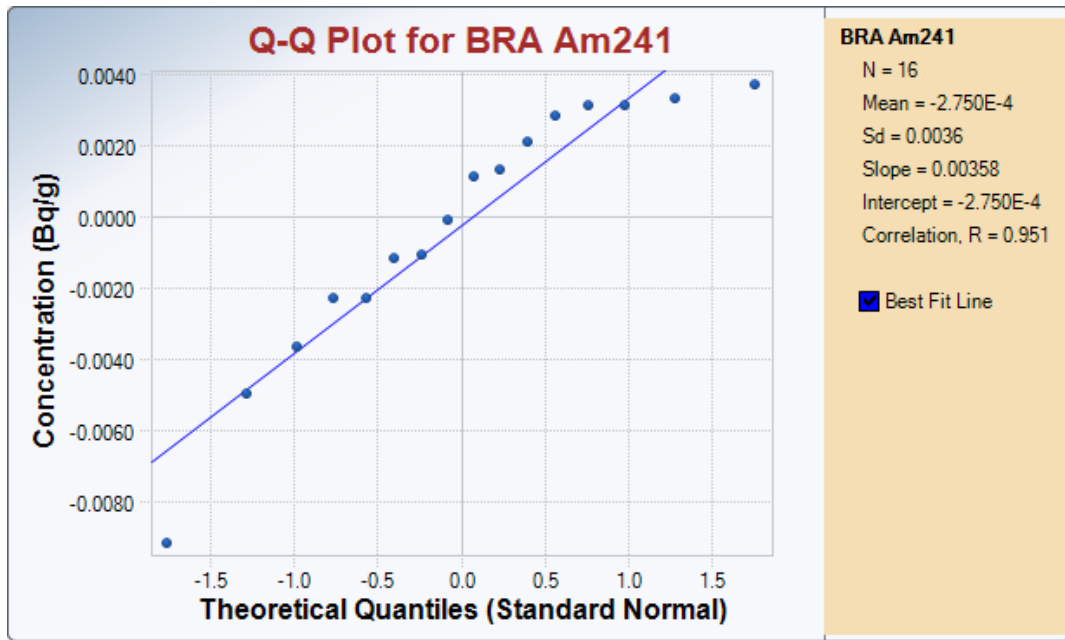
5. REFERENCES

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- [24] Health Canada, Feb 2017, Guidelines for Canadian Drinking Water Quality.
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- [26] 64-509410-036-000-0001, NPD Characterisation Technical Data Review and Verification Summary.
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Appendix A

BRA Quantile Plots and Outlier Tests for Sample Distribution Comparison.



Outlier Tests for Selected Uncensored Variables

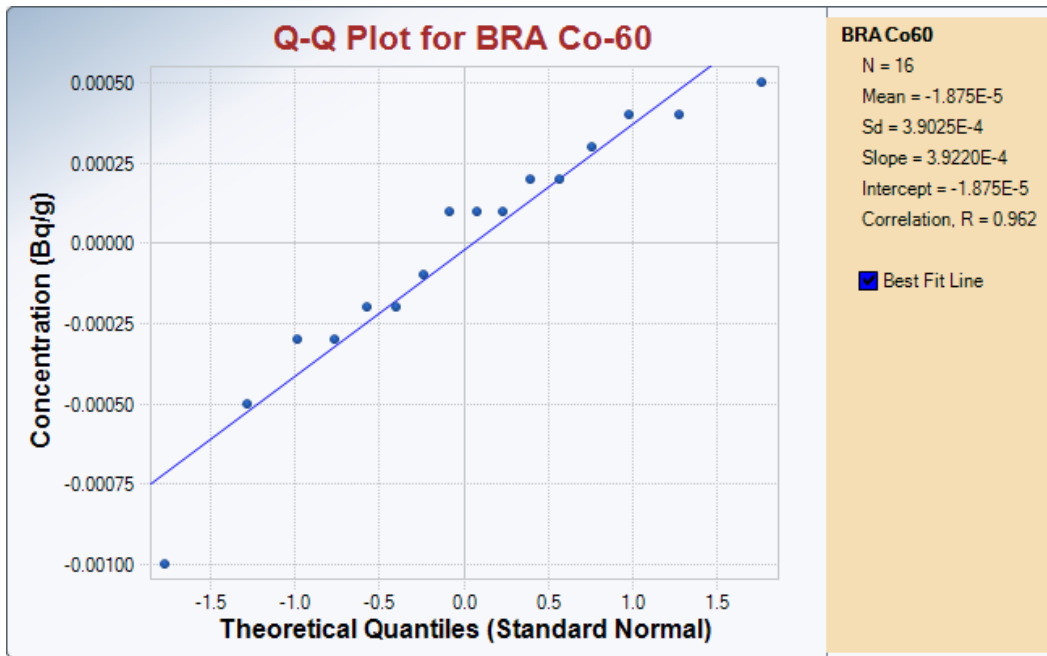
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 Full Precision: OFF

Dixon's Outlier Test for BRA Am241

Number of Observations = 16
 10% critical value: 0.454
 5% critical value: 0.507
 1% critical value: 0.595

1. Observation Value 0.0037 is a Potential Outlier (Upper Tail)?
 Test Statistic: 0.081
 For 10% significance level, 0.0037 is not an outlier.
 For 5% significance level, 0.0037 is not an outlier.
 For 1% significance level, 0.0037 is not an outlier.

2. Observation Value -0.0092 is a Potential Outlier (Lower Tail)?
 Test Statistic: 0.447
 For 10% significance level, -0.0092 is not an outlier.
 For 5% significance level, -0.0092 is not an outlier.
 For 1% significance level, -0.0092 is not an outlier.



Outlier Tests for Selected Uncensored Variables

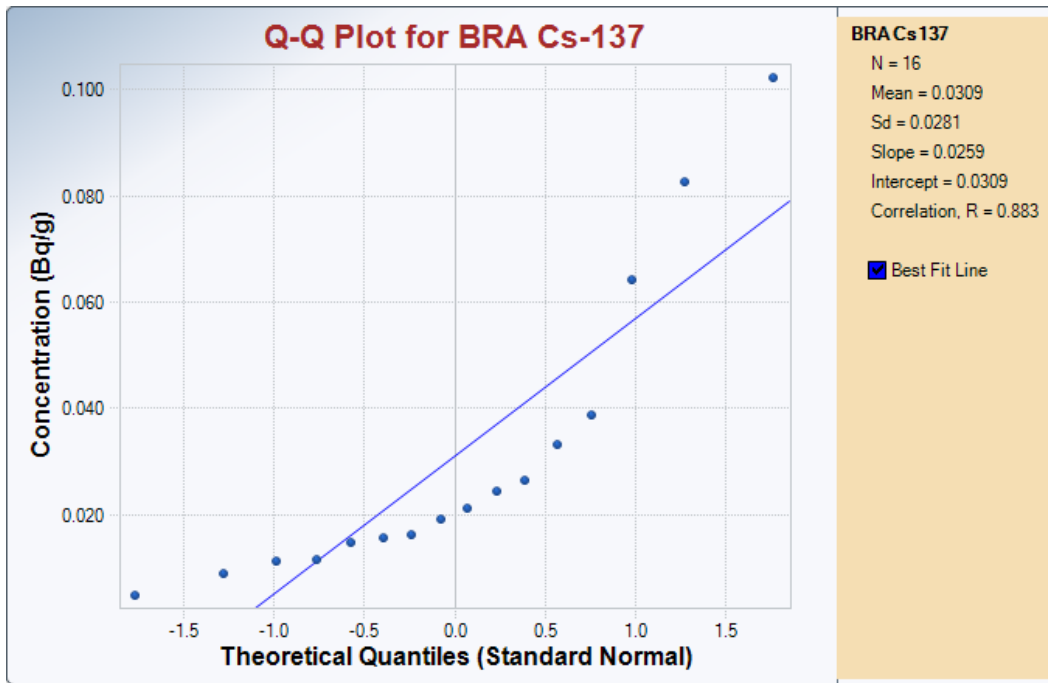
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Full Precision OFF

Dixon's Outlier Test for BRA Co60

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.0005 is a Potential Outlier (Upper Tail)?
Test Statistic: 0.125
For 10% significance level, 0.0005 is not an outlier.
For 5% significance level, 0.0005 is not an outlier.
For 1% significance level, 0.0005 is not an outlier.

2. Observation Value -0.001 is a Potential Outlier (Lower Tail)?
Test Statistic: 0.500
For 10% significance level, -0.001 is an outlier.
For 5% significance level, -0.001 is not an outlier.
For 1% significance level, -0.001 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
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Full Precision OFF

Dixon's Outlier Test for BRA Cs137

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.102 is a Potential Outlier (Upper Tail)?

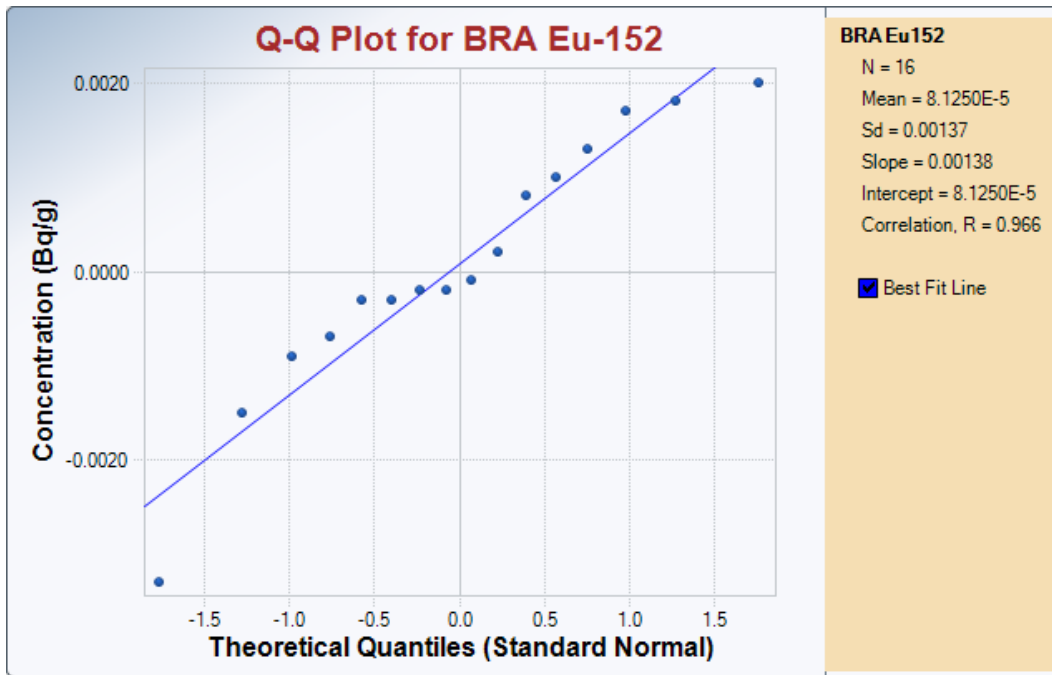
Test Statistic: 0.416

For 10% significance level, 0.102 is not an outlier.
For 5% significance level, 0.102 is not an outlier.
For 1% significance level, 0.102 is not an outlier.

2. Observation Value 0.0048 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.108

For 10% significance level, 0.0048 is not an outlier.
For 5% significance level, 0.0048 is not an outlier.
For 1% significance level, 0.0048 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
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Dixon's Outlier Test for BRA Eu152

Number of Observations = 16
 10% critical value: 0.454
 5% critical value: 0.507
 1% critical value: 0.595

1. Observation Value 0.002 is a Potential Outlier (Upper Tail)?

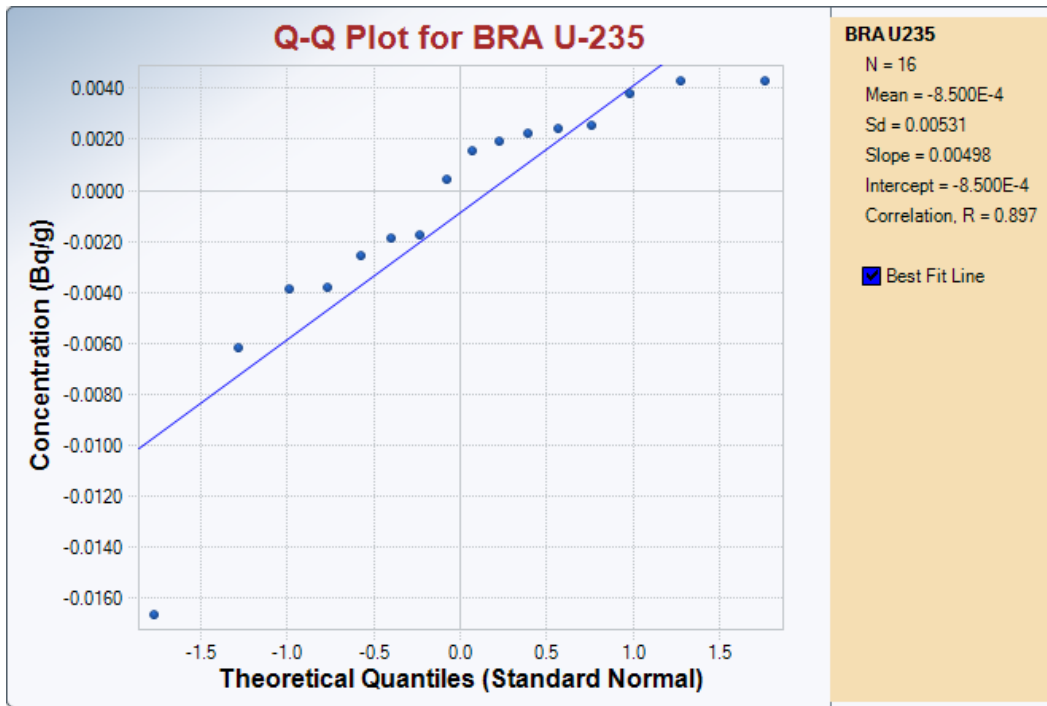
Test Statistic: 0.103

For 10% significance level, 0.002 is not an outlier.
 For 5% significance level, 0.002 is not an outlier.
 For 1% significance level, 0.002 is not an outlier.

2. Observation Value -0.0033 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.480

For 10% significance level, -0.0033 is an outlier.
 For 5% significance level, -0.0033 is not an outlier.
 For 1% significance level, -0.0033 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.12017/12/05 1:35:25 PM
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Dixon's Outlier Test for BRA U235

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.0043 is a Potential Outlier (Upper Tail)?

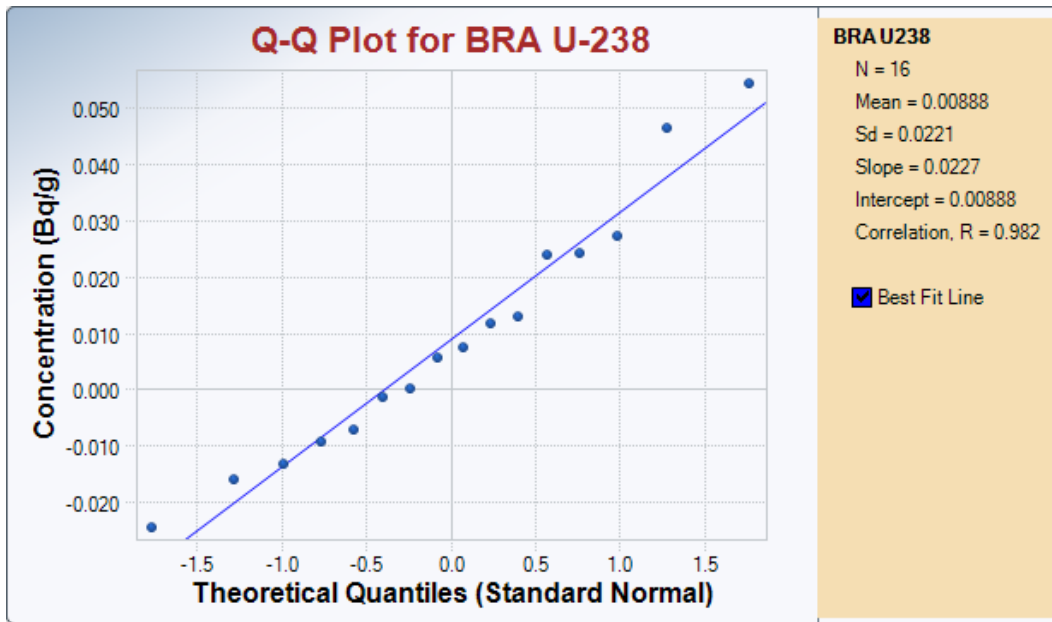
Test Statistic: 0.061

For 10% significance level, 0.0043 is not an outlier.
For 5% significance level, 0.0043 is not an outlier.
For 1% significance level, 0.0043 is not an outlier.

2. Observation Value -0.0167 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.624

For 10% significance level, -0.0167 is an outlier.
For 5% significance level, -0.0167 is an outlier.
For 1% significance level, -0.0167 is an outlier.



Outlier Tests for Selected Uncensored Variables

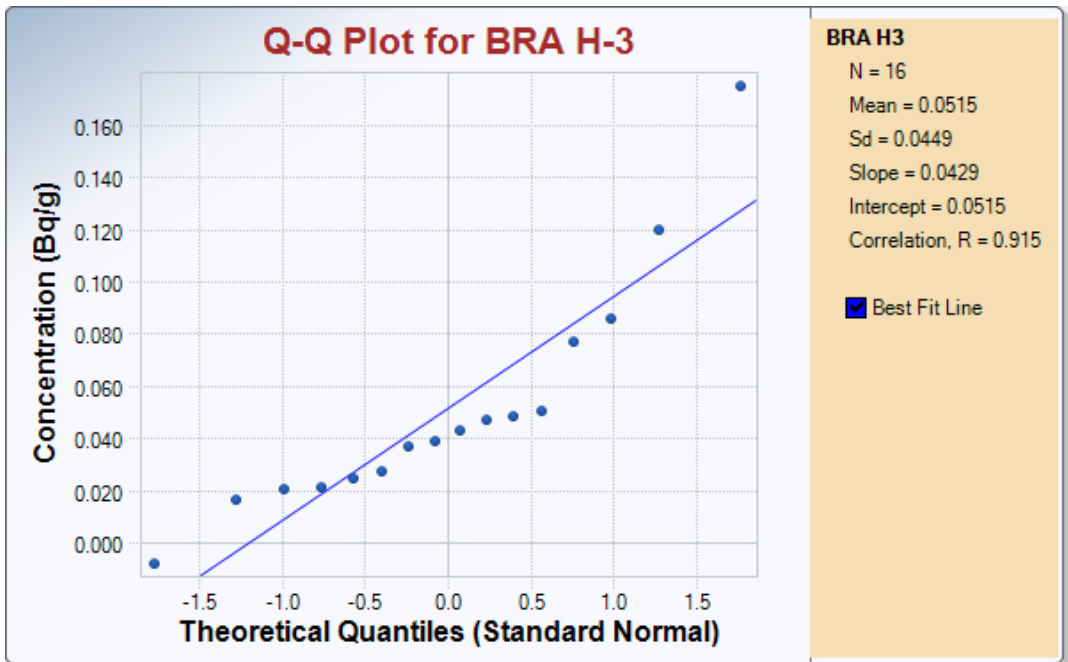
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Dixon's Outlier Test for BRA U238

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.0545 is a Potential Outlier (Upper Tail)?
Test Statistic: 0.401
For 10% significance level, 0.0545 is not an outlier.
For 5% significance level, 0.0545 is not an outlier.
For 1% significance level, 0.0545 is not an outlier.

2. Observation Value -0.0247 is a Potential Outlier (Lower Tail)?
Test Statistic: 0.219
For 10% significance level, -0.0247 is not an outlier.
For 5% significance level, -0.0247 is not an outlier.
For 1% significance level, -0.0247 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
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Dixon's Outlier Test for BRA H3

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.175 is a Potential Outlier (Upper Tail)?

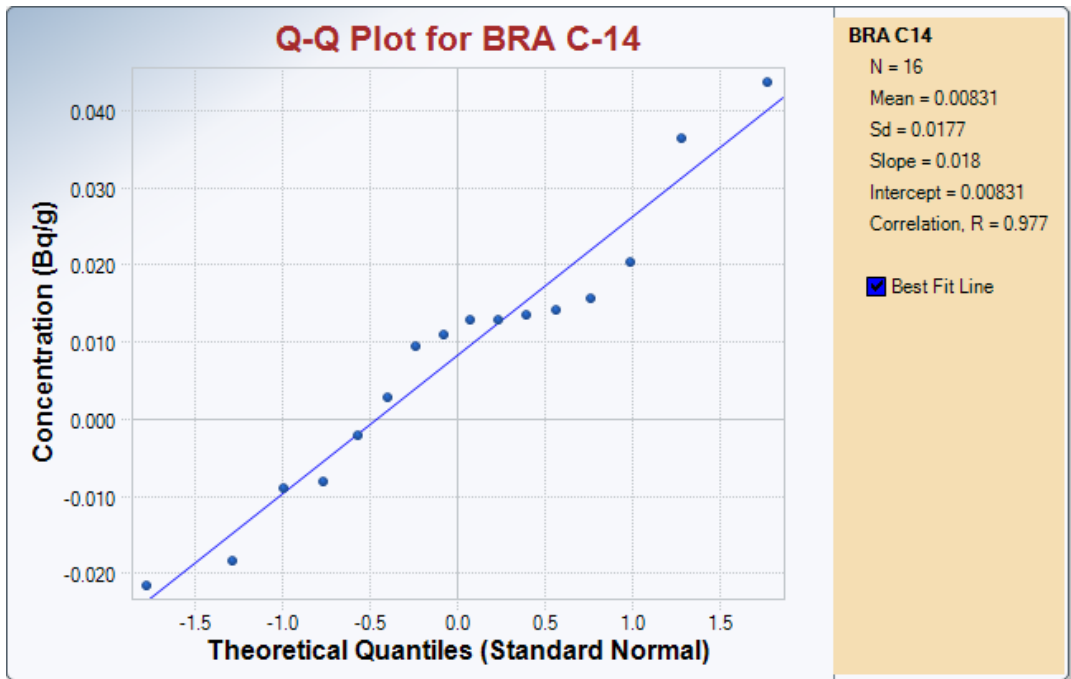
Test Statistic: 0.579

For 10% significance level, 0.175 is an outlier.
For 5% significance level, 0.175 is an outlier.
For 1% significance level, 0.175 is not an outlier.

2. Observation Value -0.00829 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.307

For 10% significance level, -0.00829 is not an outlier.
For 5% significance level, -0.00829 is not an outlier.
For 1% significance level, -0.00829 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
Date/Time of Computation ProUCL 5.12017/12/05 1:58:21 PM
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Dixon's Outlier Test for BRA C14

Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

1. Observation Value 0.0437 is a Potential Outlier (Upper Tail)?

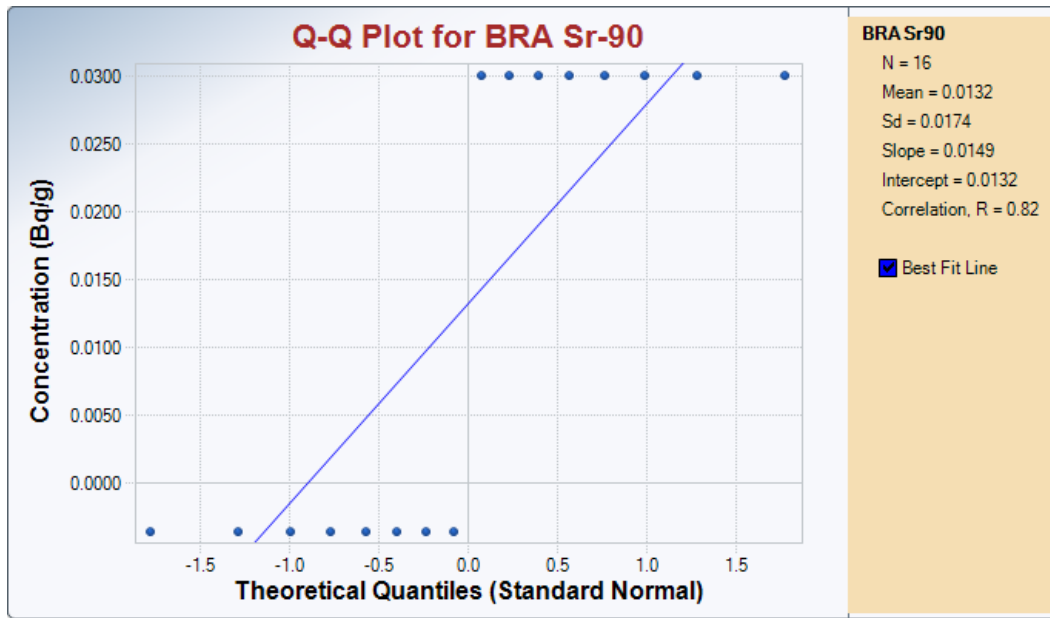
Test Statistic: 0.441

For 10% significance level, 0.0437 is not an outlier.
For 5% significance level, 0.0437 is not an outlier.
For 1% significance level, 0.0437 is not an outlier.

2. Observation Value -0.0217 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.299

For 10% significance level, -0.0217 is not an outlier.
For 5% significance level, -0.0217 is not an outlier.
For 1% significance level, -0.0217 is not an outlier.



Outlier Tests for Selected Uncensored Variables

User Selected Options
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Dixon's Outlier Test for BRA Sr90

Number of Observations = 16
 10% critical value: 0.454
 5% critical value: 0.507
 1% critical value: 0.595

1. Observation Value 0.03 is a Potential Outlier (Upper Tail)?

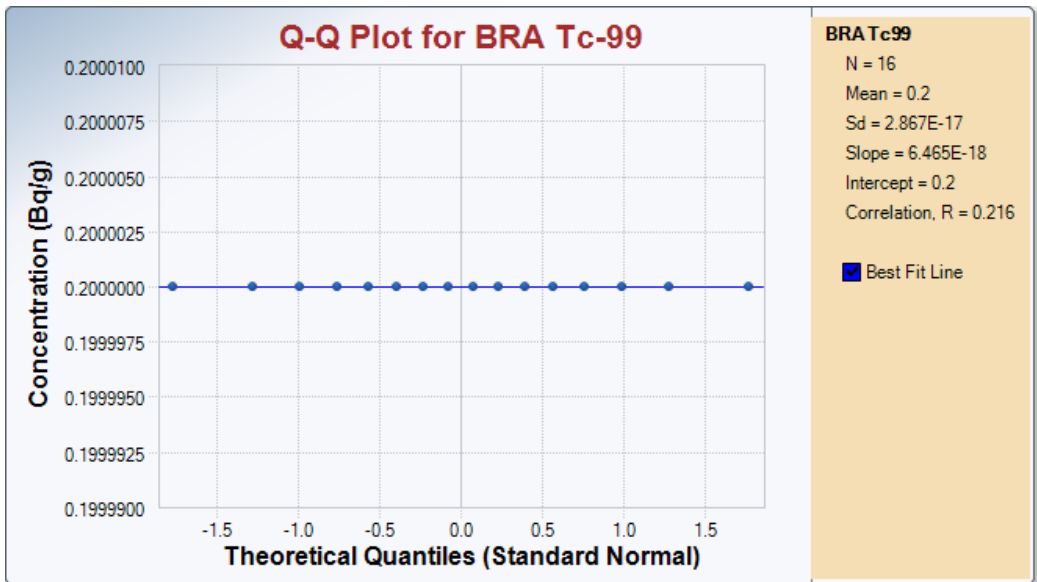
Test Statistic: 0.000

For 10% significance level, 0.03 is not an outlier.
 For 5% significance level, 0.03 is not an outlier.
 For 1% significance level, 0.03 is not an outlier.

2. Observation Value -0.0036 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.000

For 10% significance level, -0.0036 is not an outlier.
 For 5% significance level, -0.0036 is not an outlier.
 For 1% significance level, -0.0036 is not an outlier.



Outlier Tests for Selected Uncensored Variables

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Dixon's Outlier Test for BRA Tc99

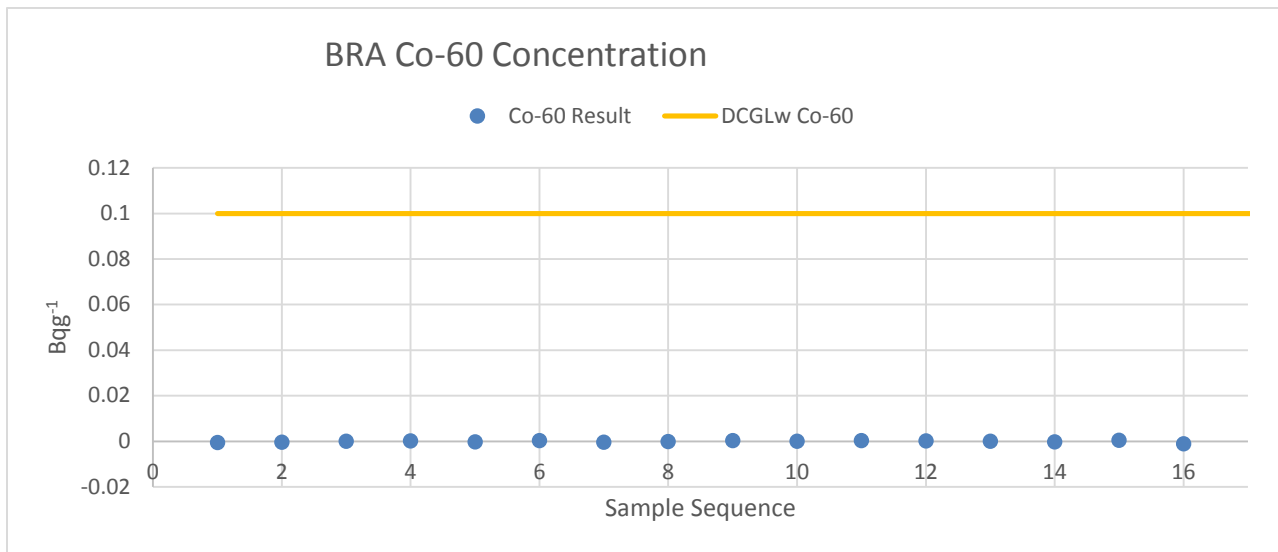
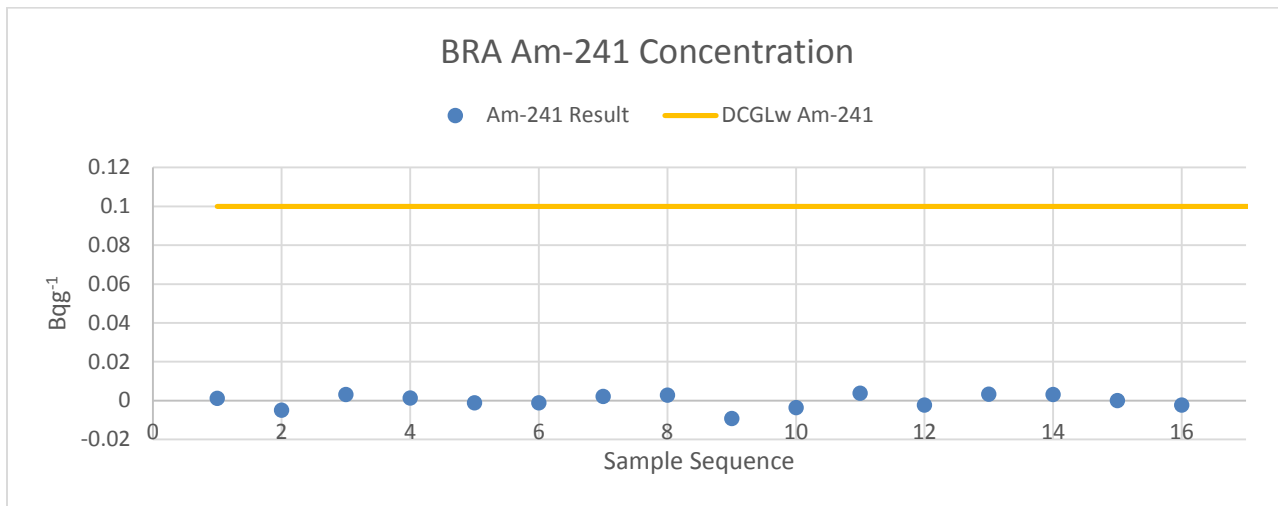
Number of Observations = 16
10% critical value: 0.454
5% critical value: 0.507
1% critical value: 0.595

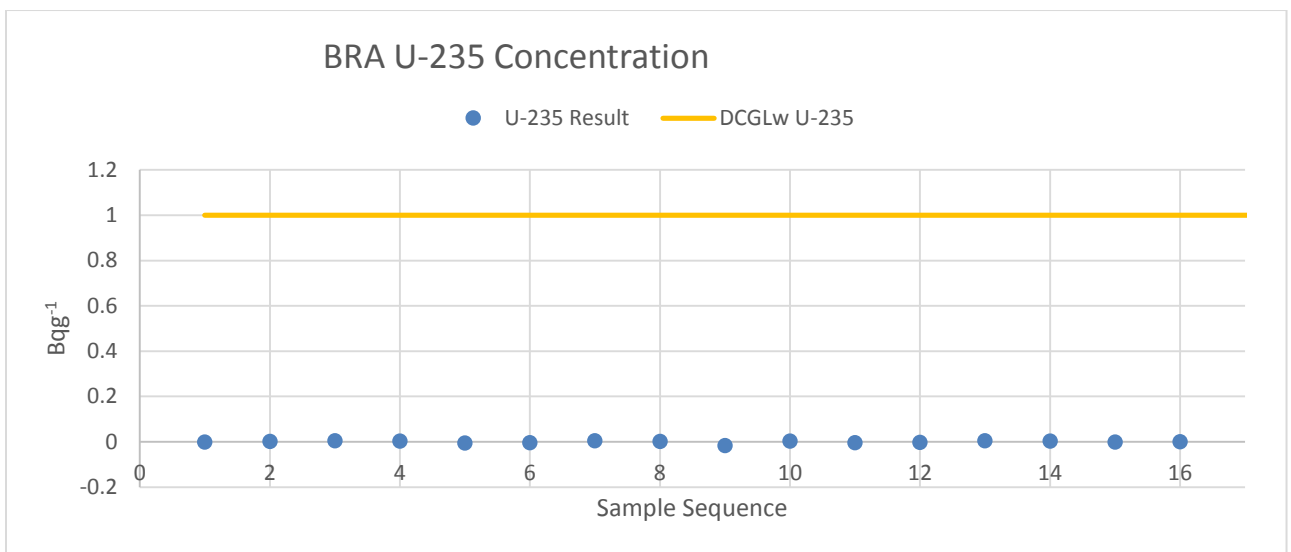
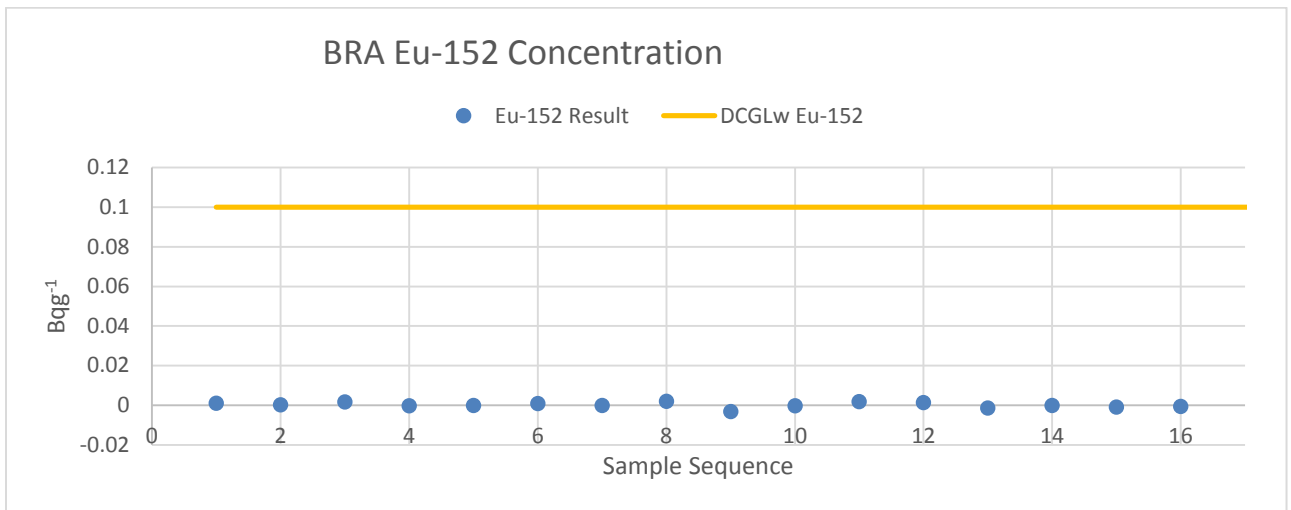
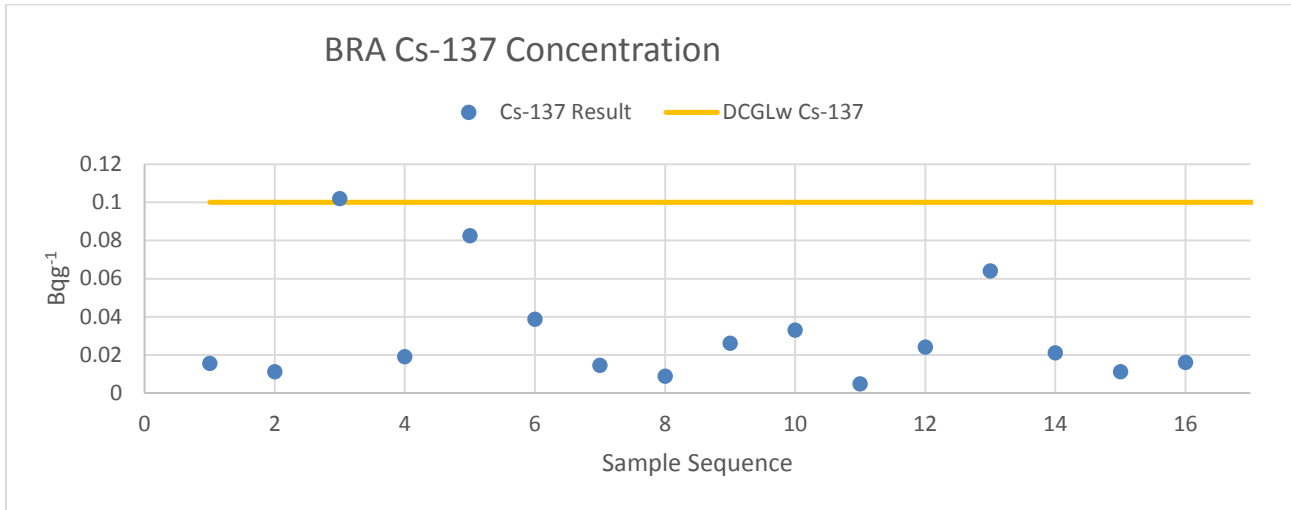
1. Observation Value 0.2 is a Potential Outlier (Upper Tail)?
Test Statistic: NaN
For 10% significance level, 0.2 is an outlier.
For 5% significance level, 0.2 is an outlier.
For 1% significance level, 0.2 is an outlier.

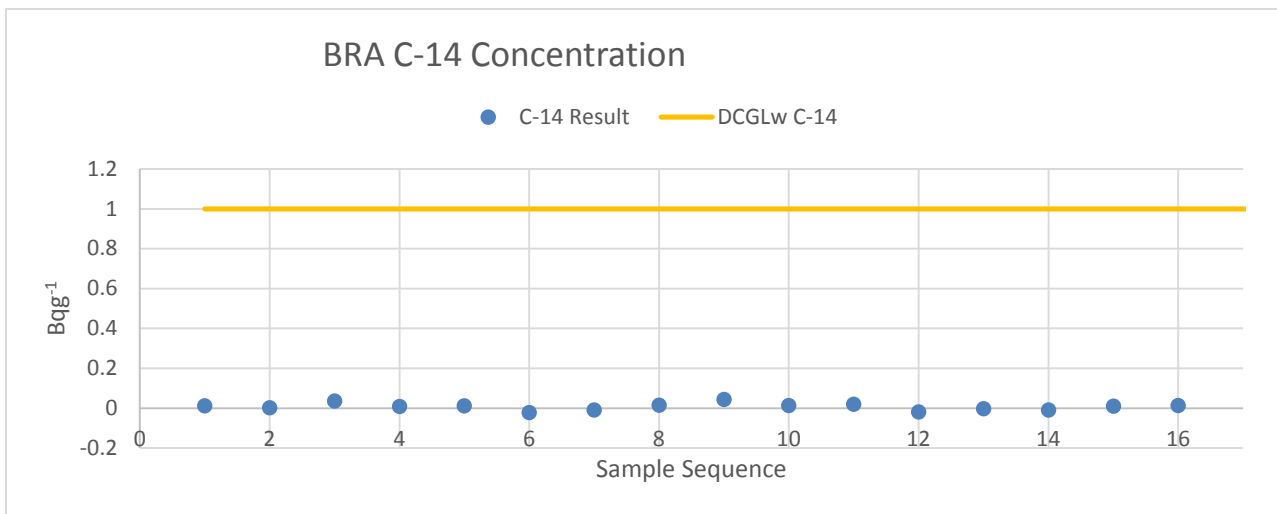
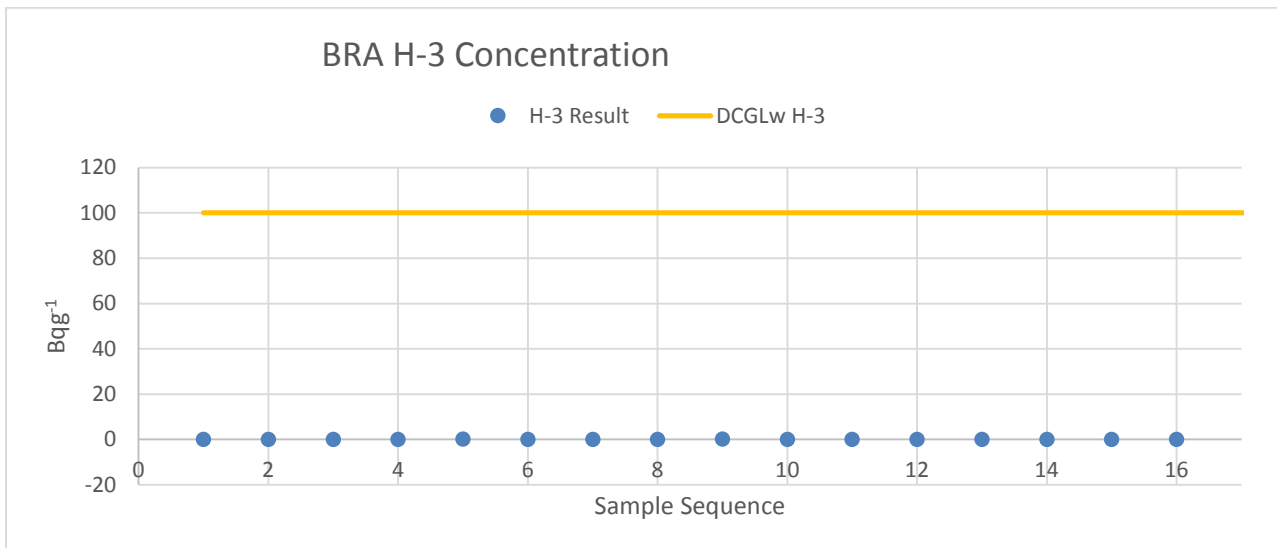
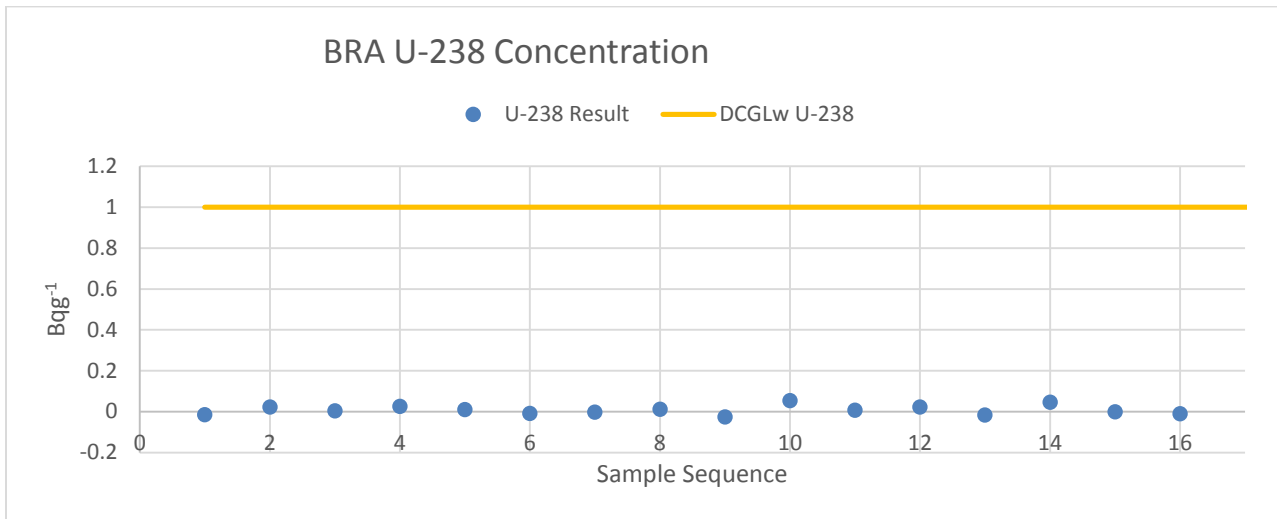
2. Observation Value 0.2 is a Potential Outlier (Lower Tail)?
Test Statistic: NaN
For 10% significance level, 0.2 is an outlier.
For 5% significance level, 0.2 is an outlier.
For 1% significance level, 0.2 is an outlier.

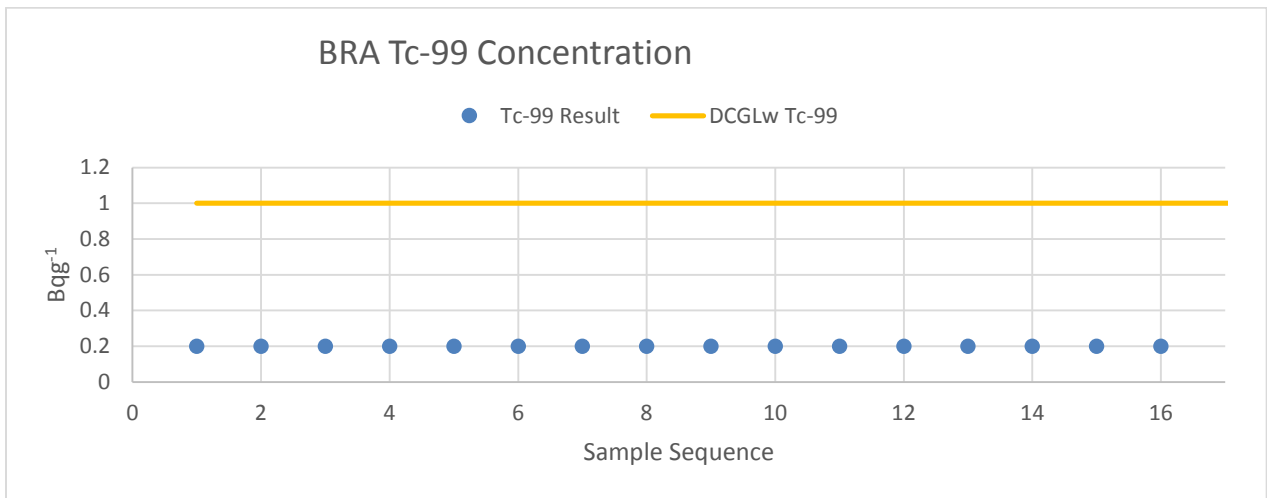
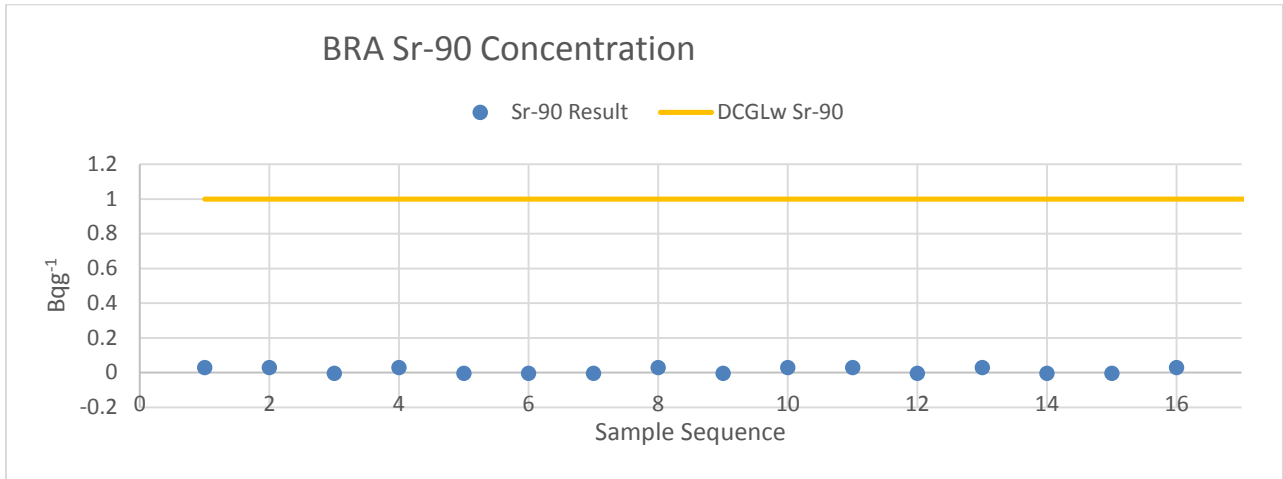
Appendix B

BRA Scatter Plots for Sample Concentration Comparison with UCLs.



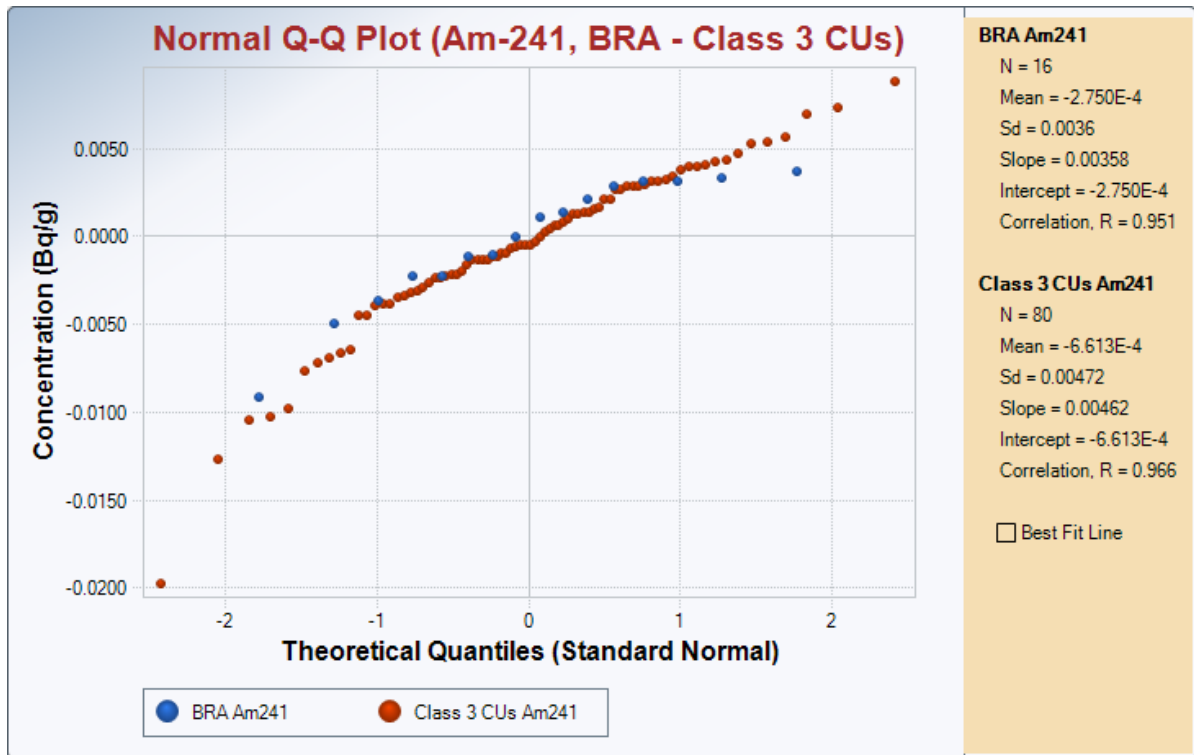


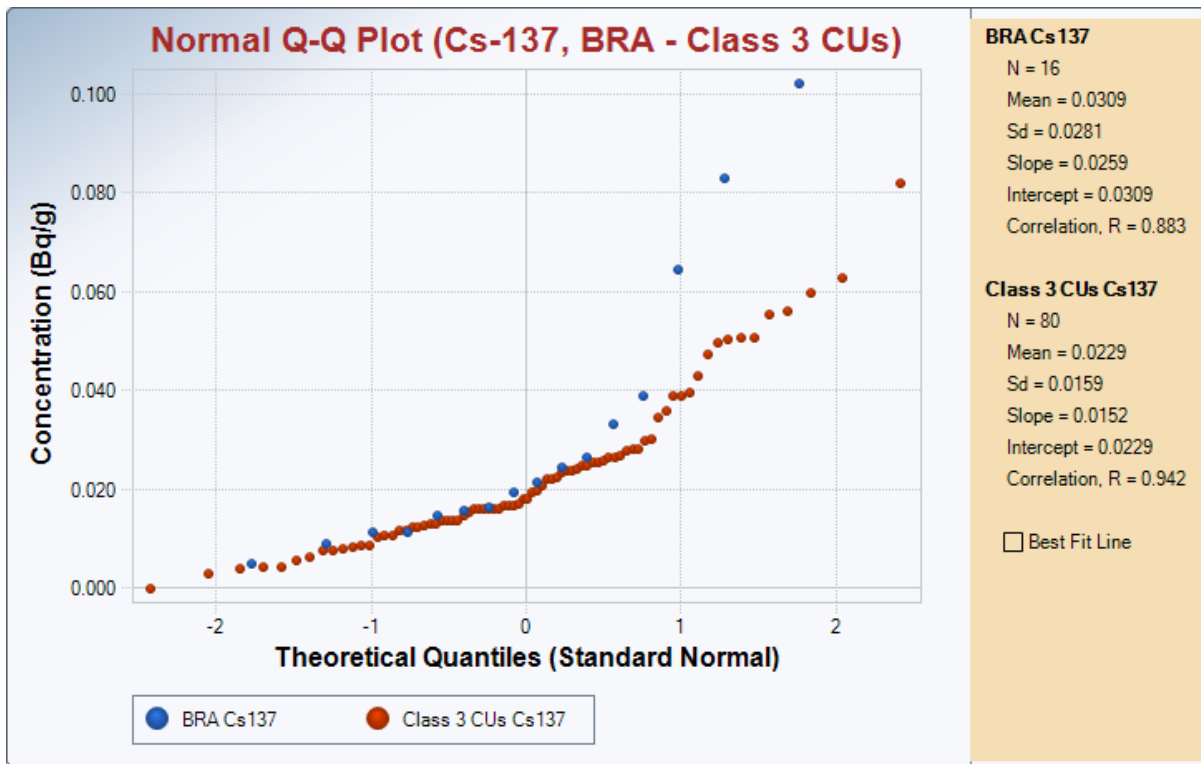
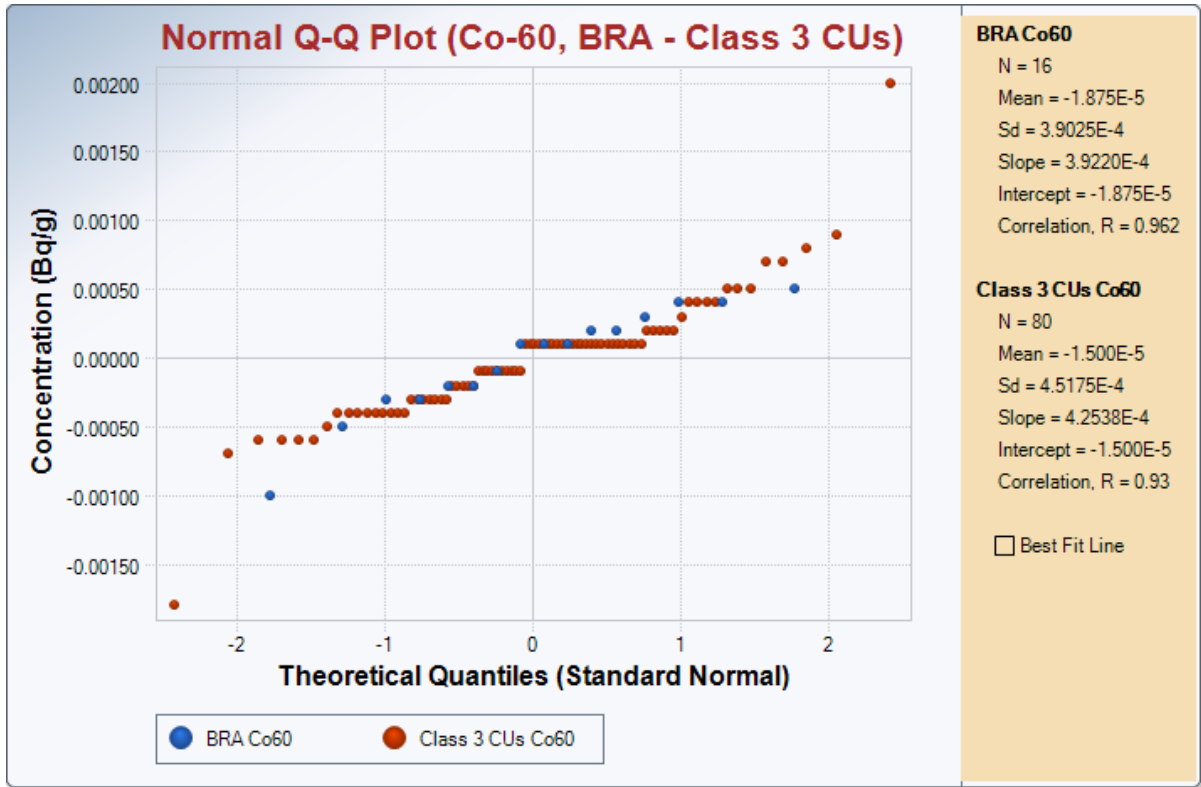


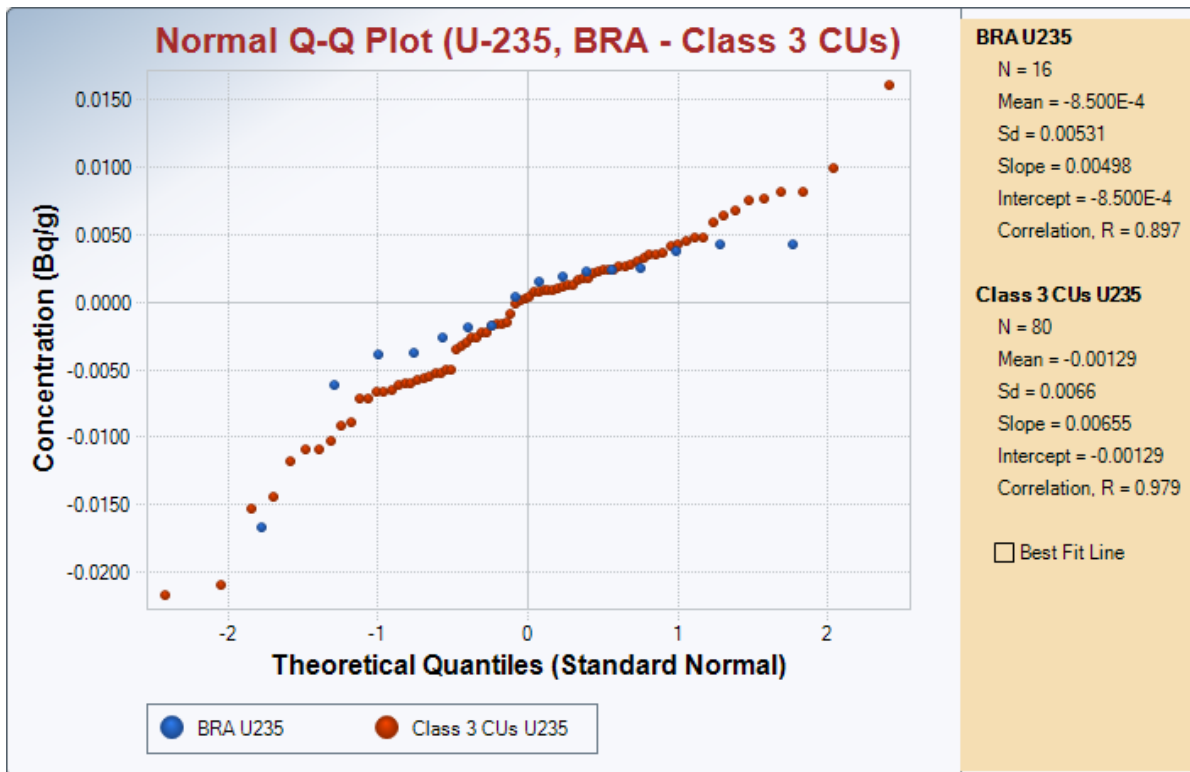
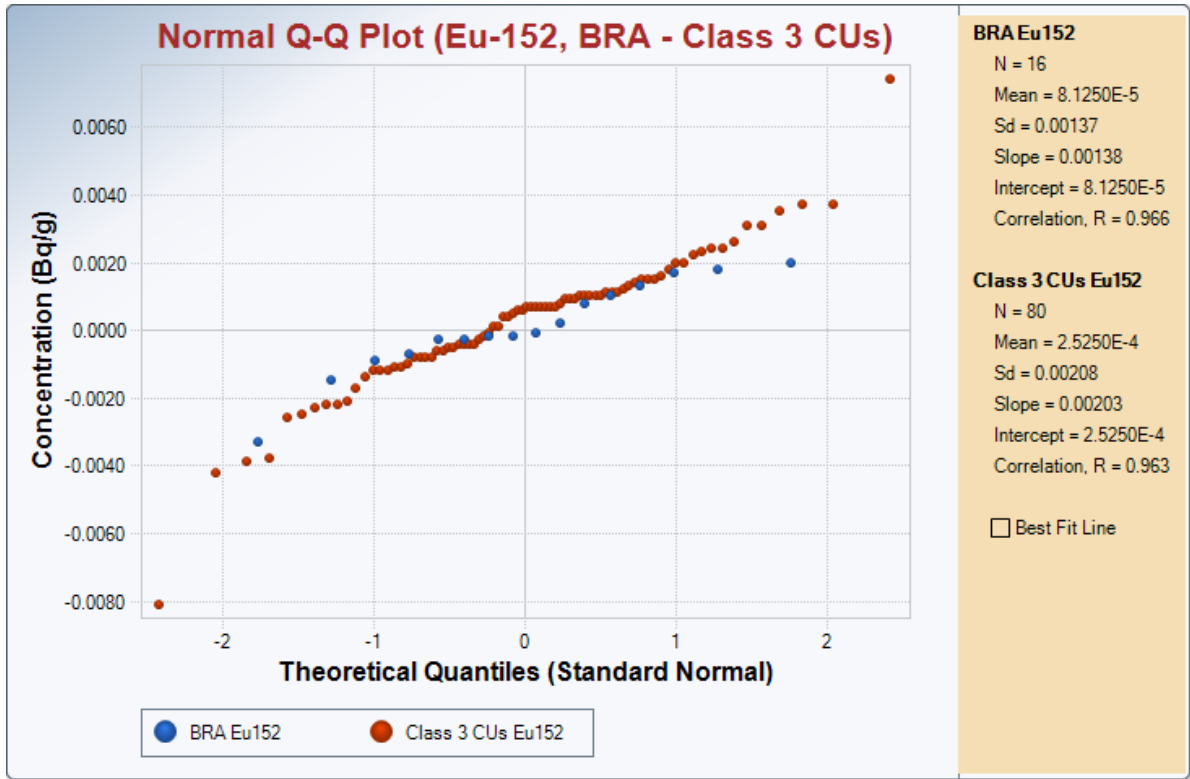


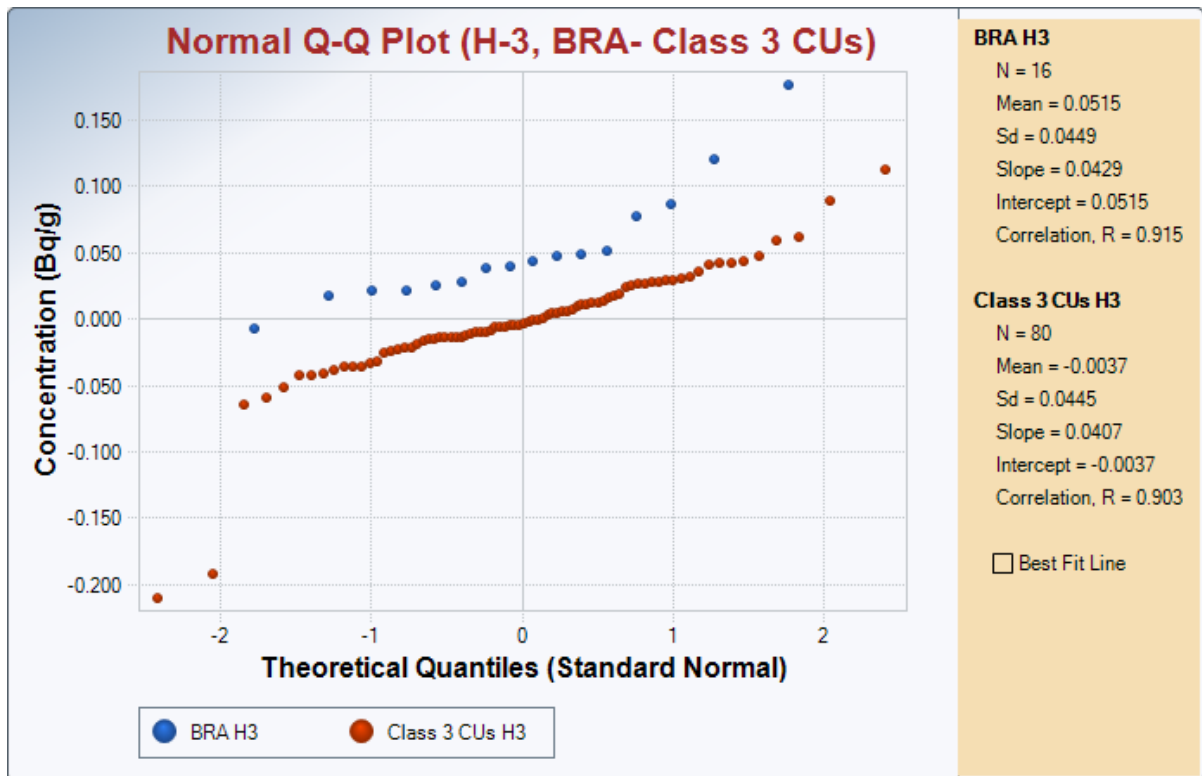
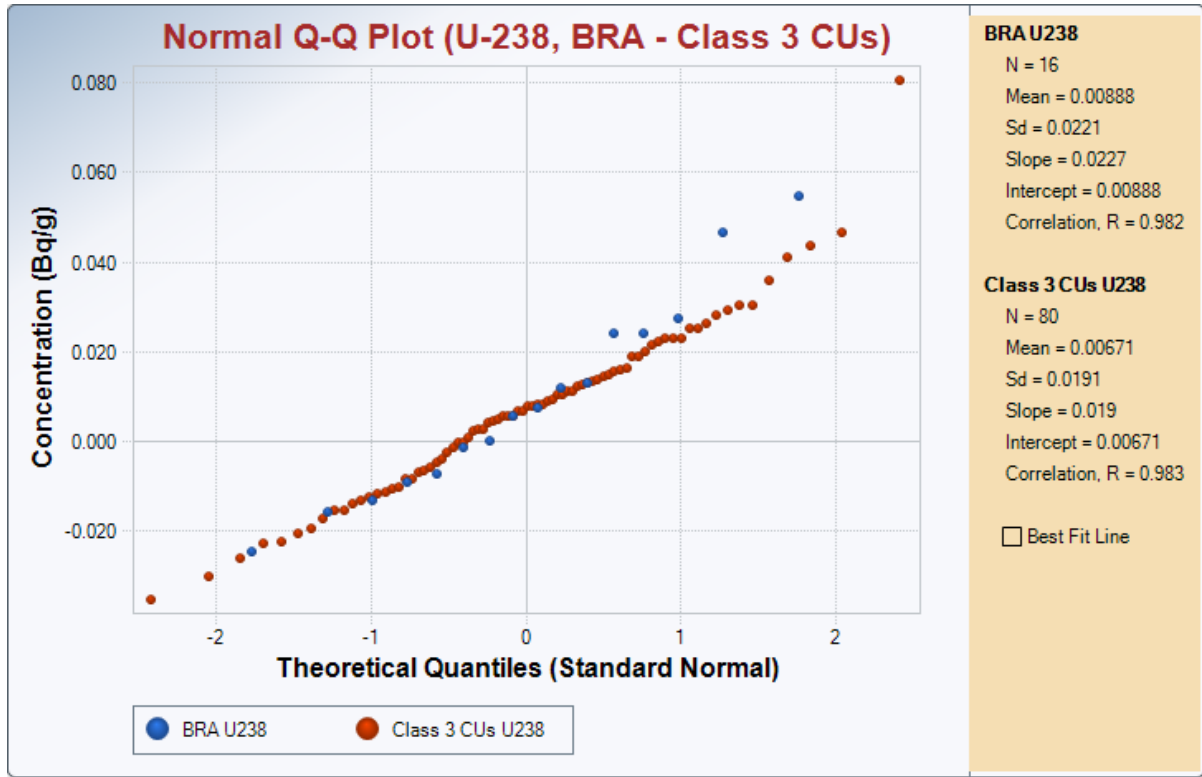
Appendix C

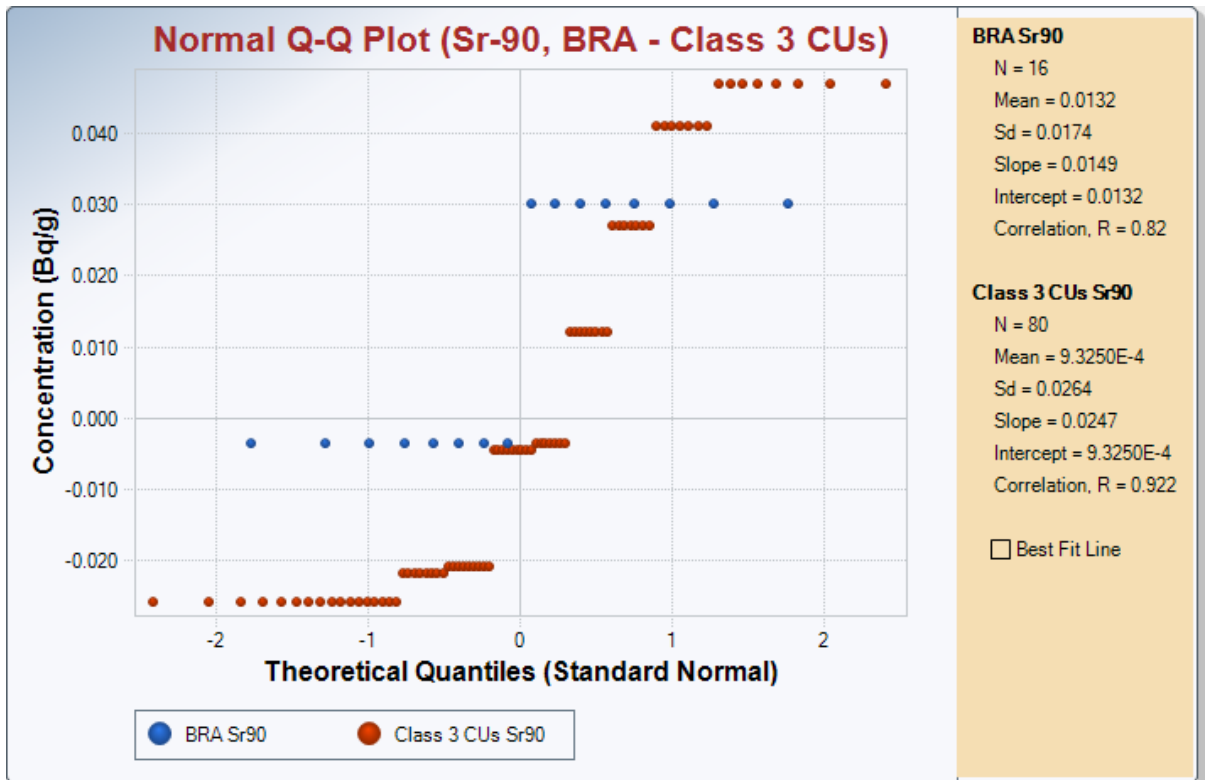
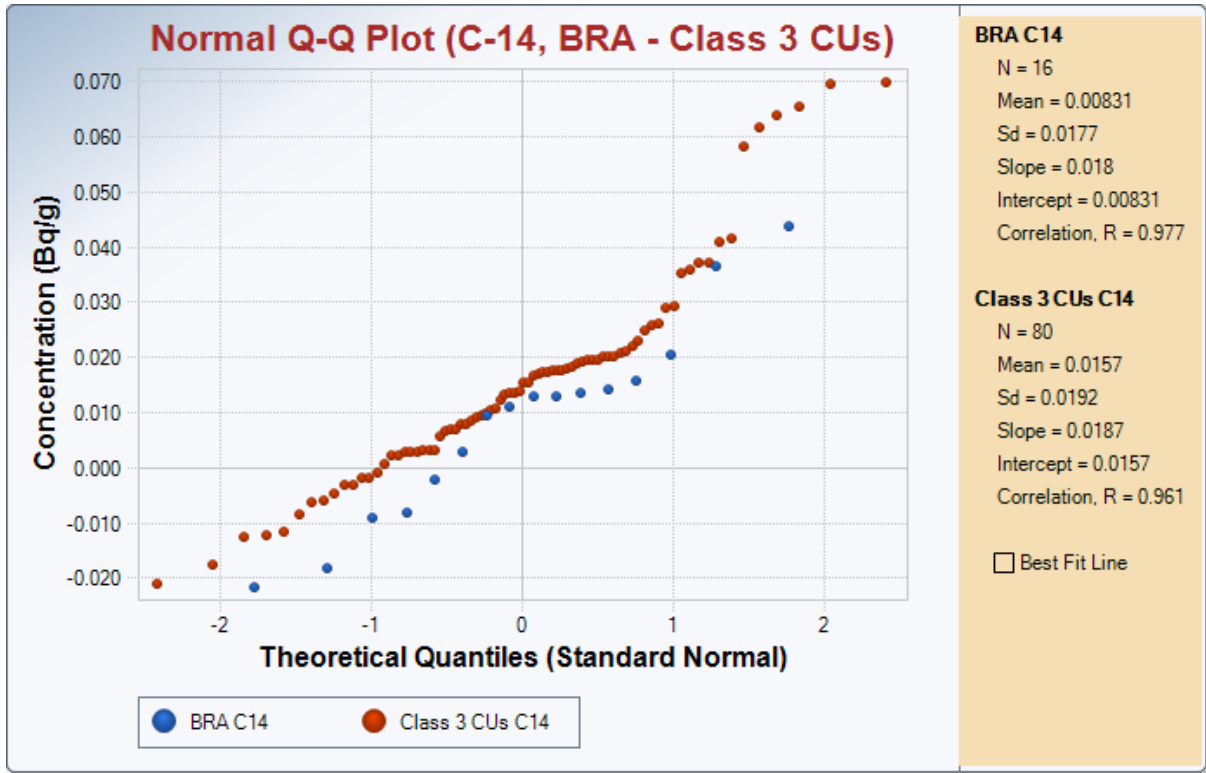
Class 3 CUs Quantile Plots for Sample Distribution Comparison (Surface).

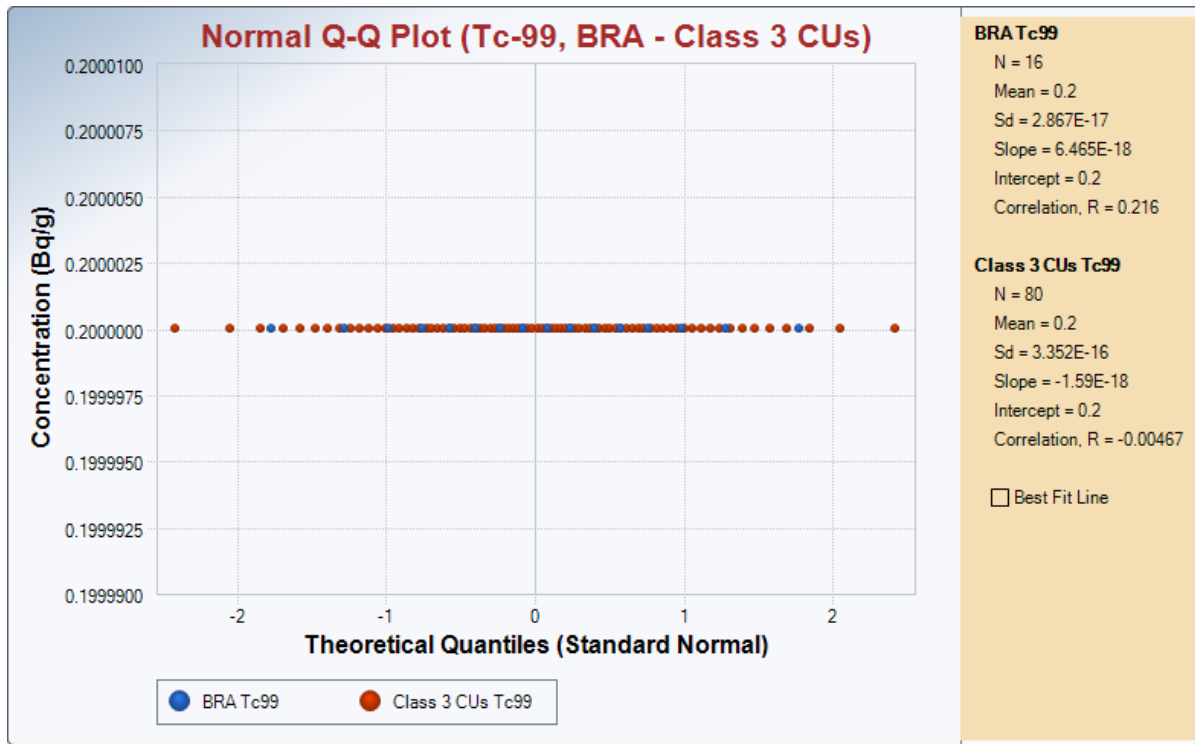






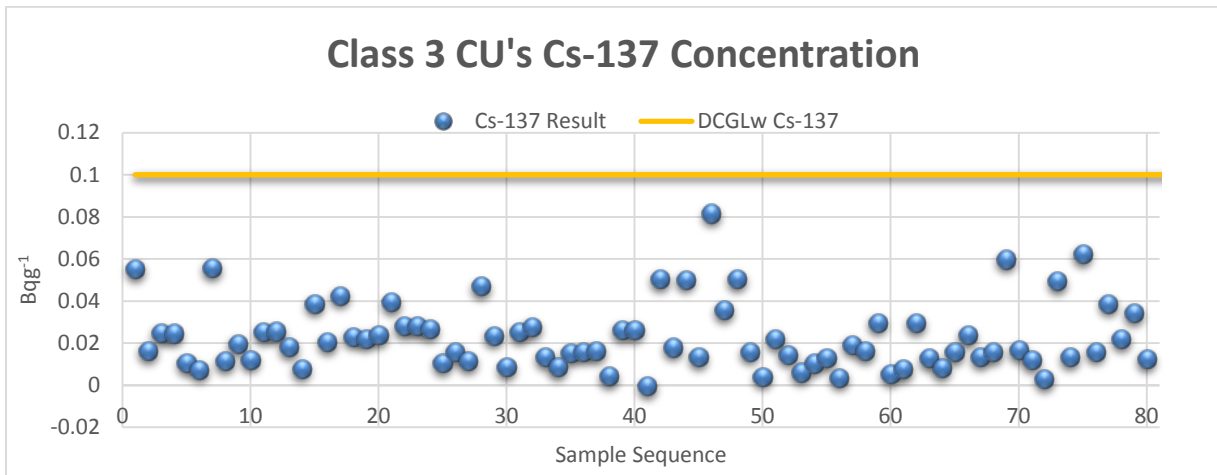
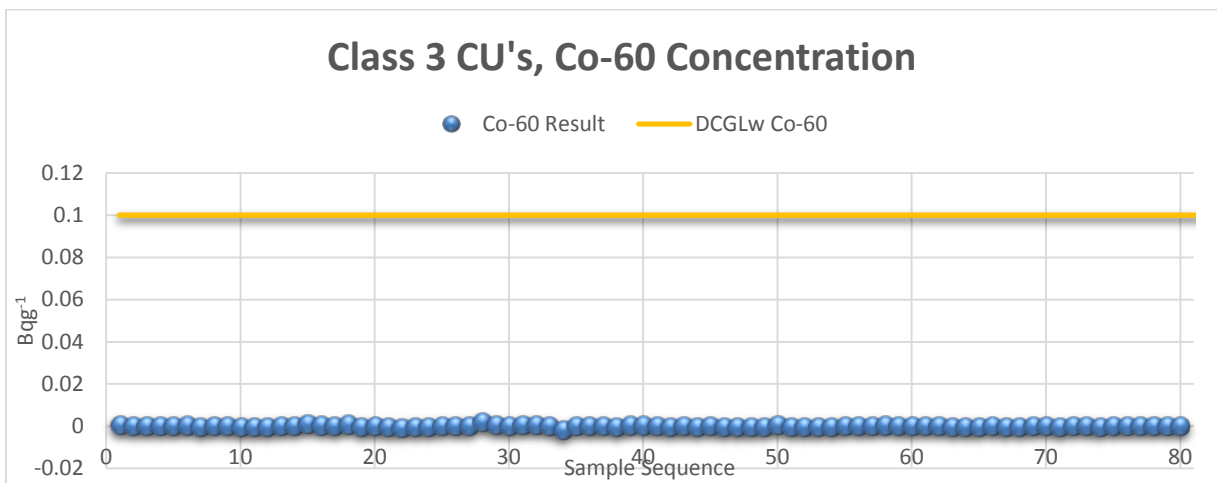
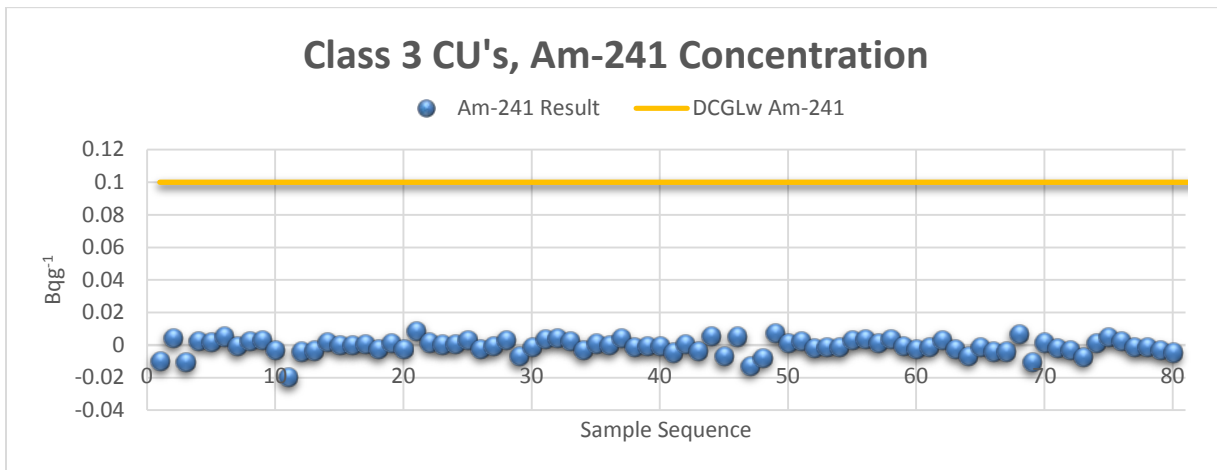


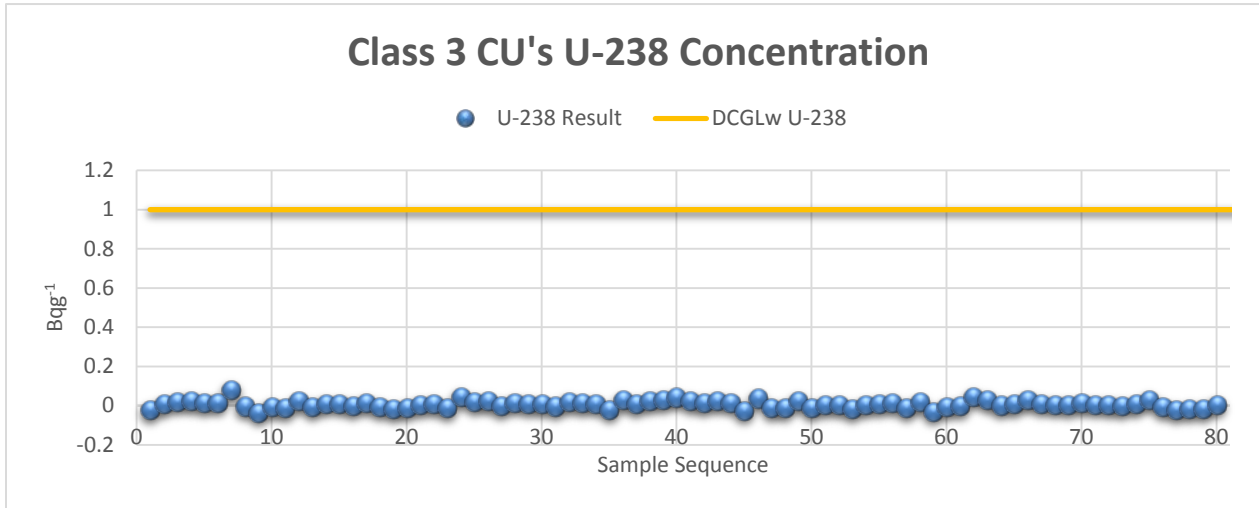
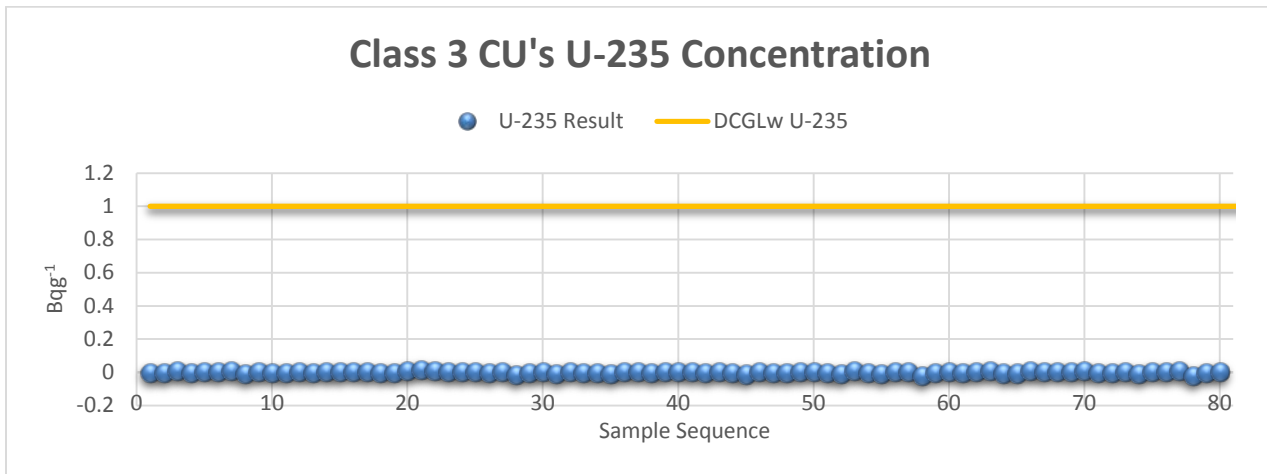
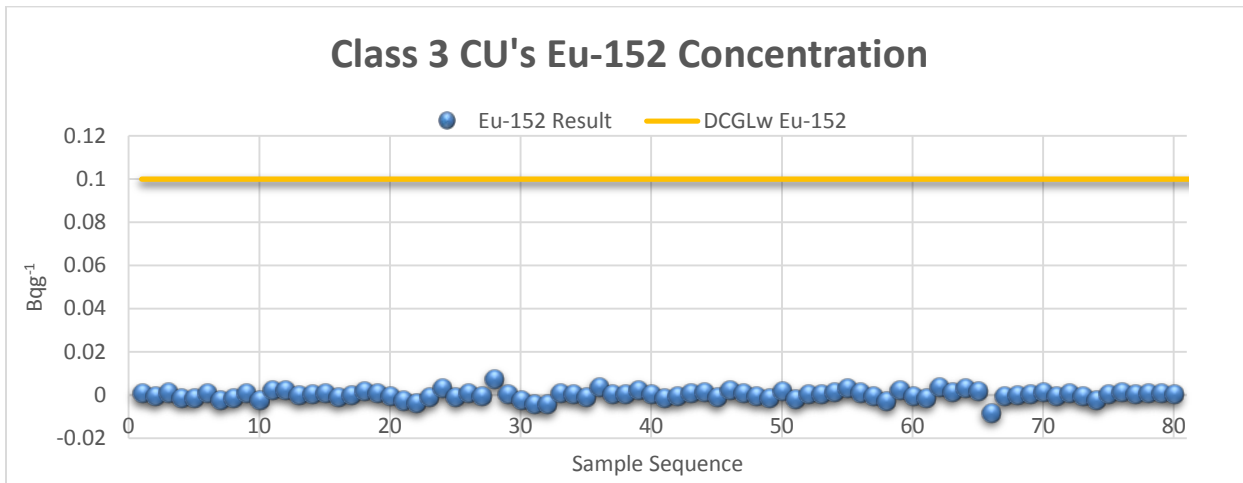


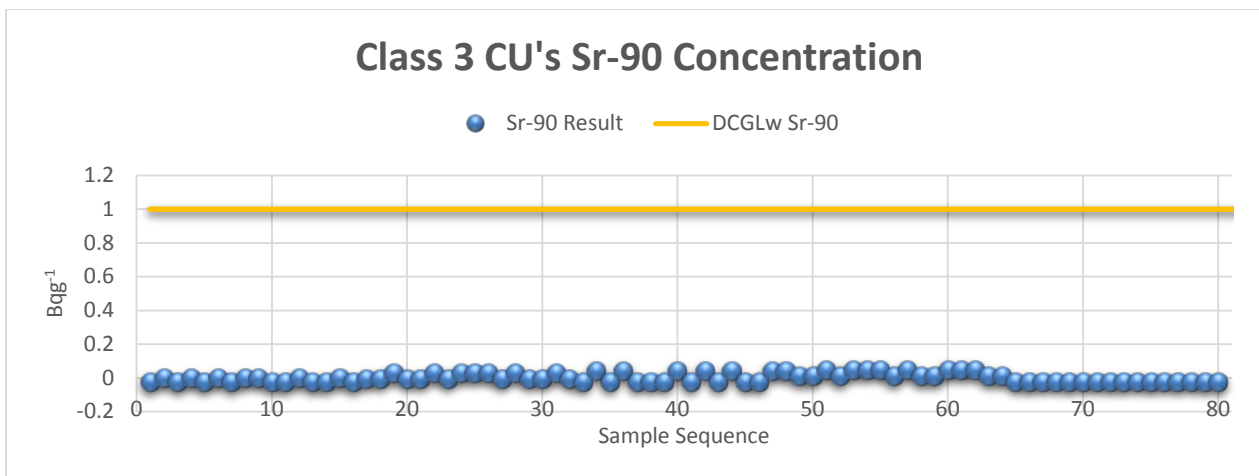
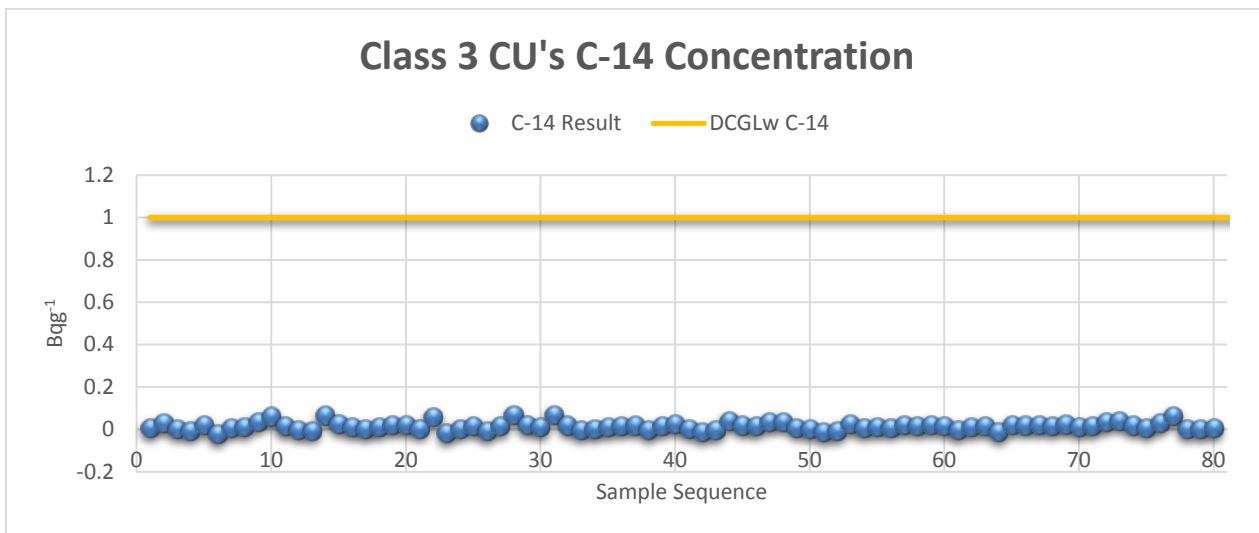
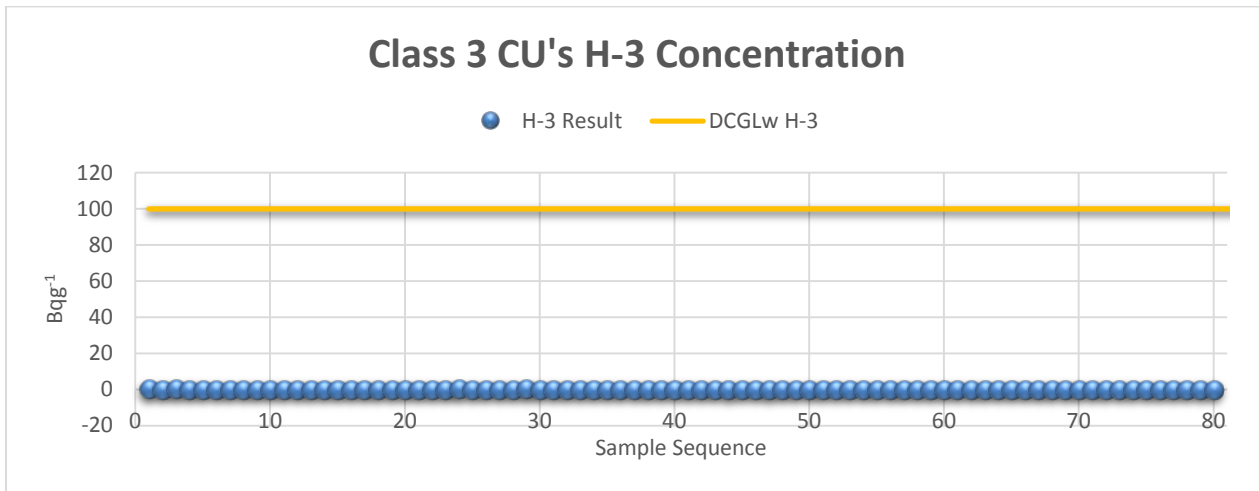


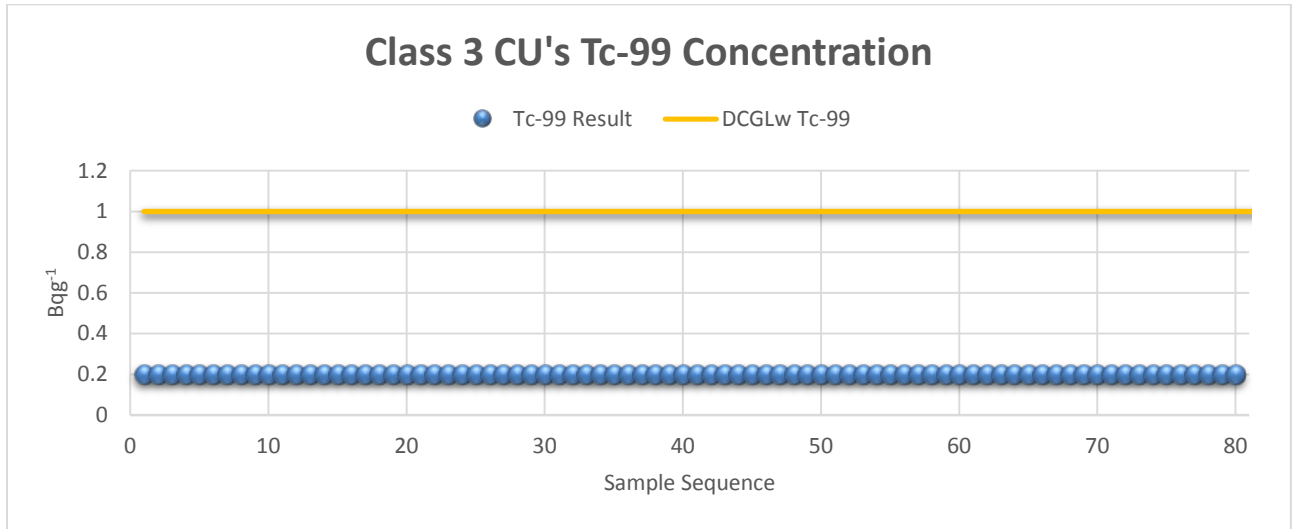
Appendix D

Class 3 CUs Scatter Plots for Sample Concentration Comparison with UCLs (Surface).

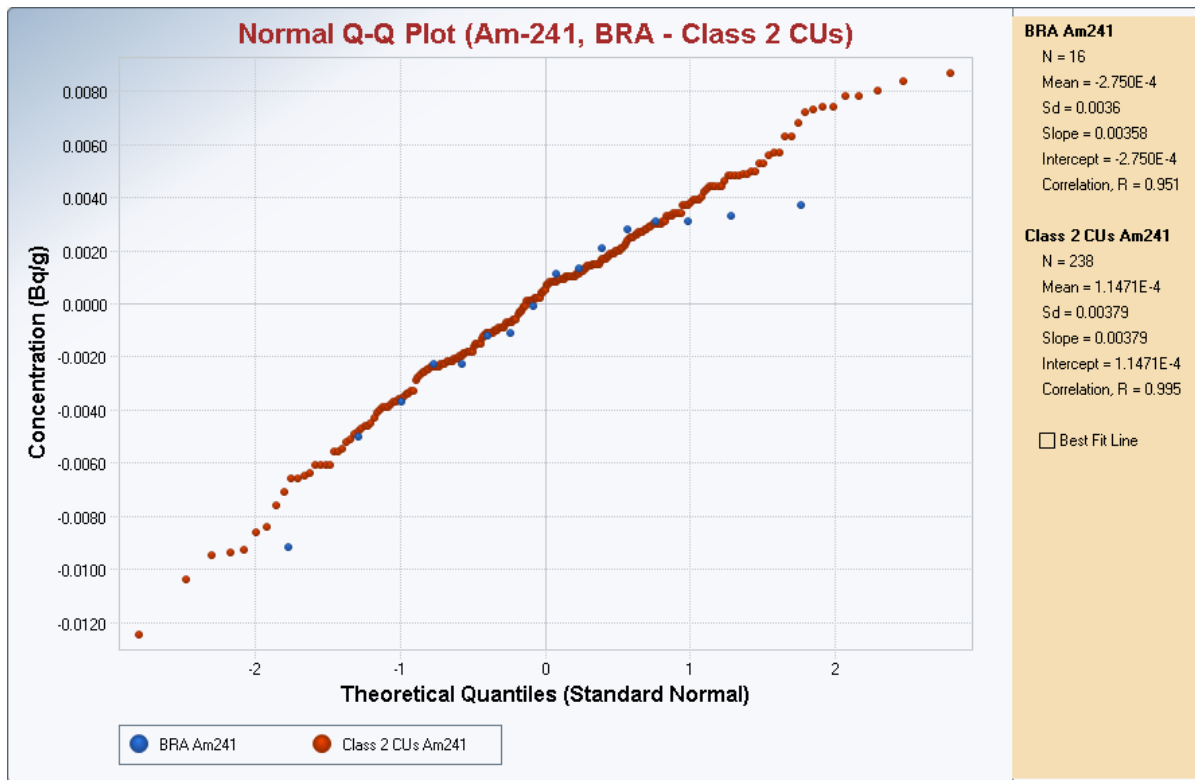


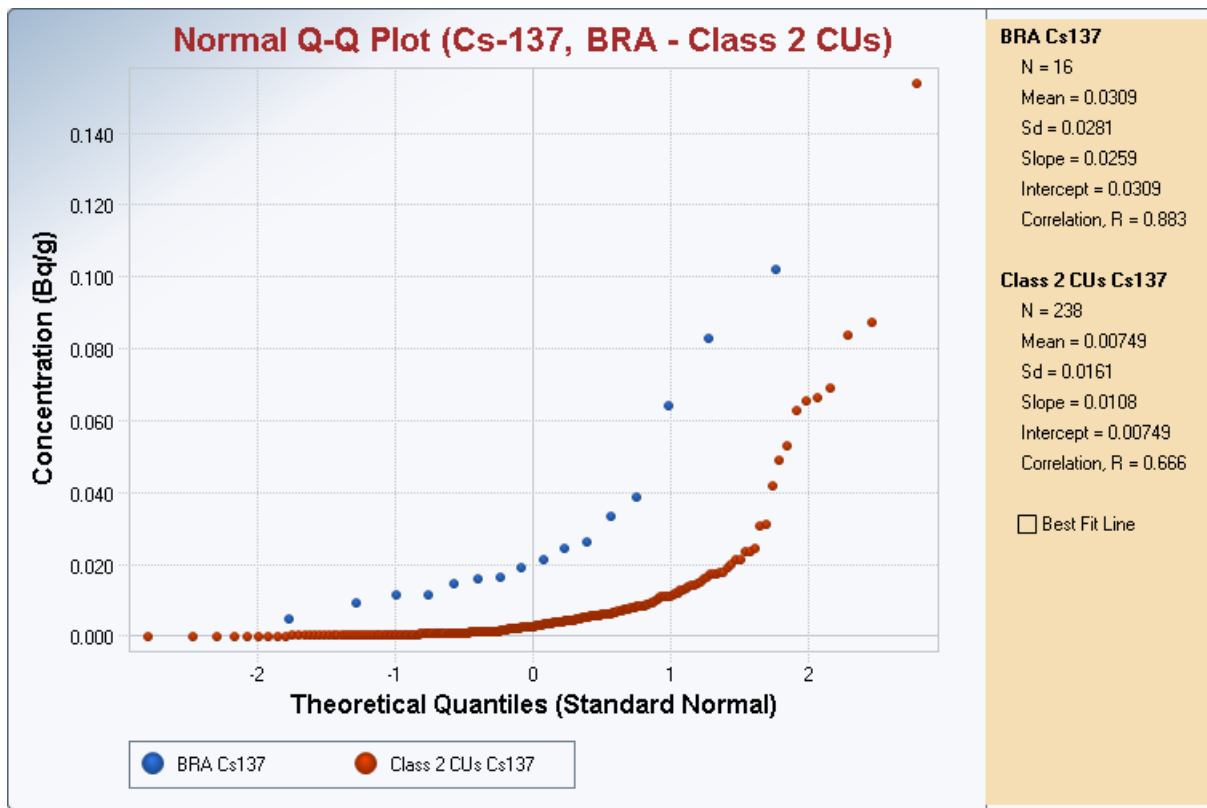
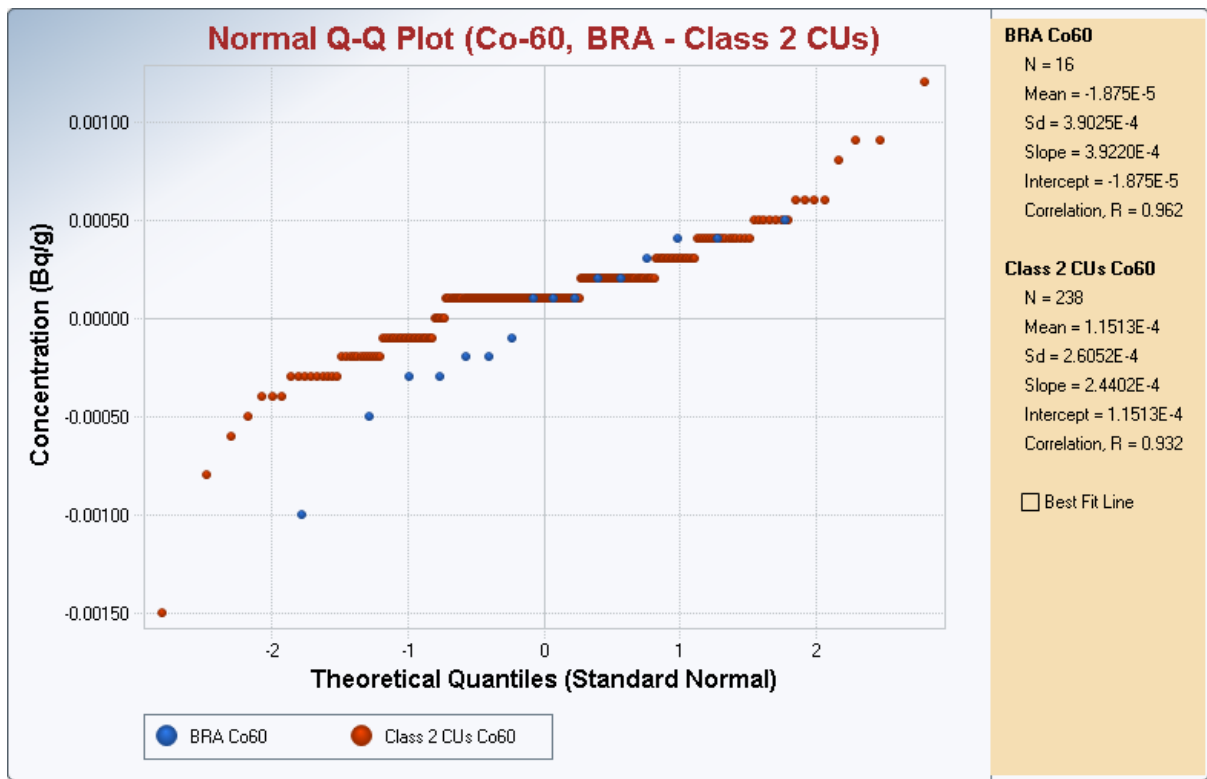


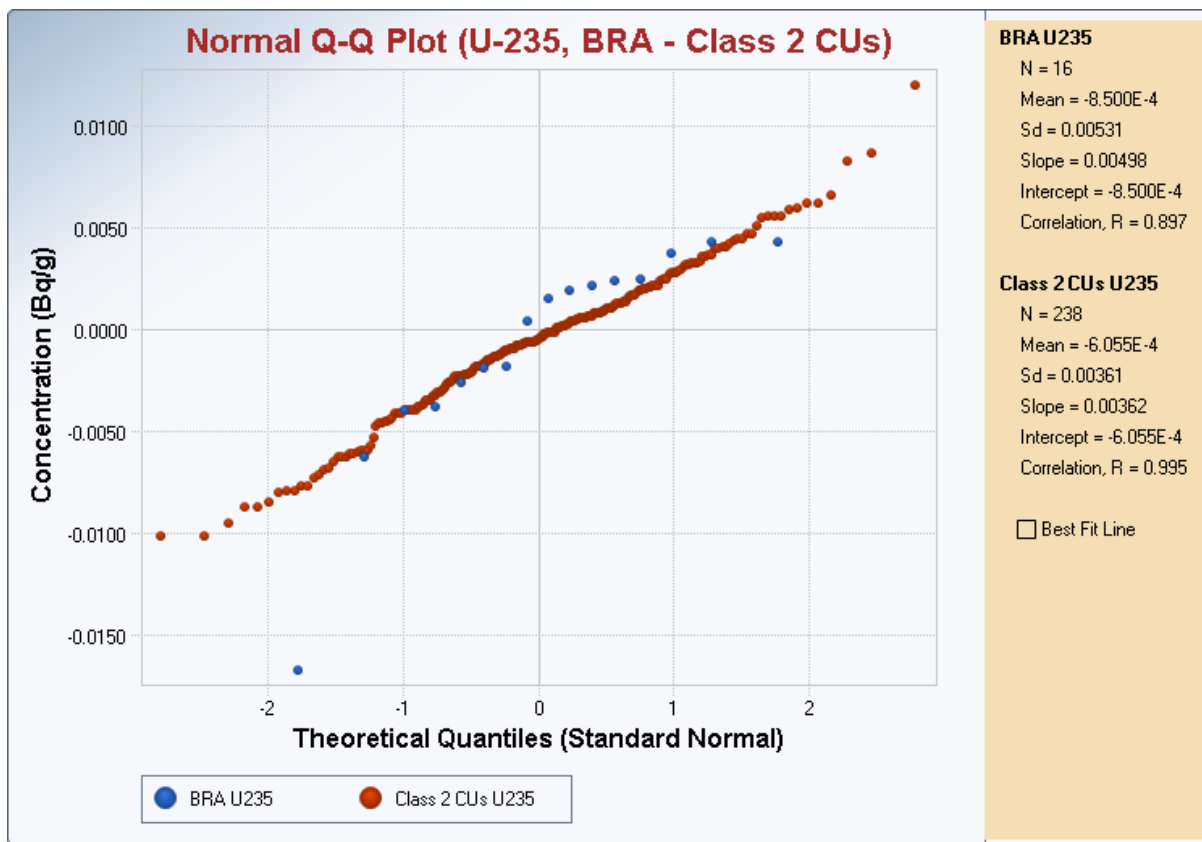
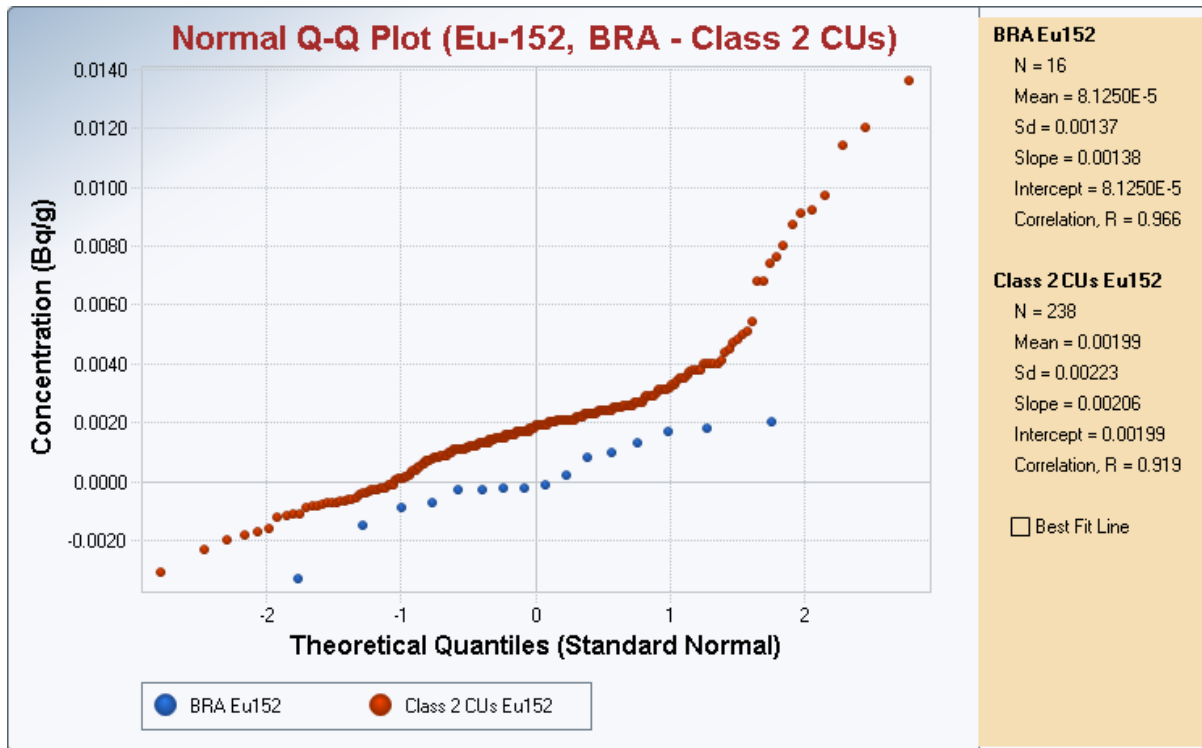


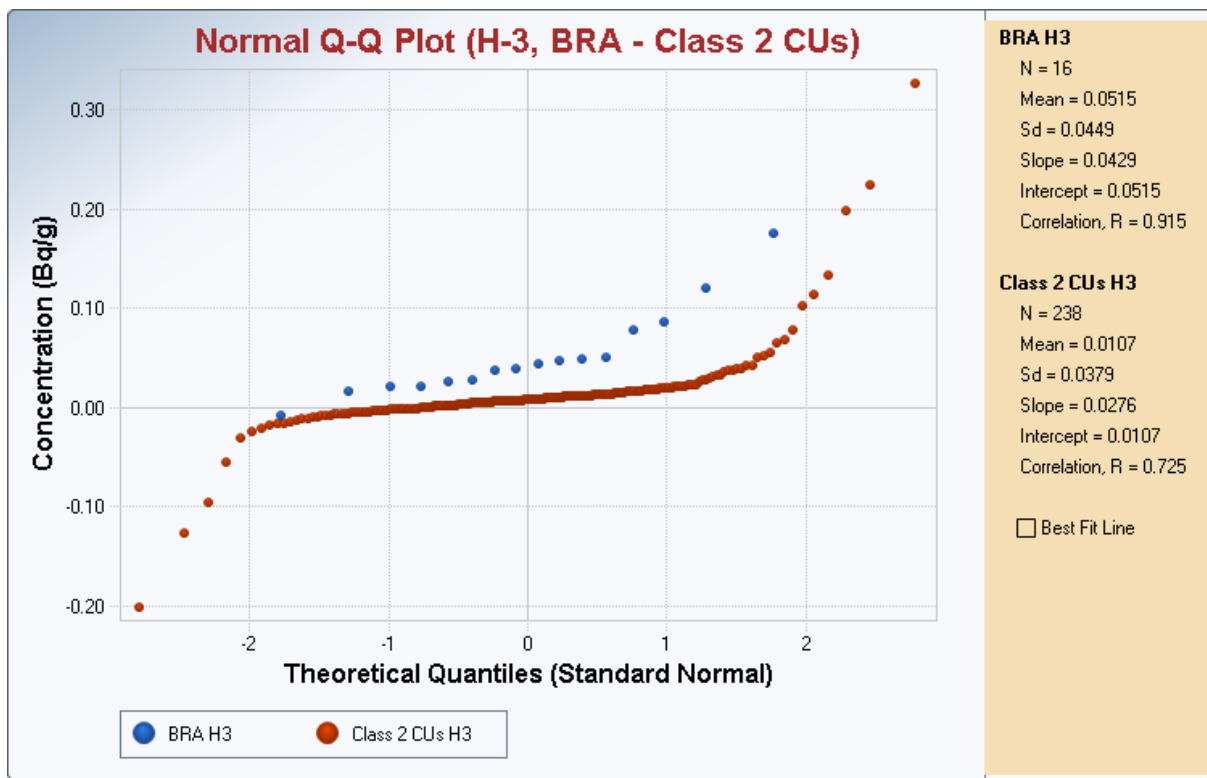
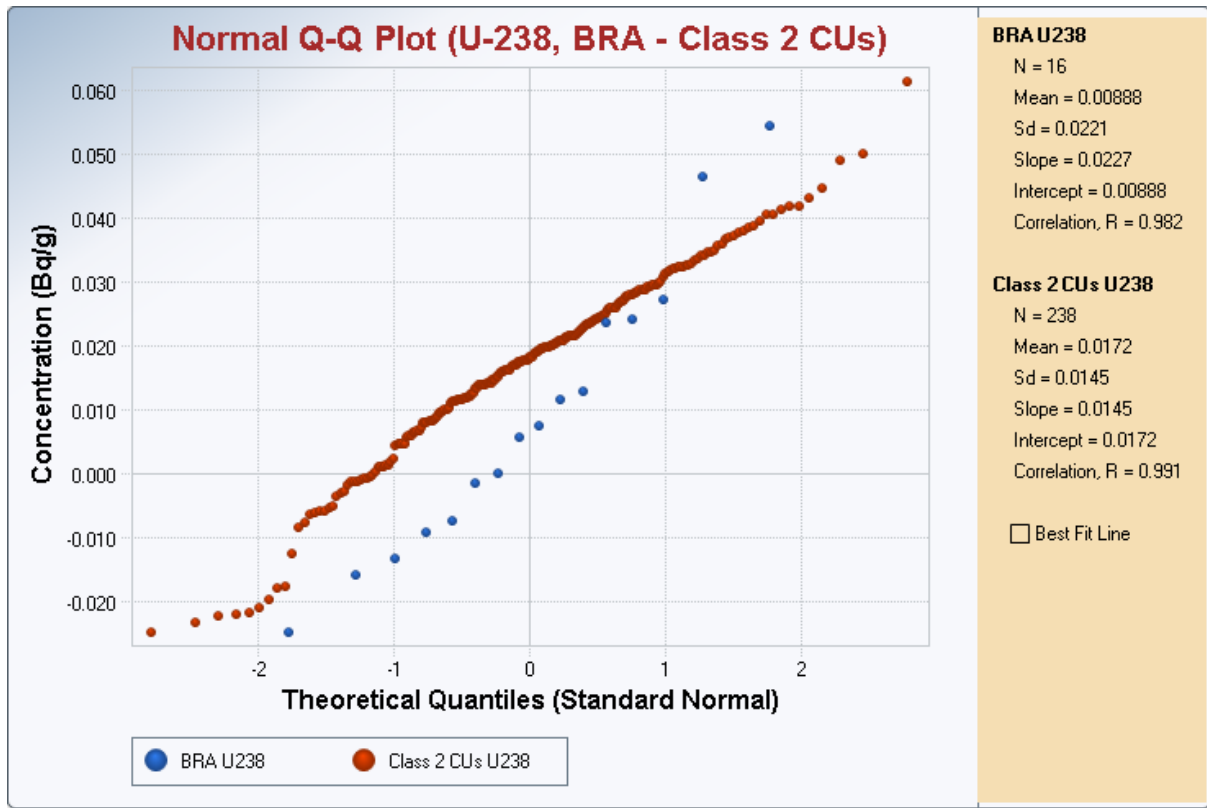


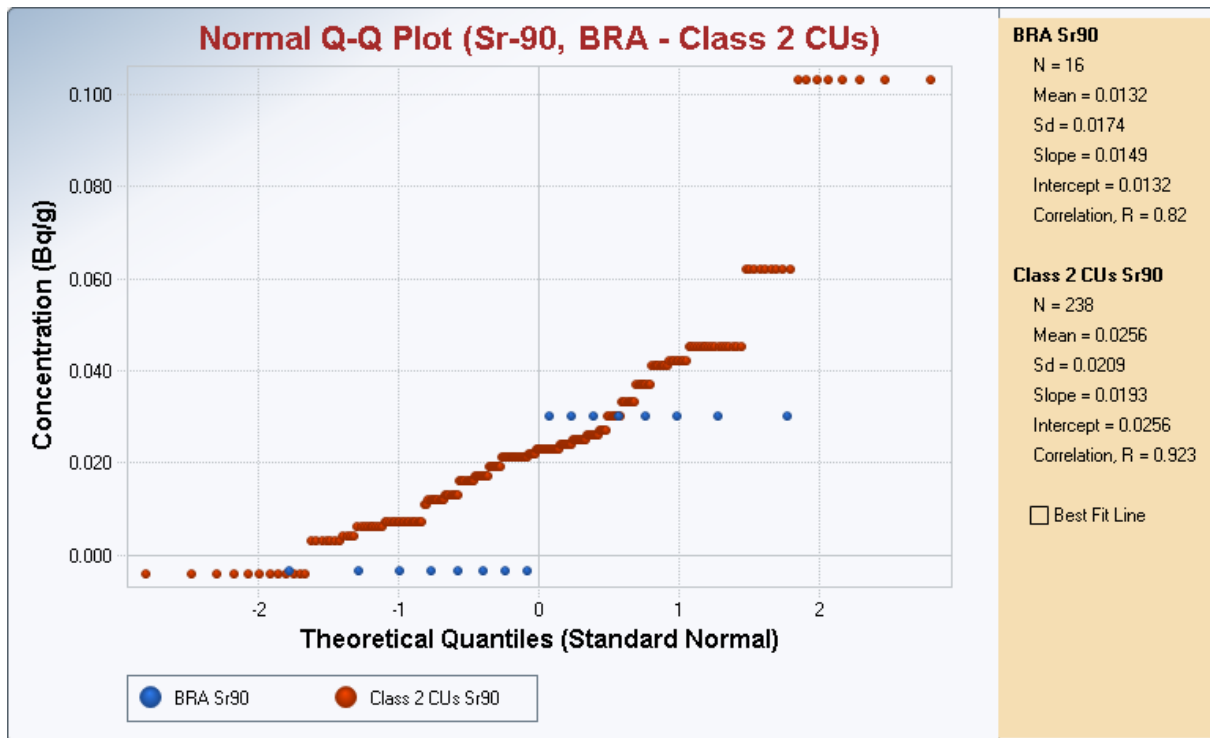
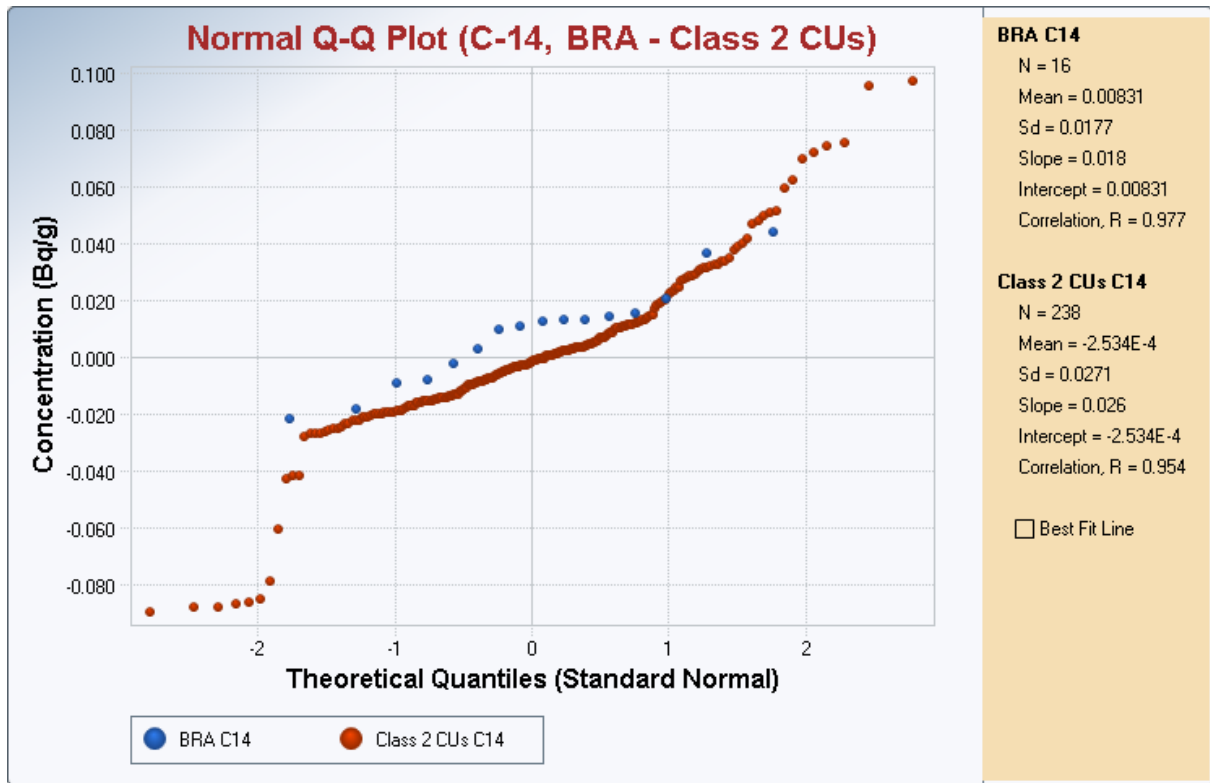
Appendix E Class 2 CUs Quantile Plots for Sample Distribution Comparison (Surface).





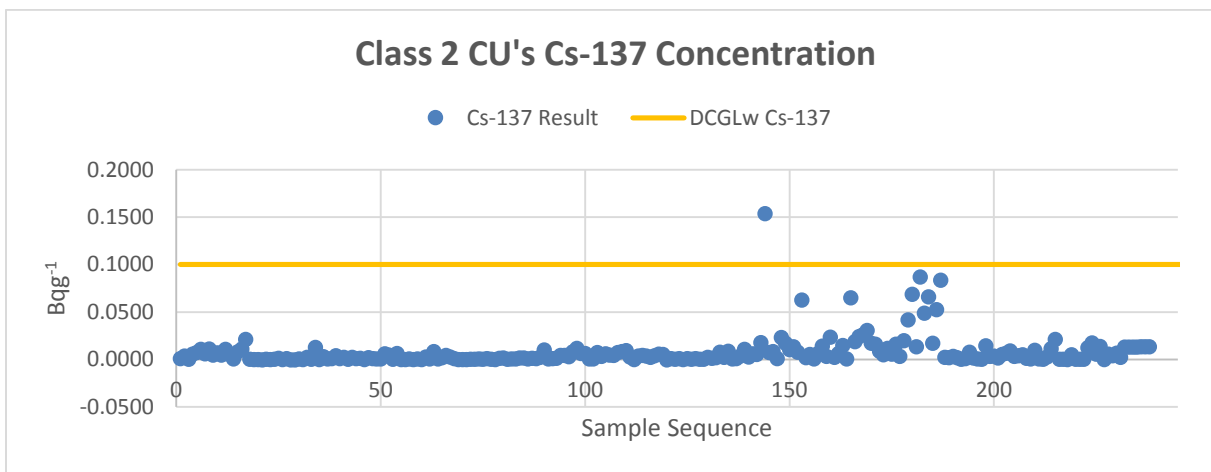
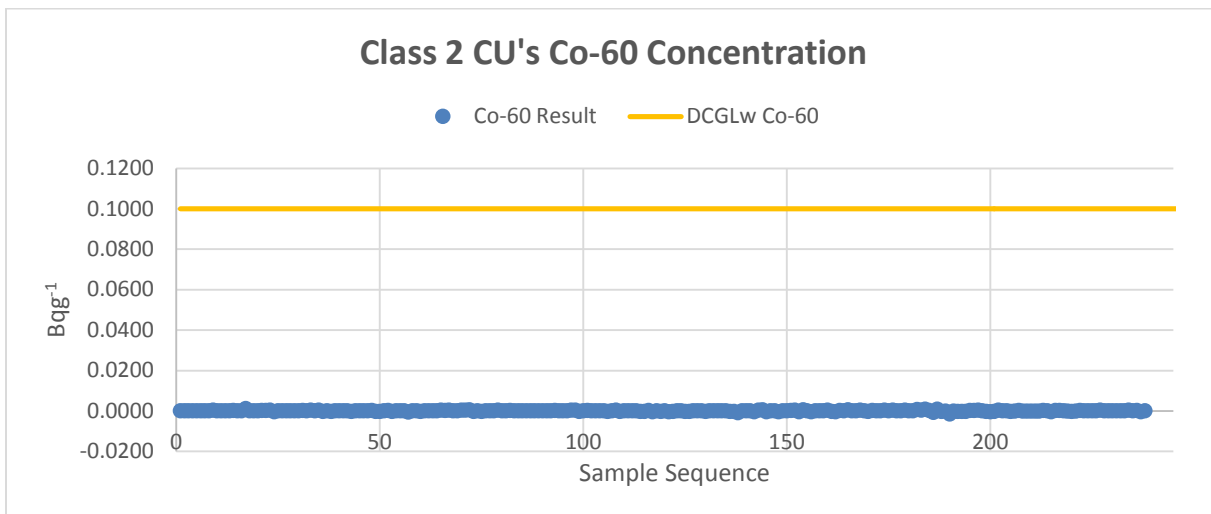
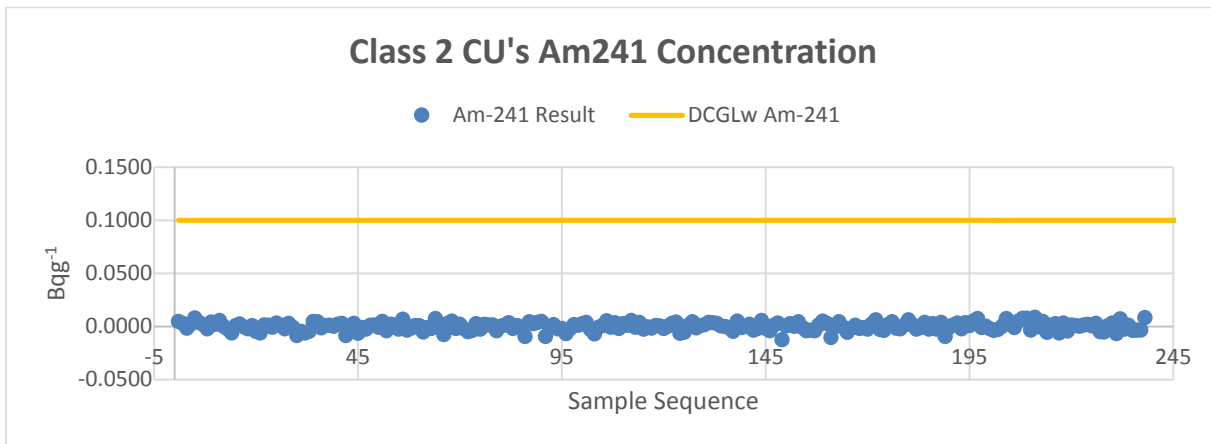


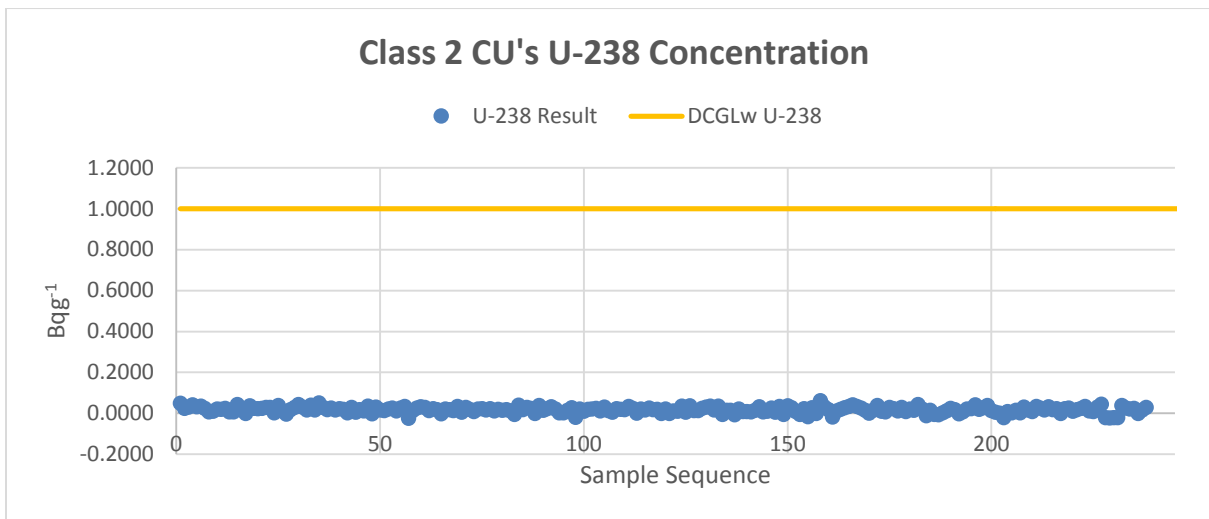
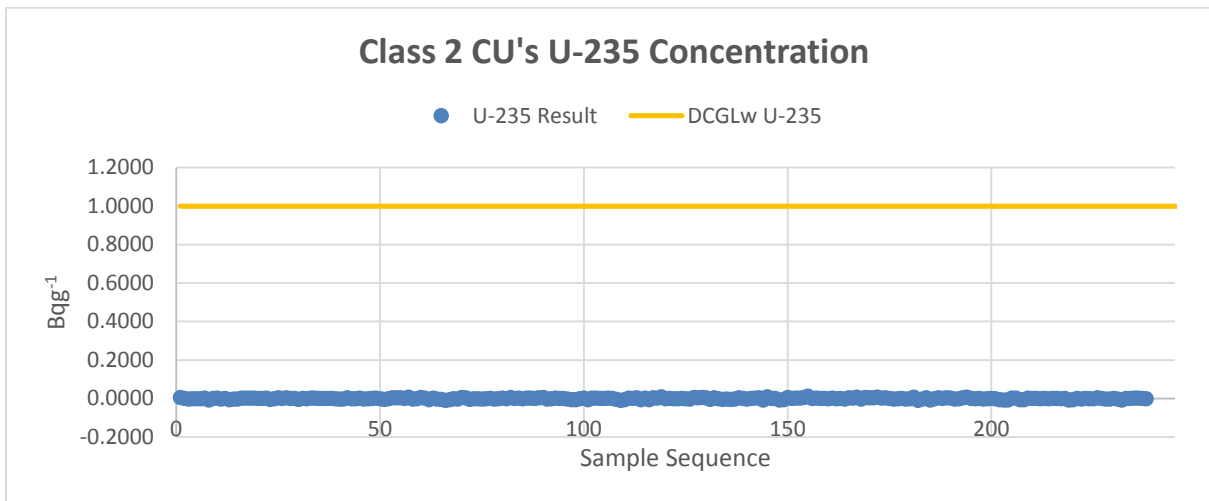
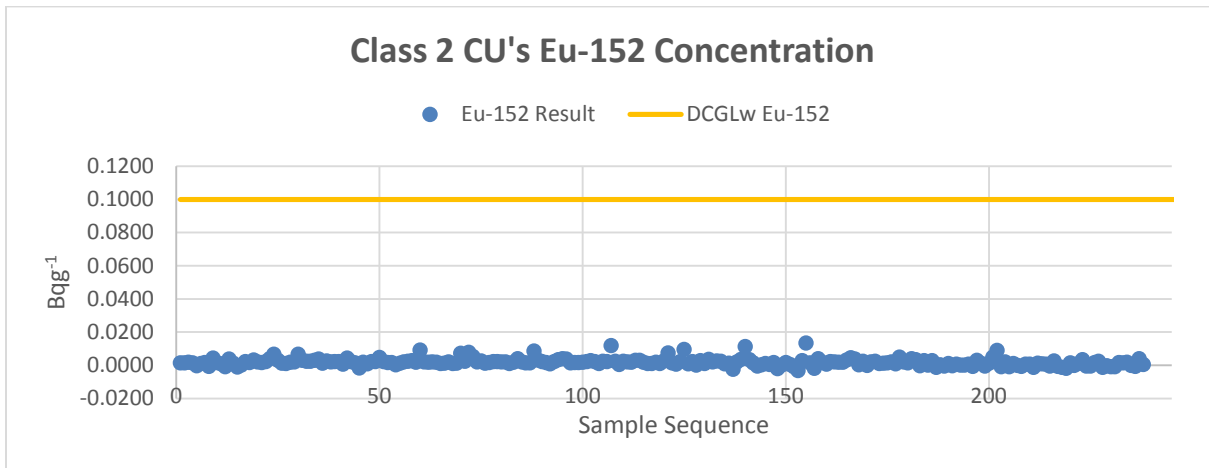


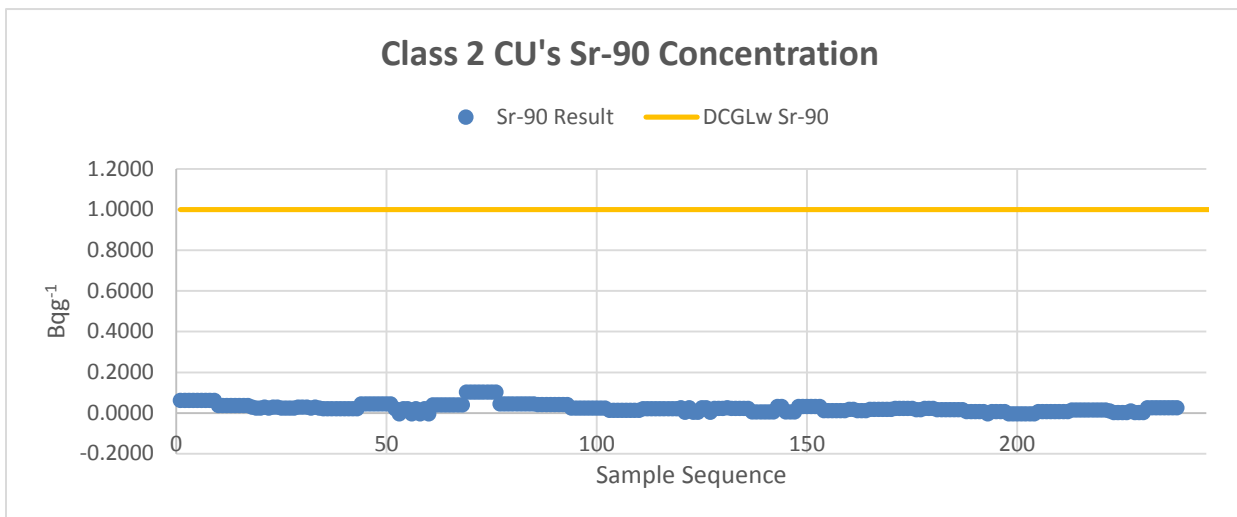
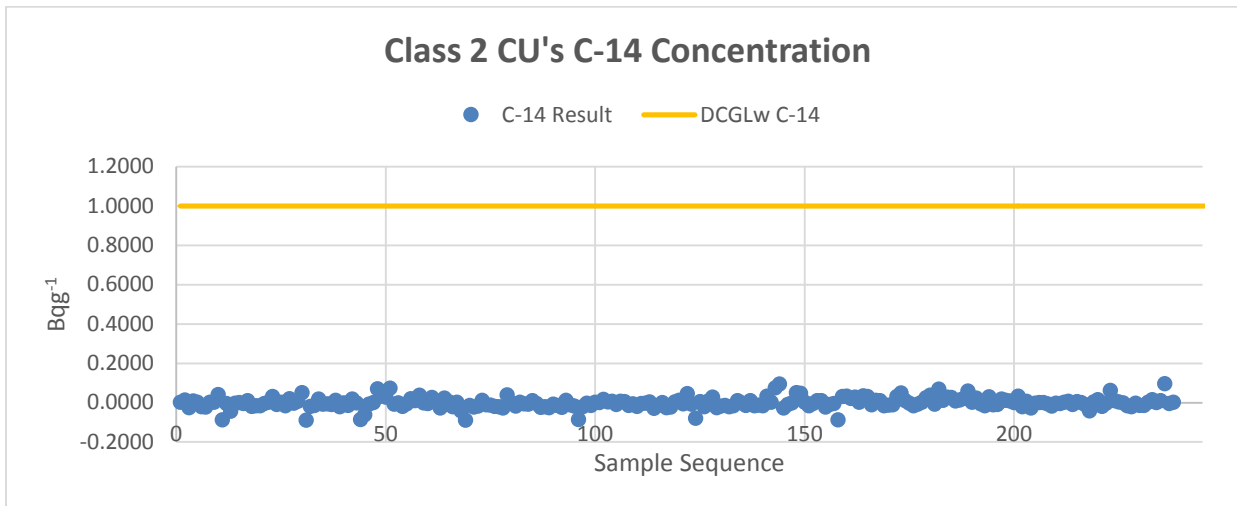
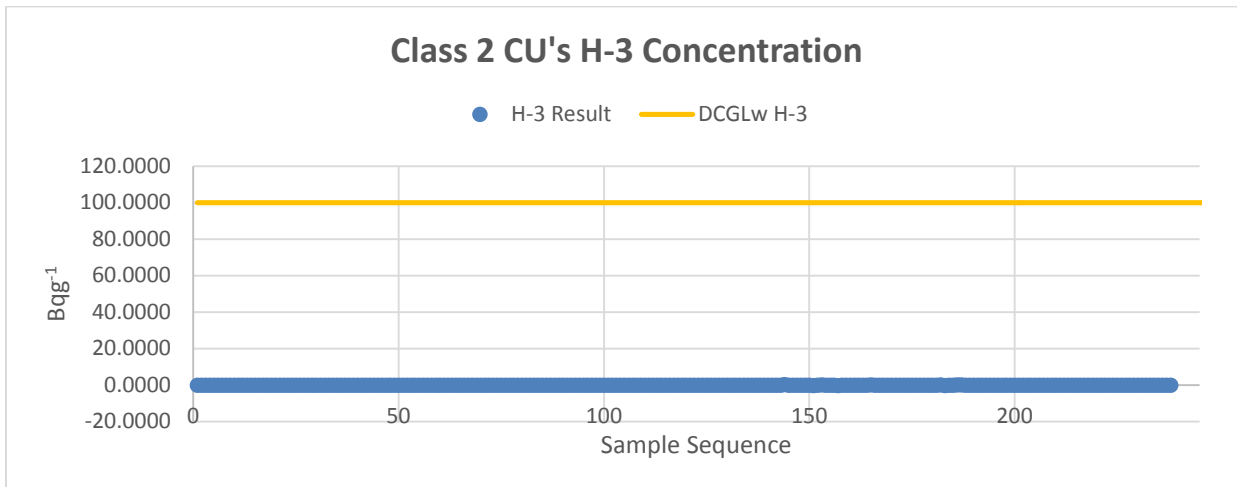


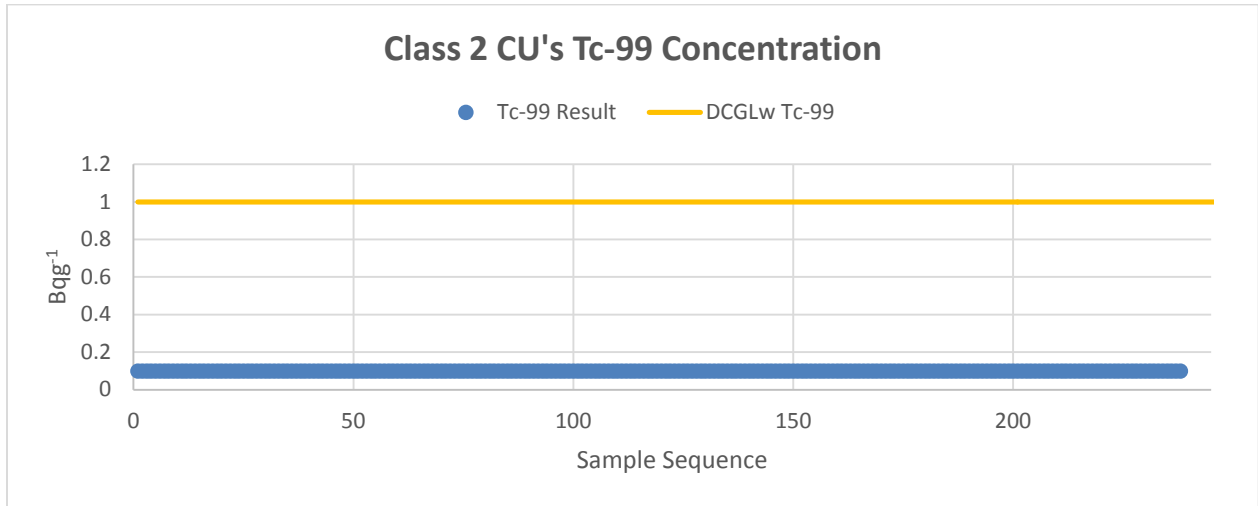


Appendix F
Class 2 CUs Scatter Plots for Sample Concentration Comparison with UCLs (Surface).

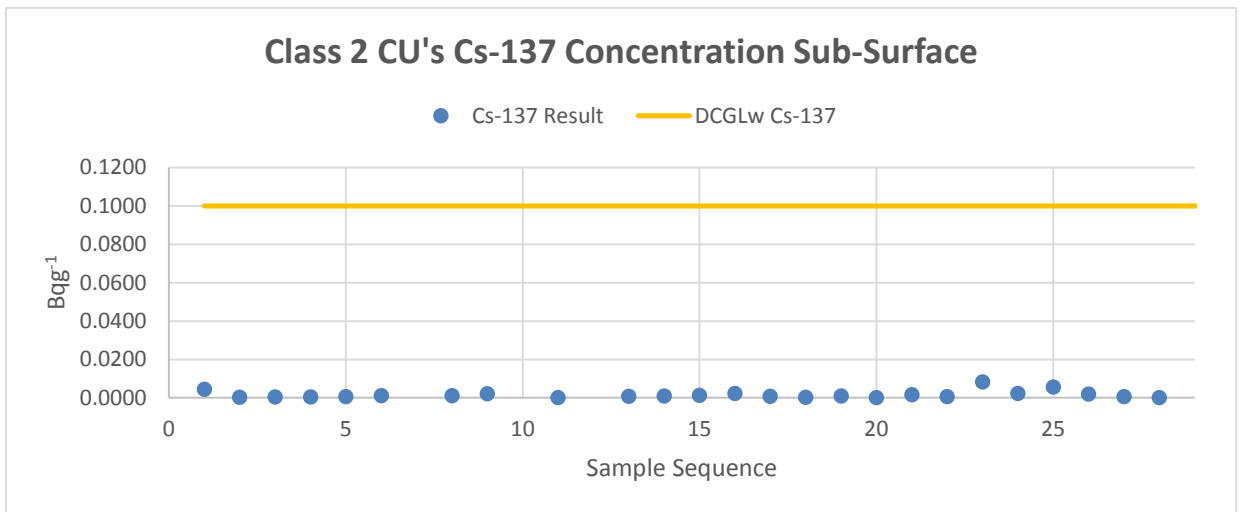
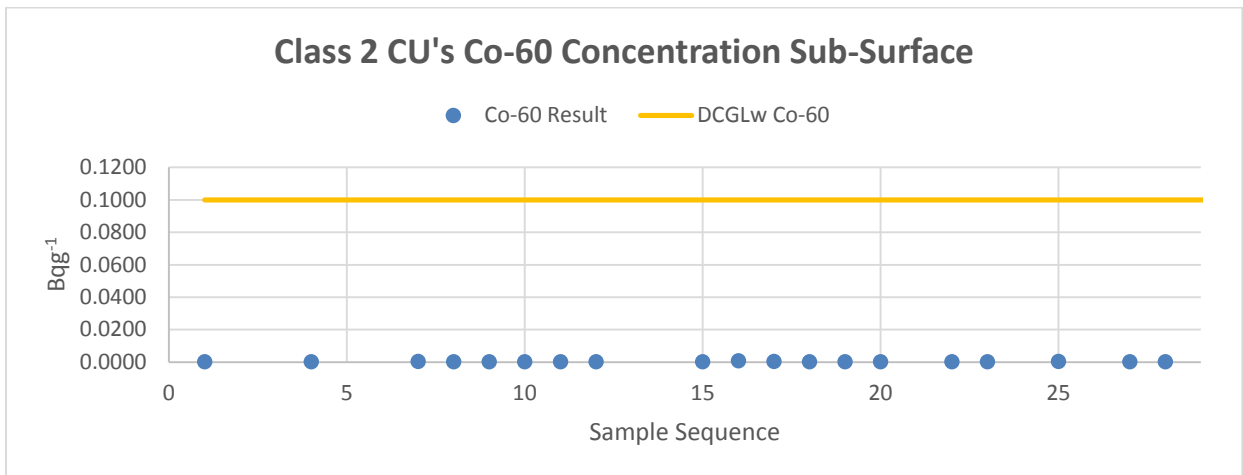
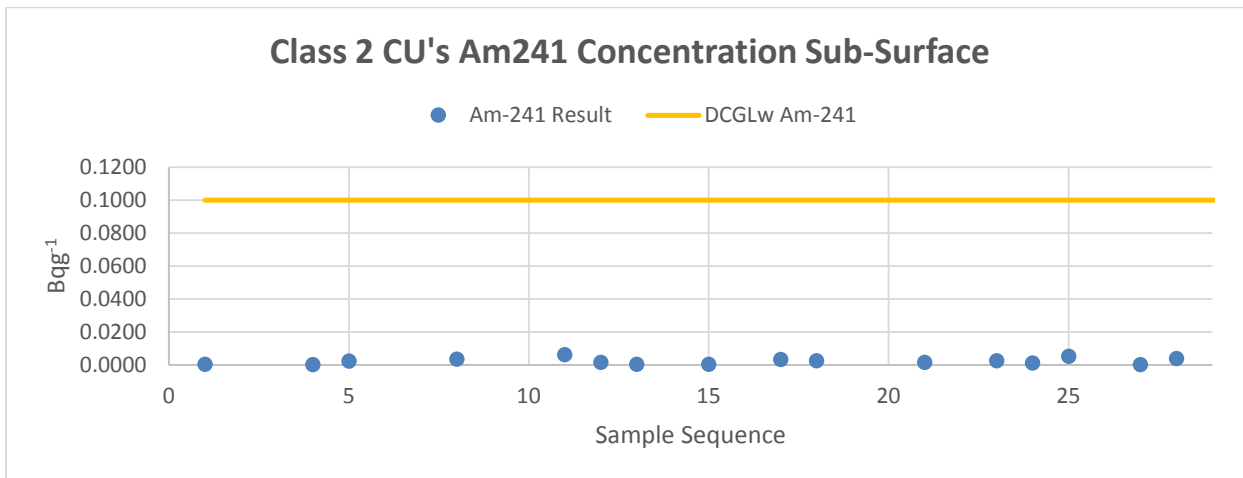


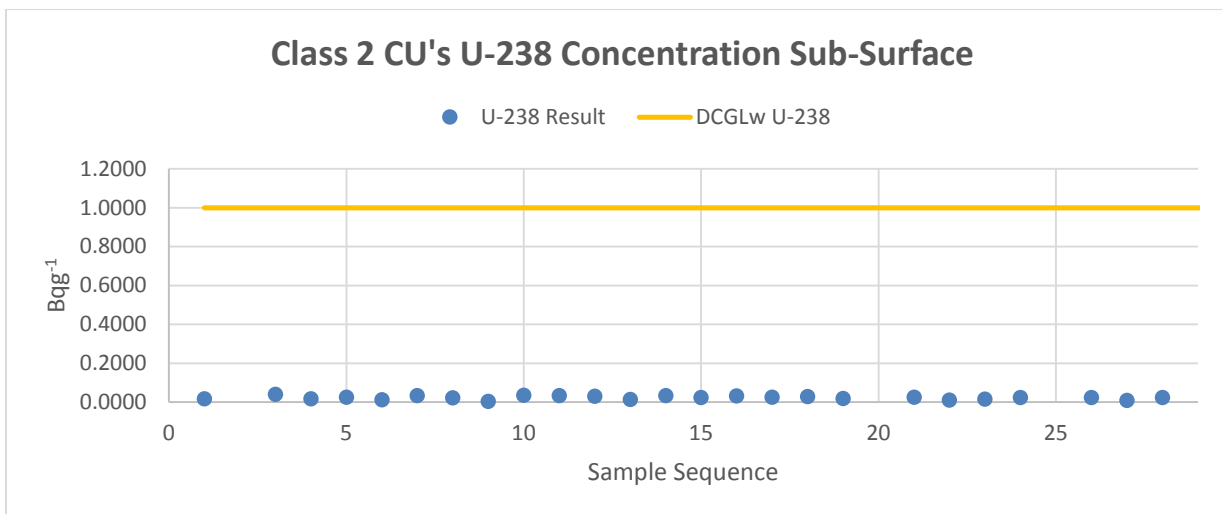
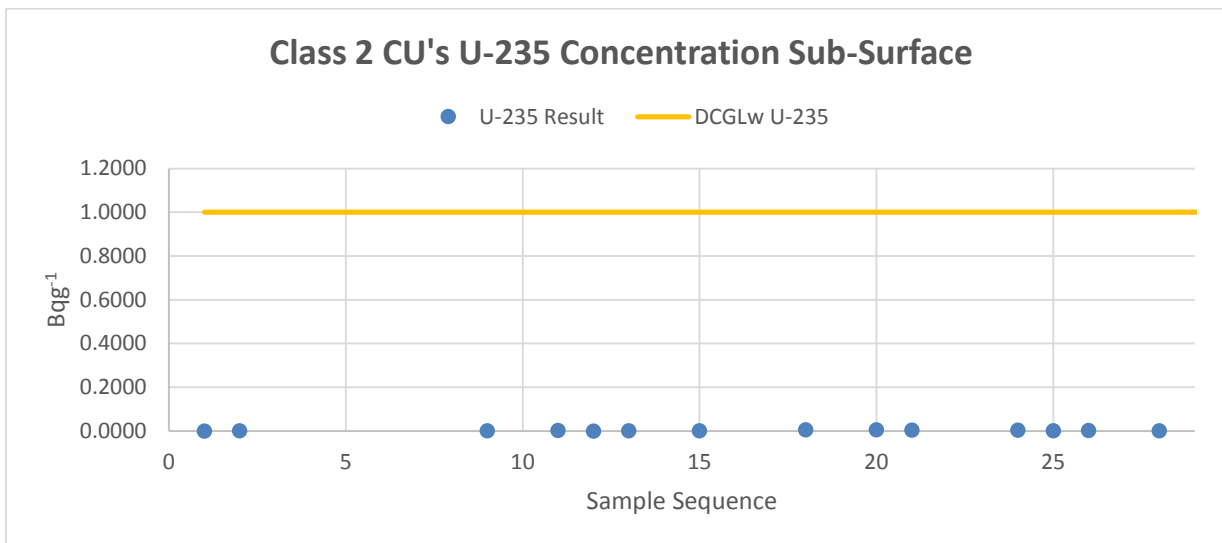
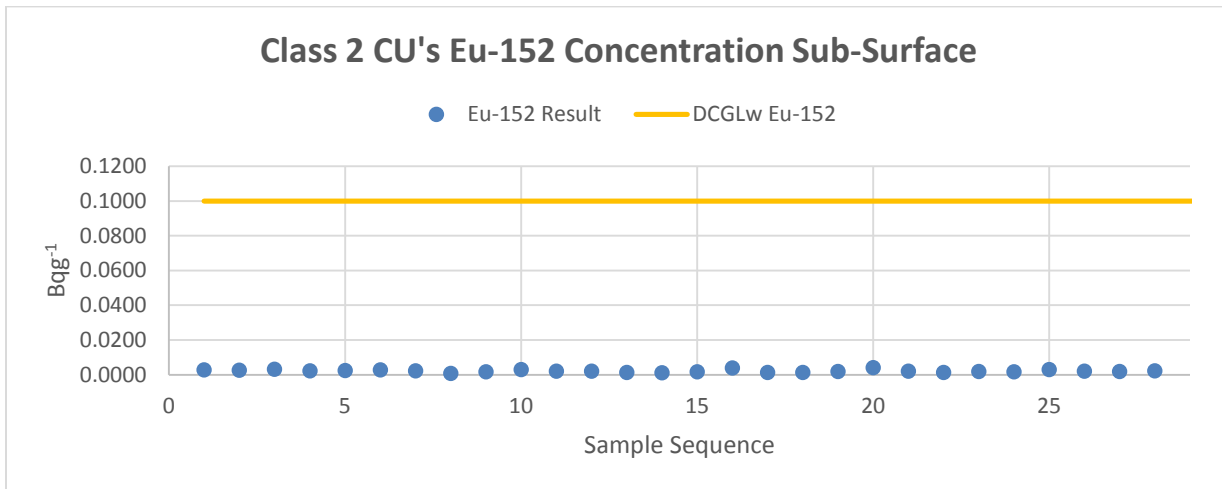


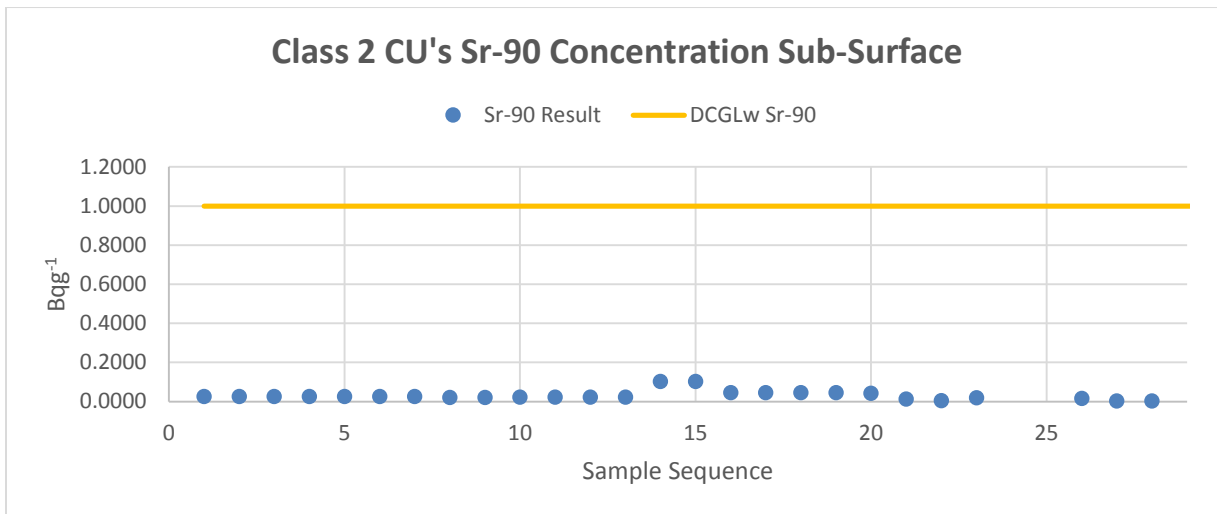
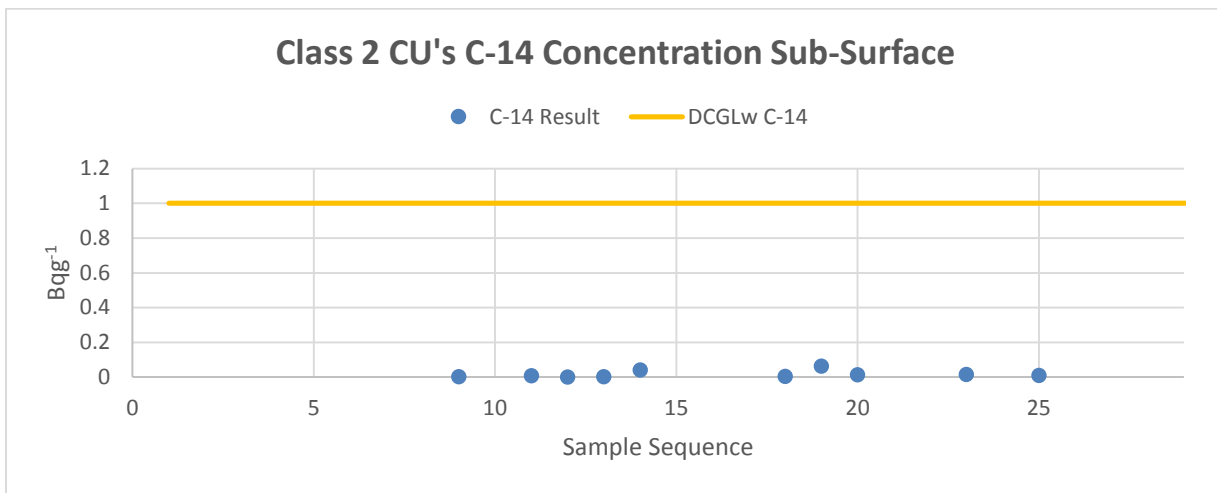
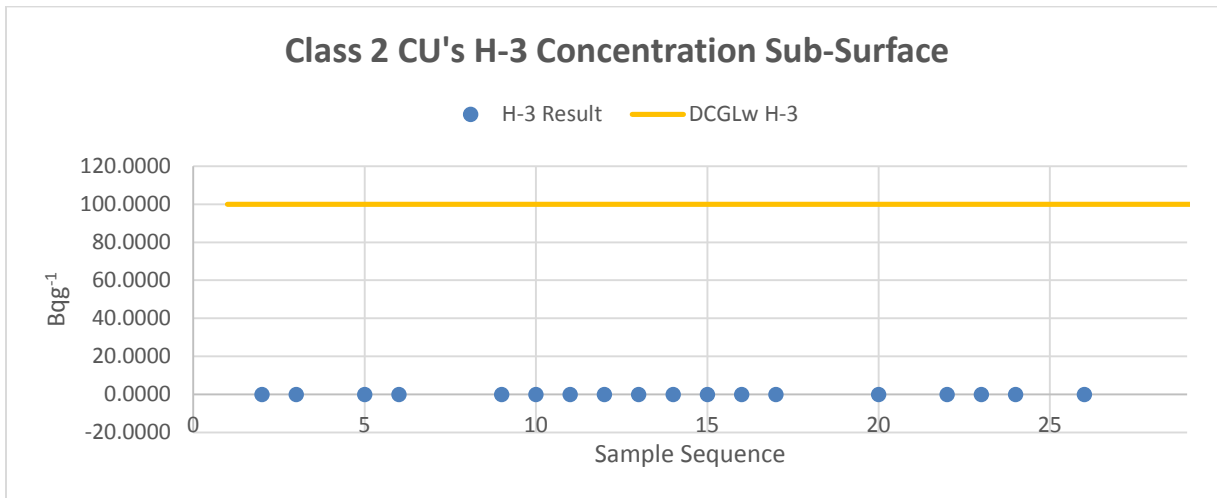


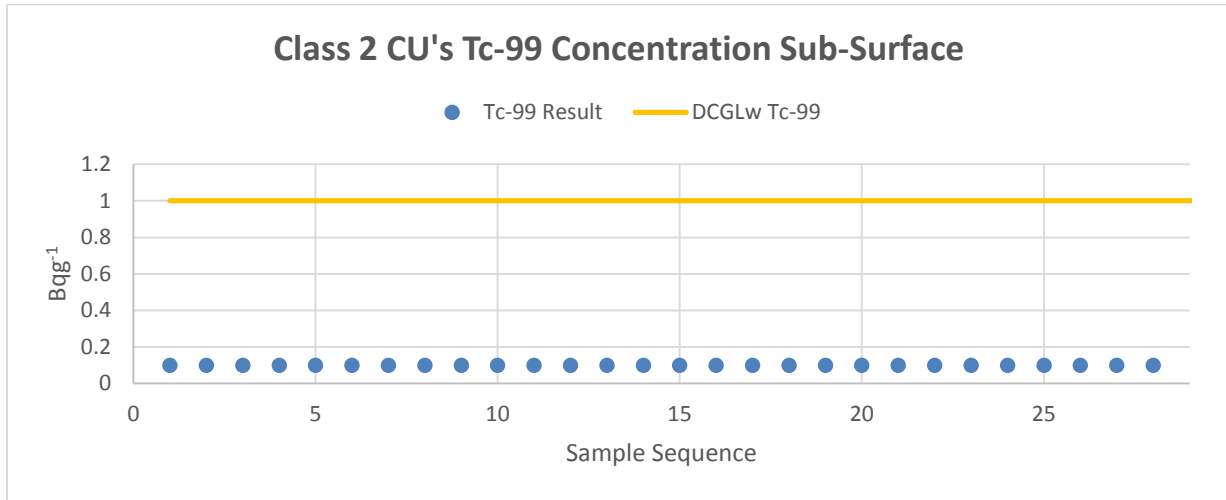


Appendix G
Class 2 CUs Scatter Plots for Sample Comparison (Sub-Surface).

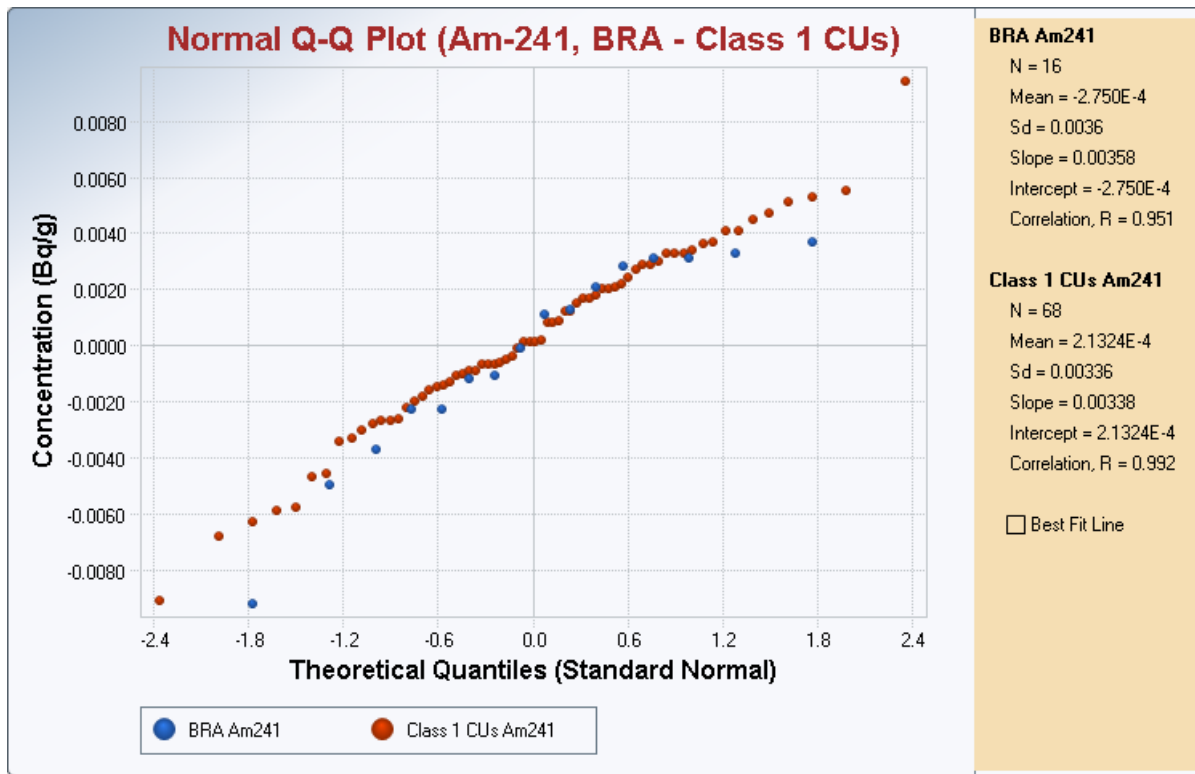


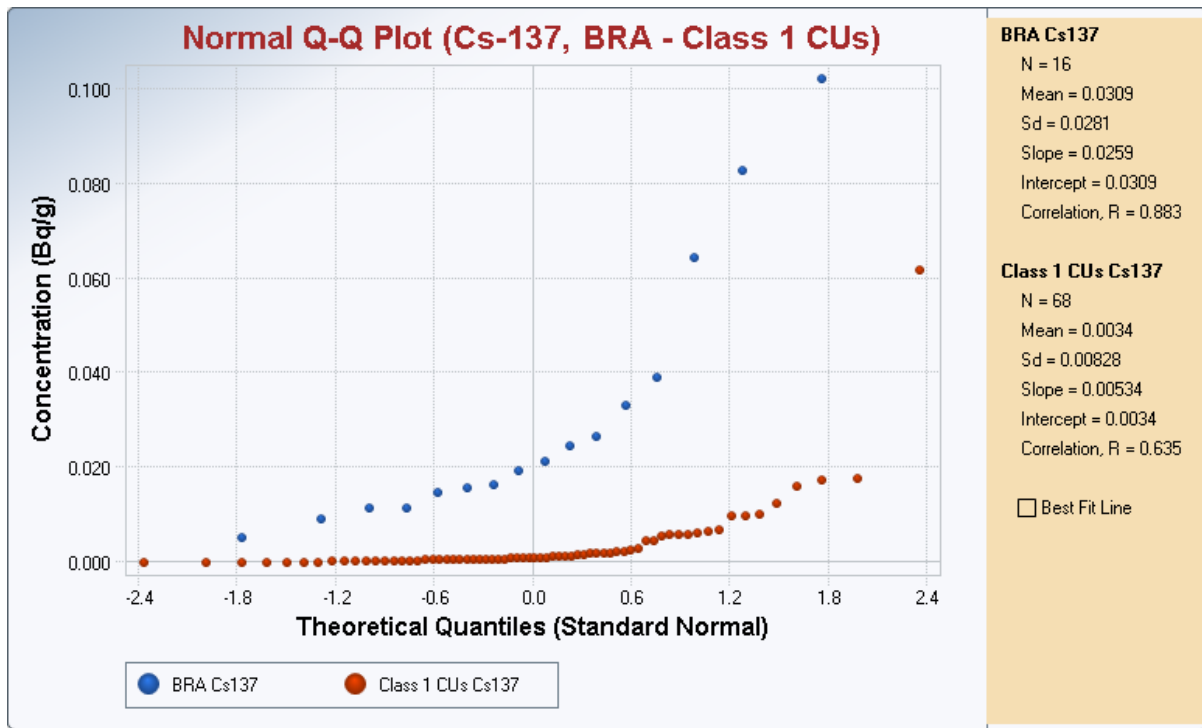
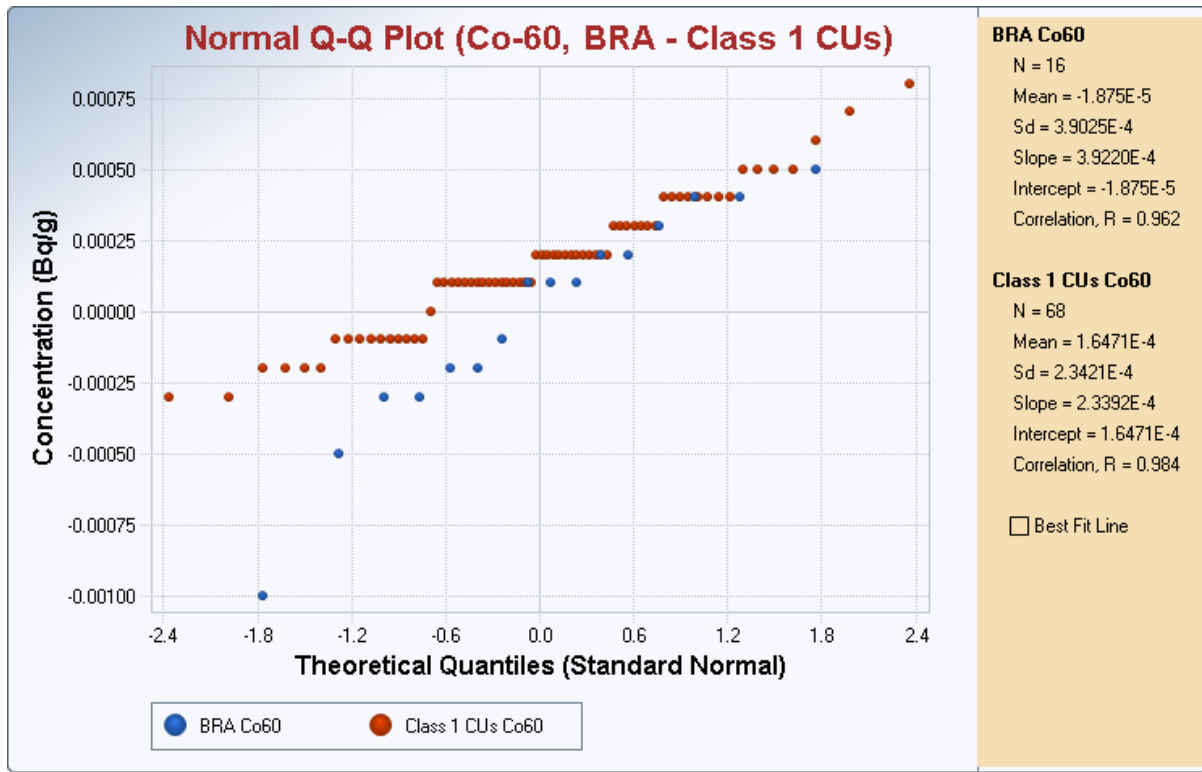


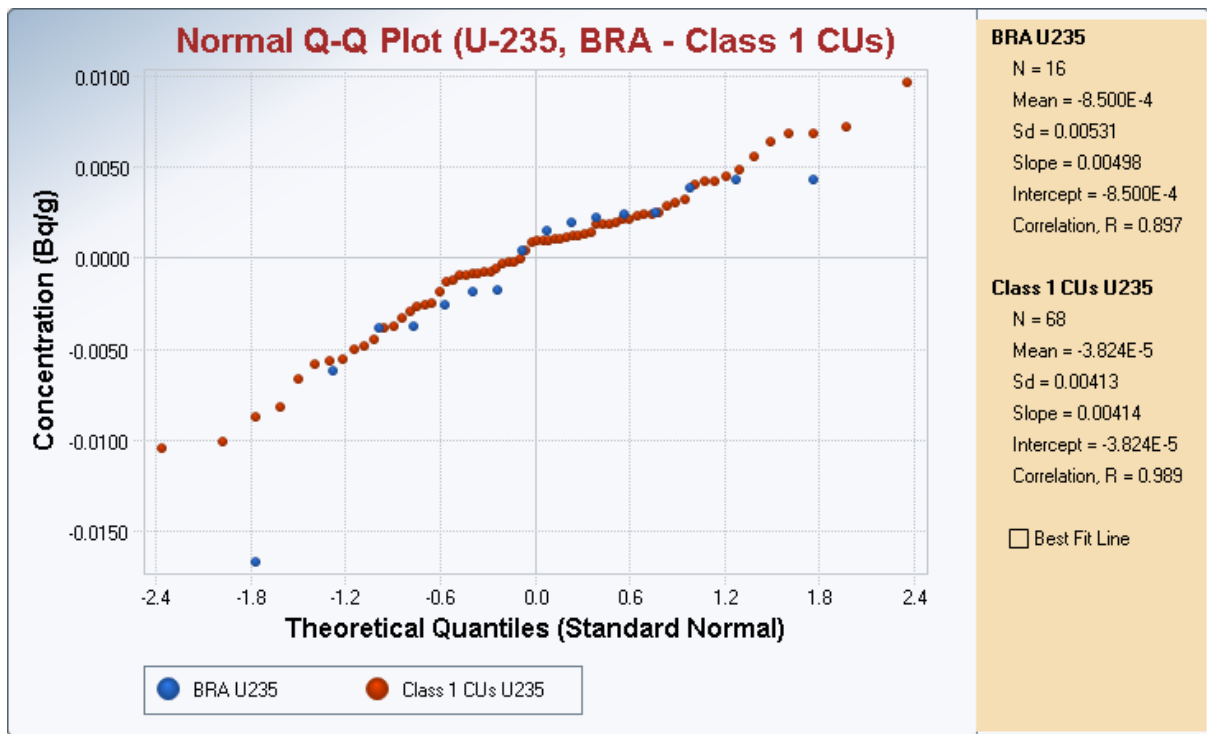
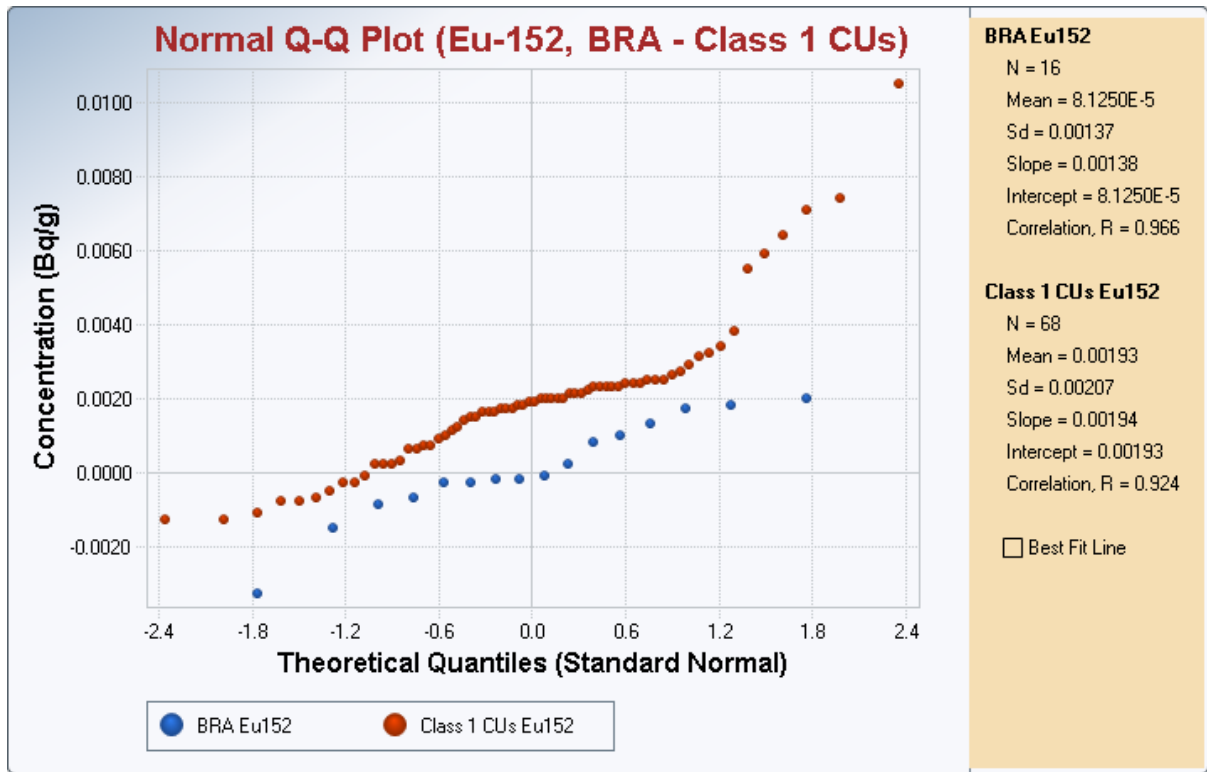


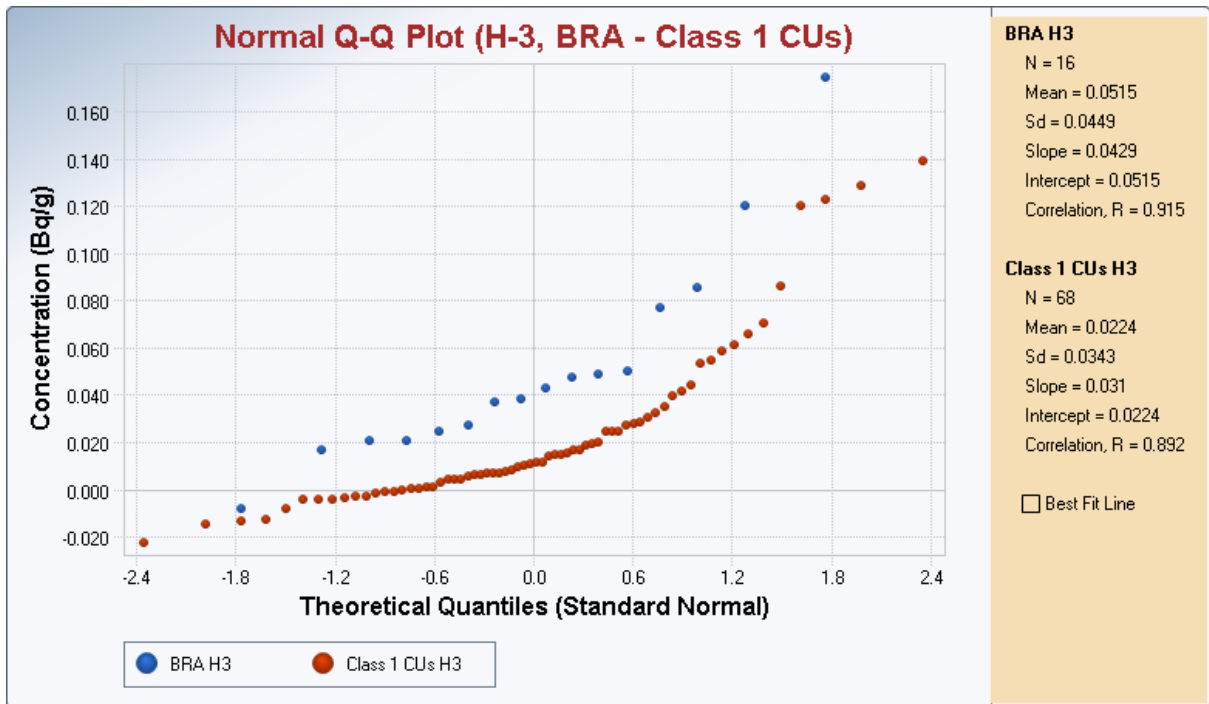
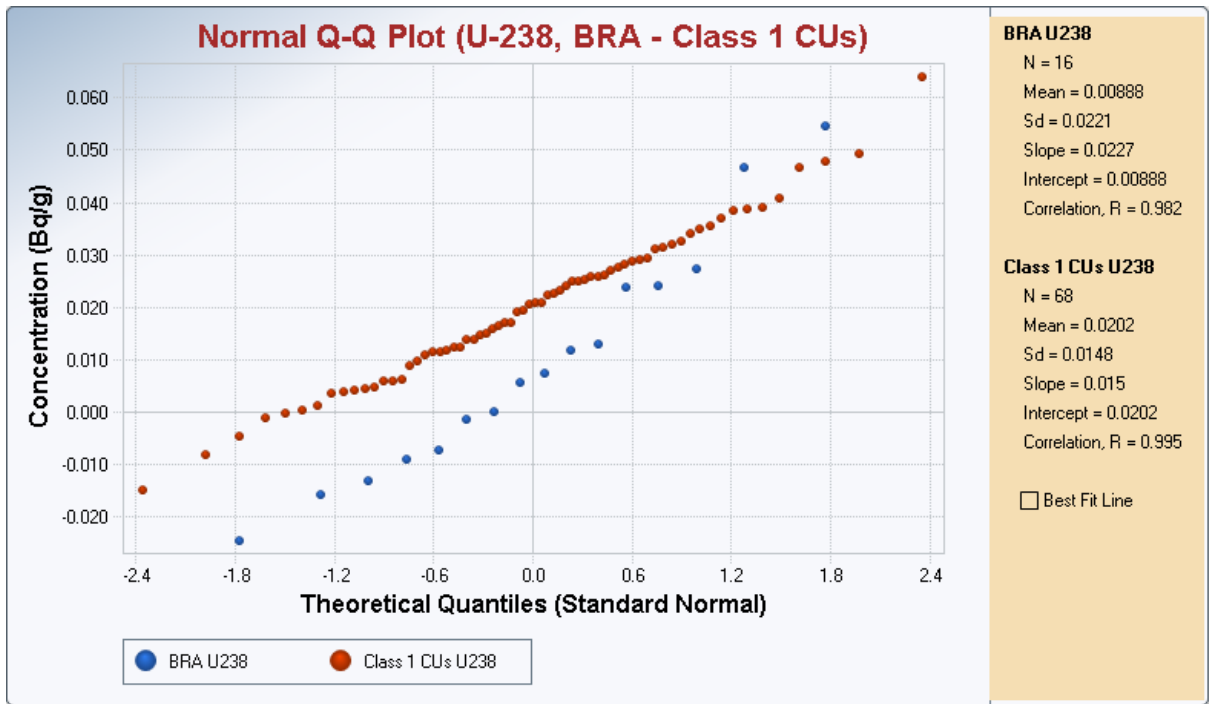


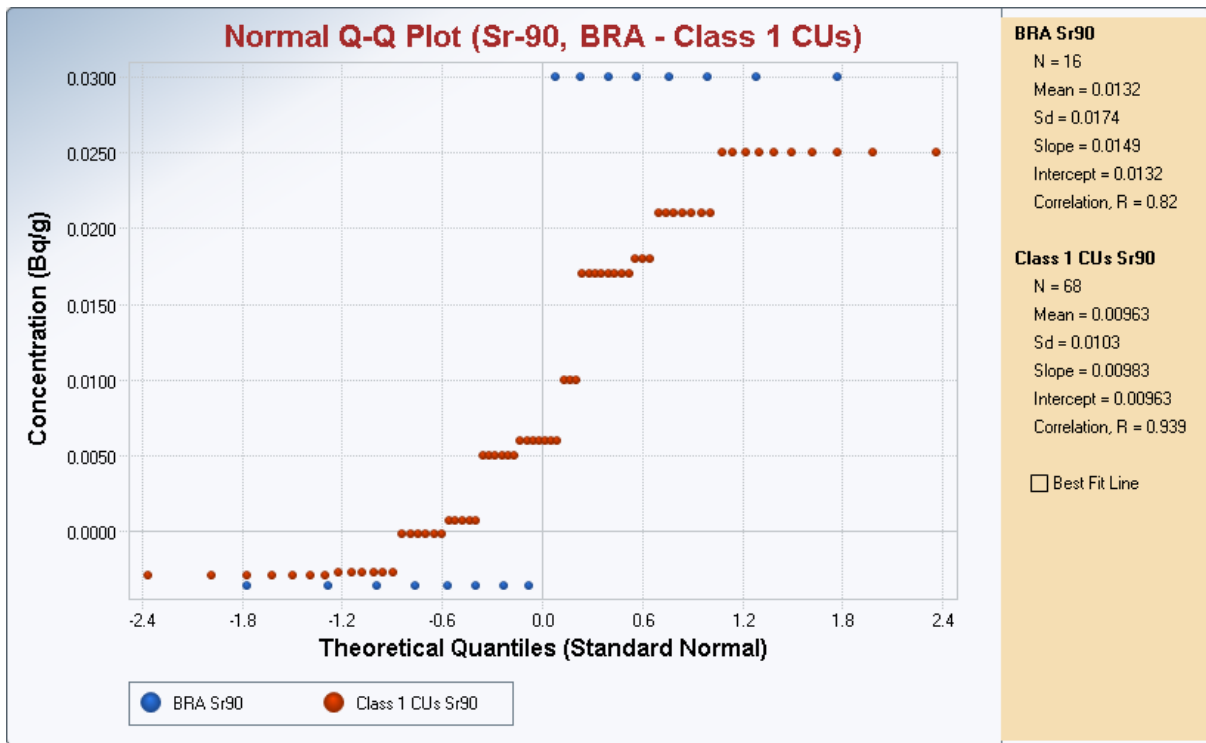
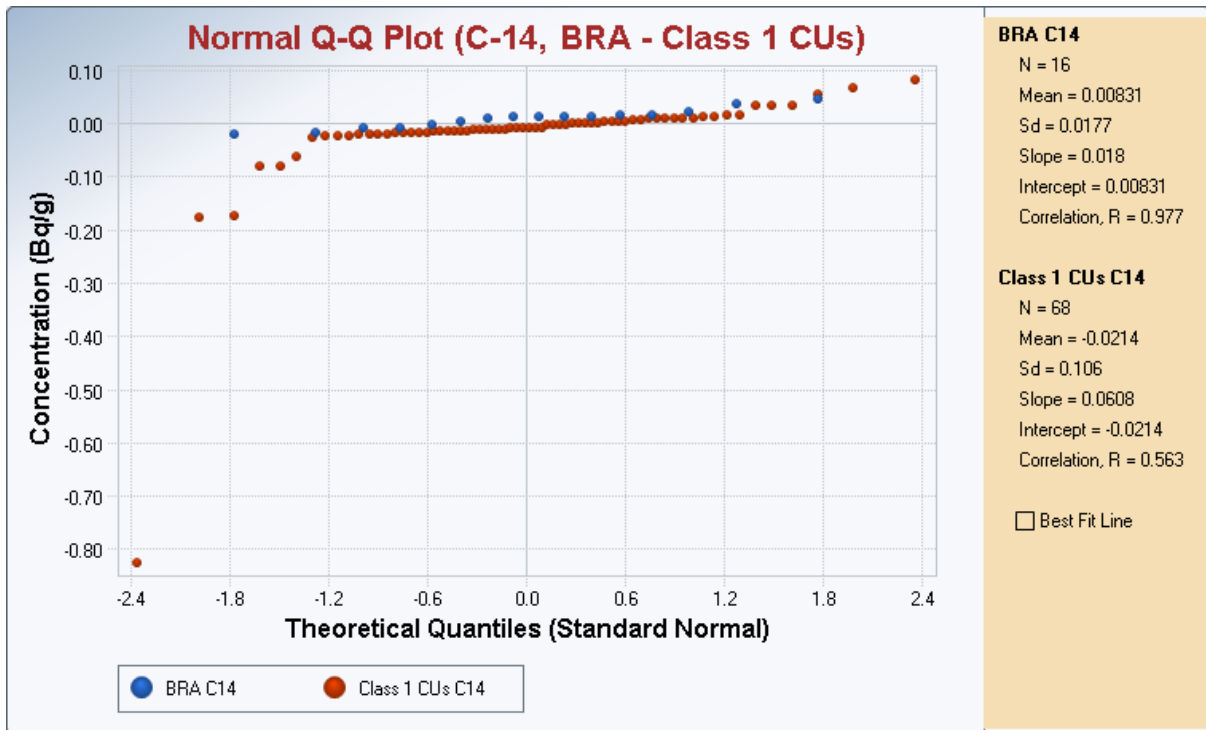
Appendix H
Class 1 CUs Quantile Plots for Sample Distribution Comparison (Surface).

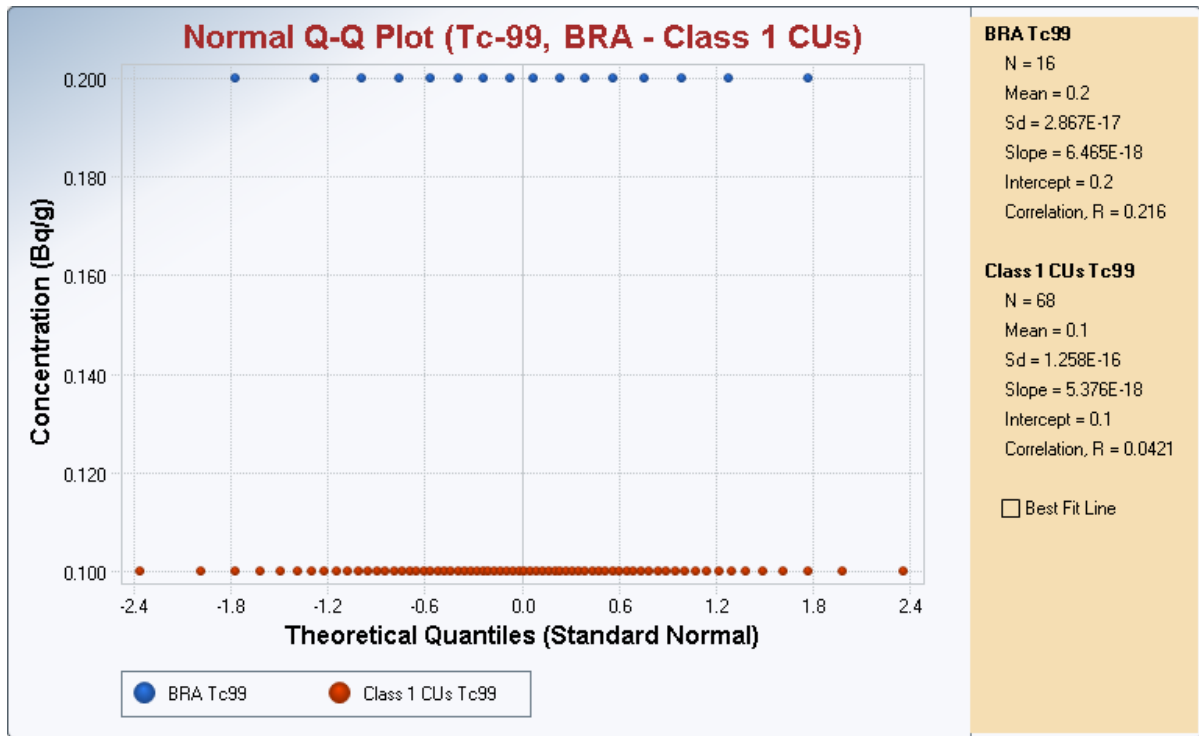




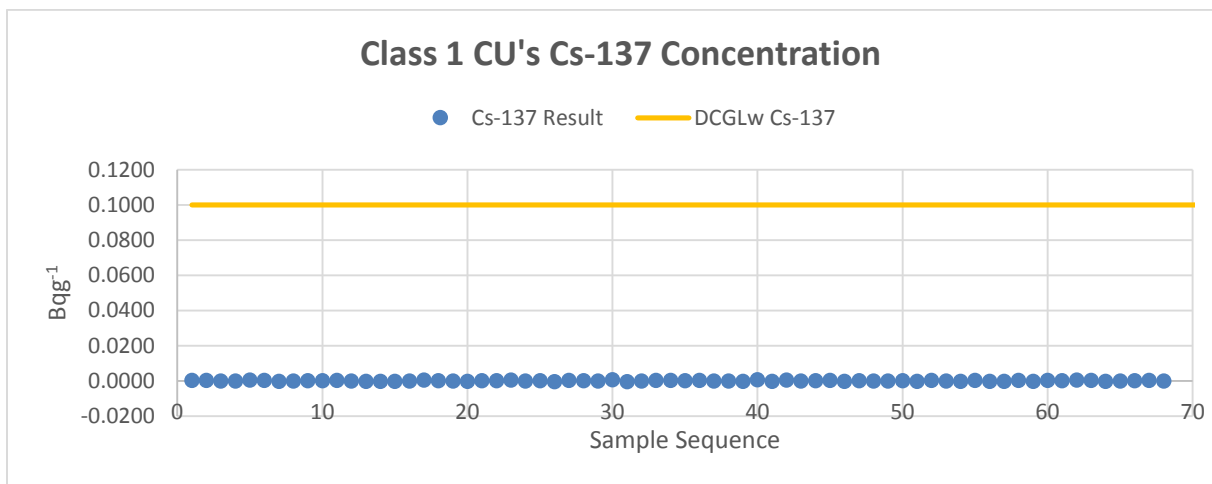
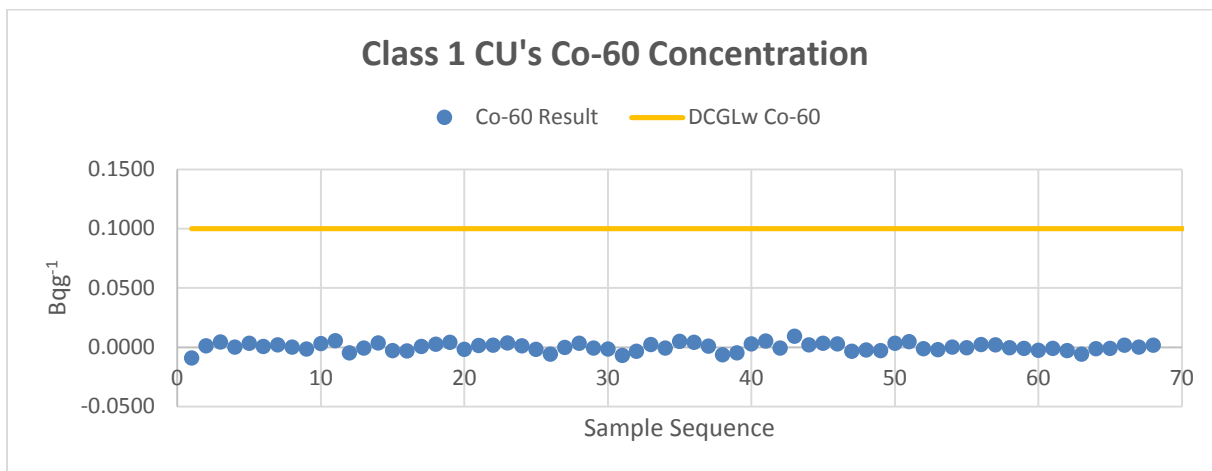
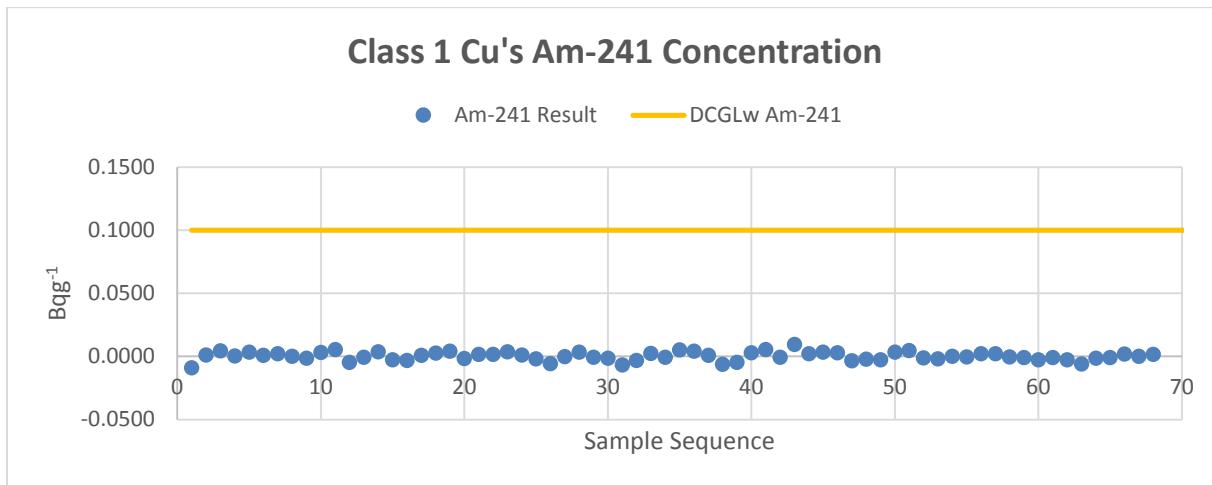


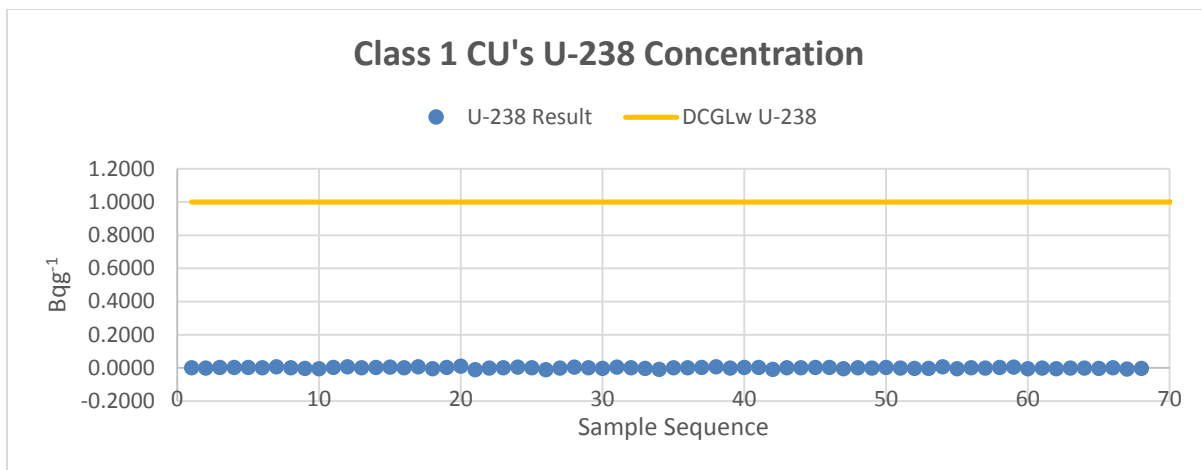
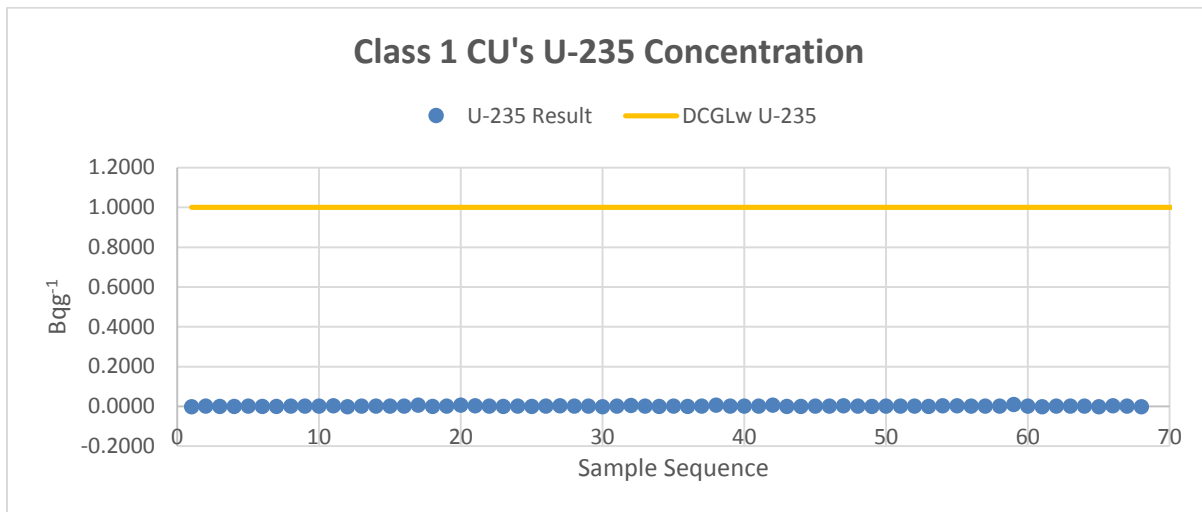
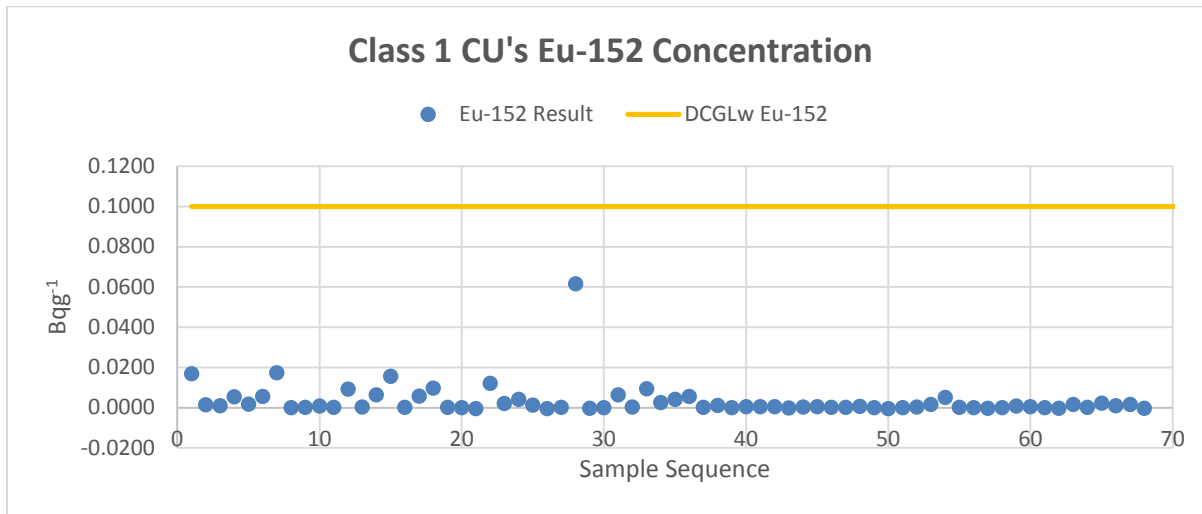


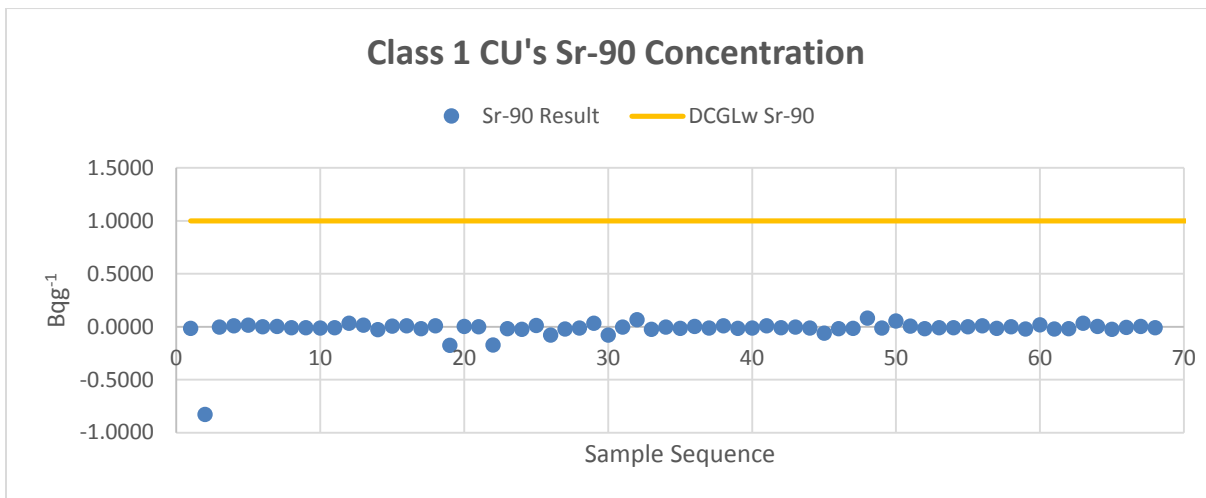
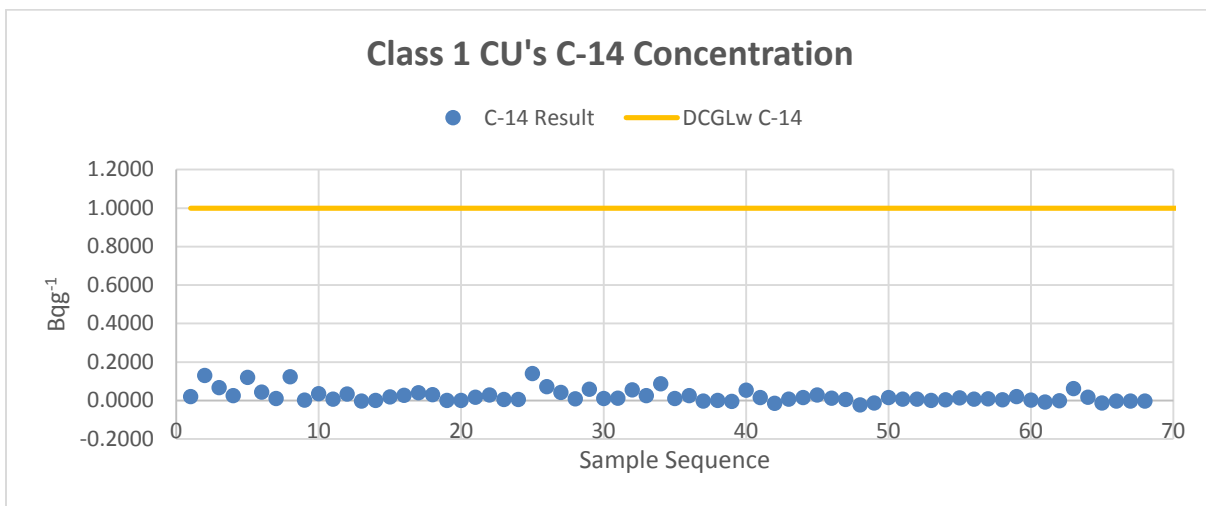
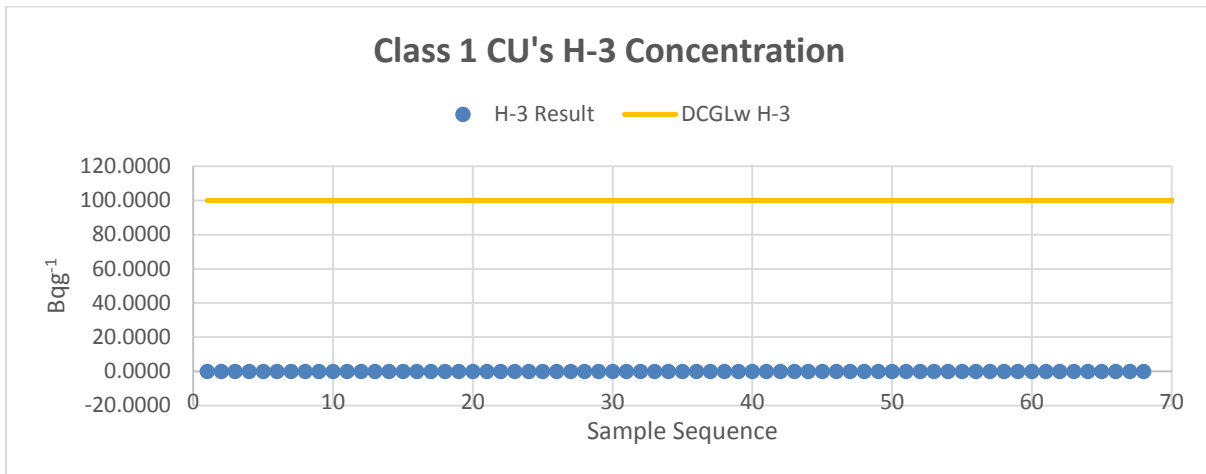


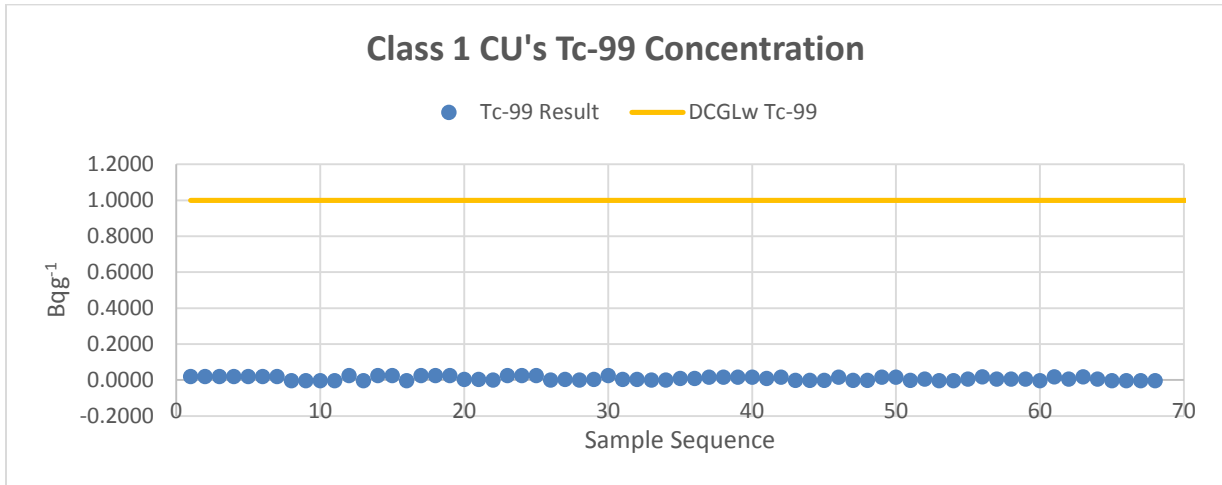


Appendix I Class 1 CUs Scatter Plots for Sample Concentration Comparison with UCLs (Surface)



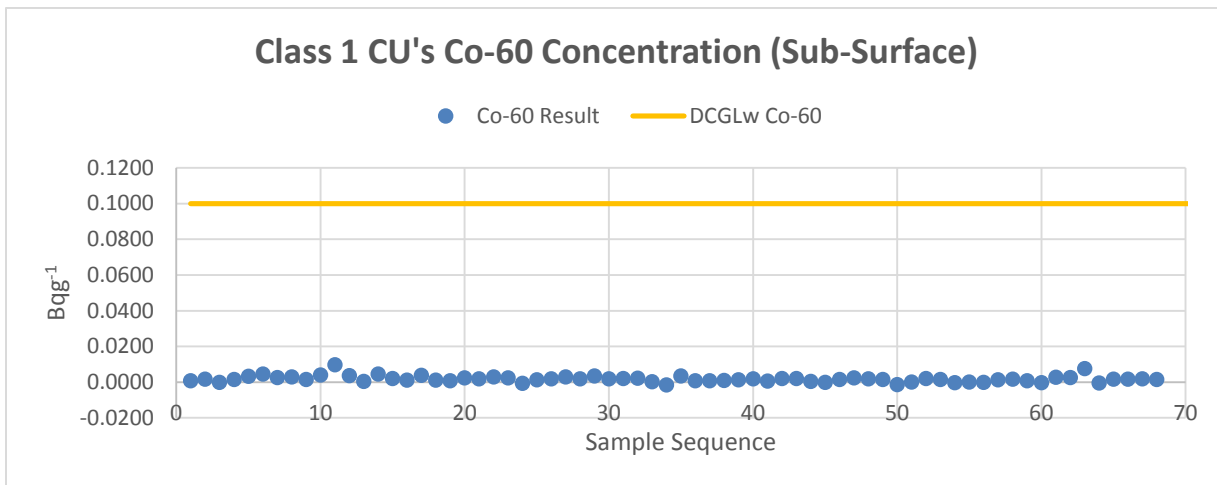
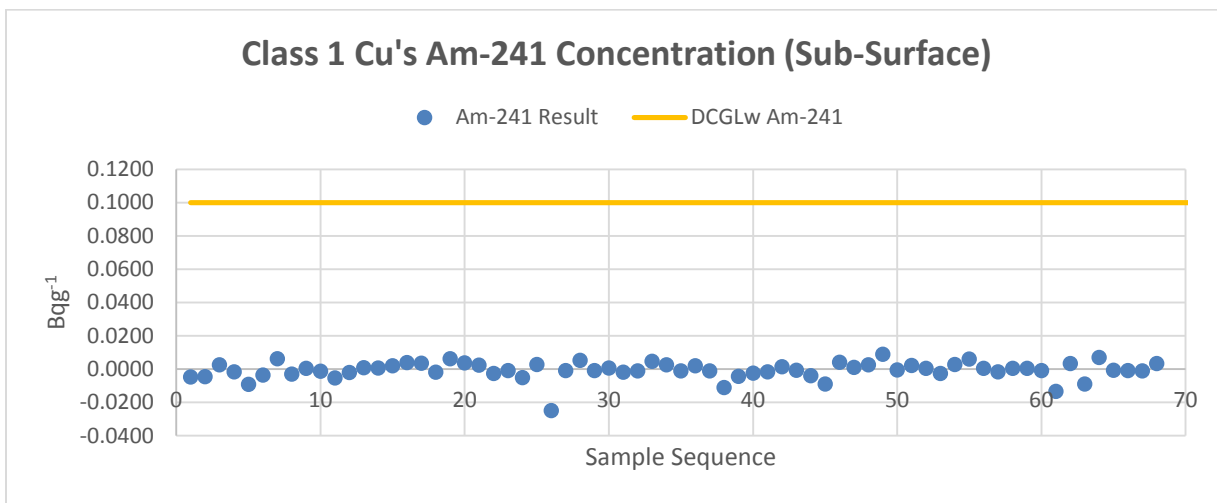


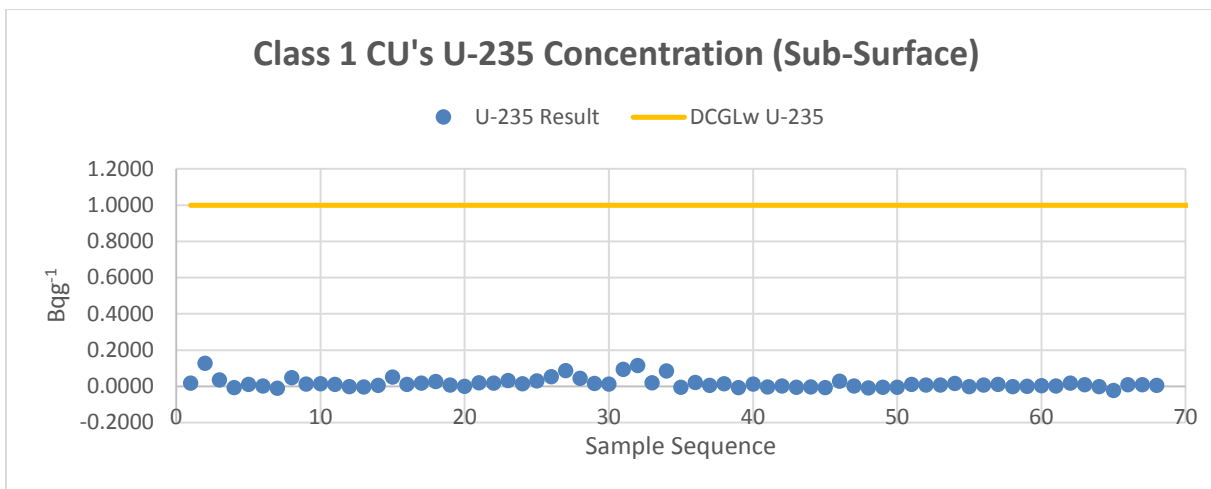
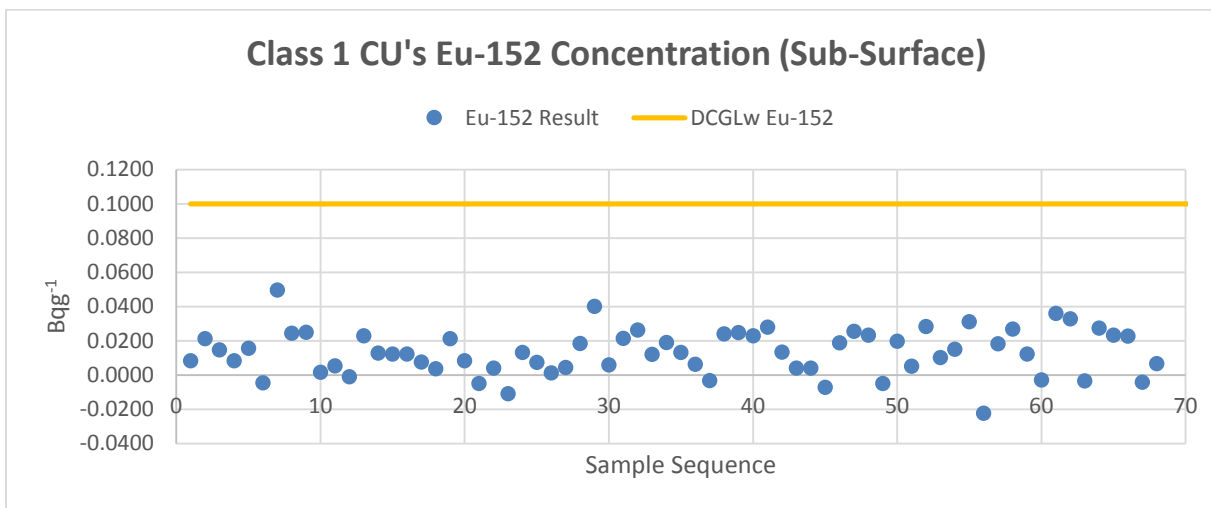
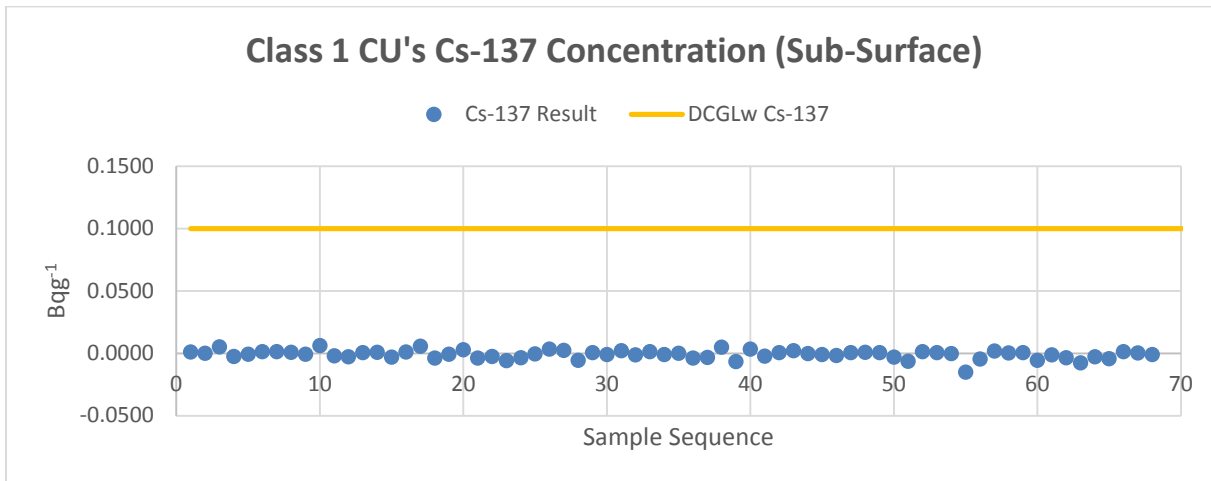


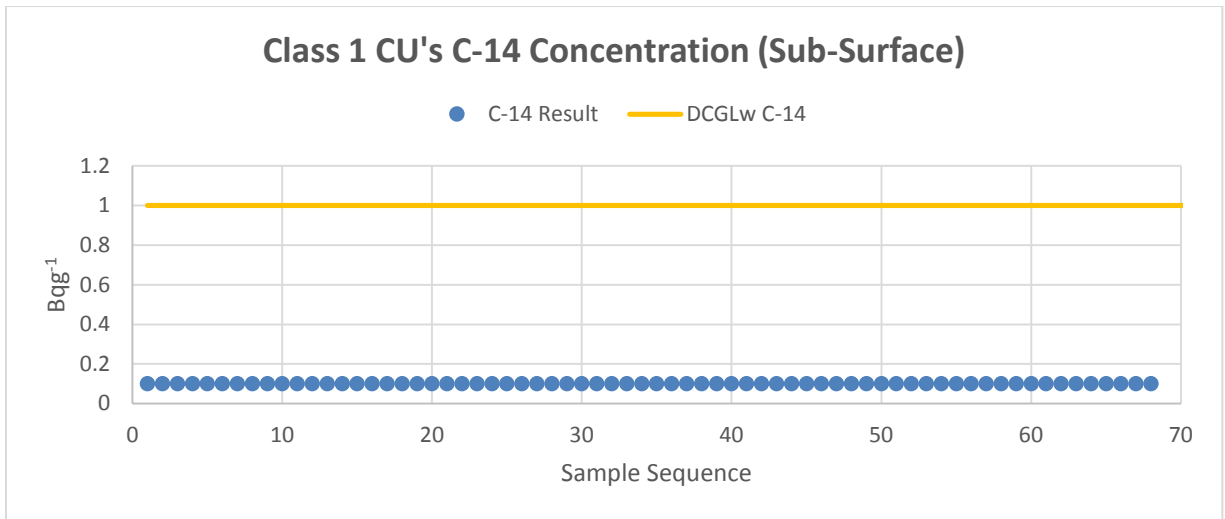
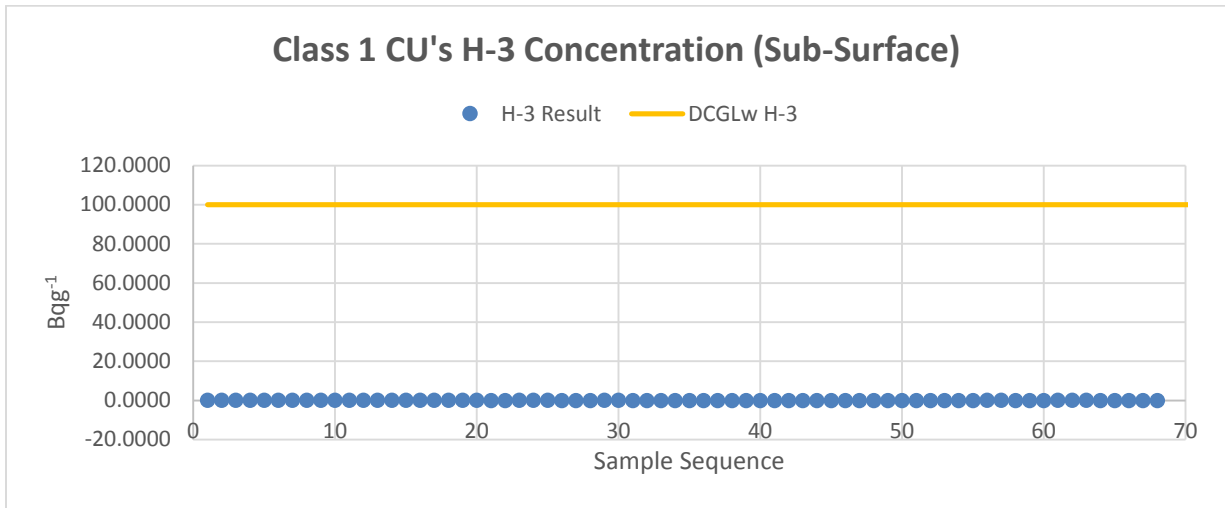
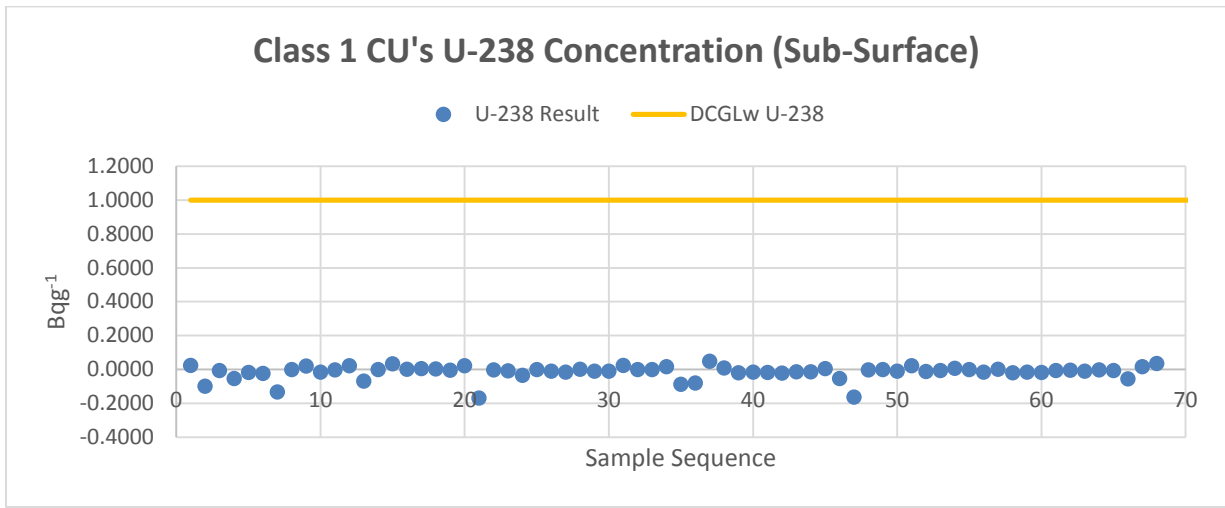


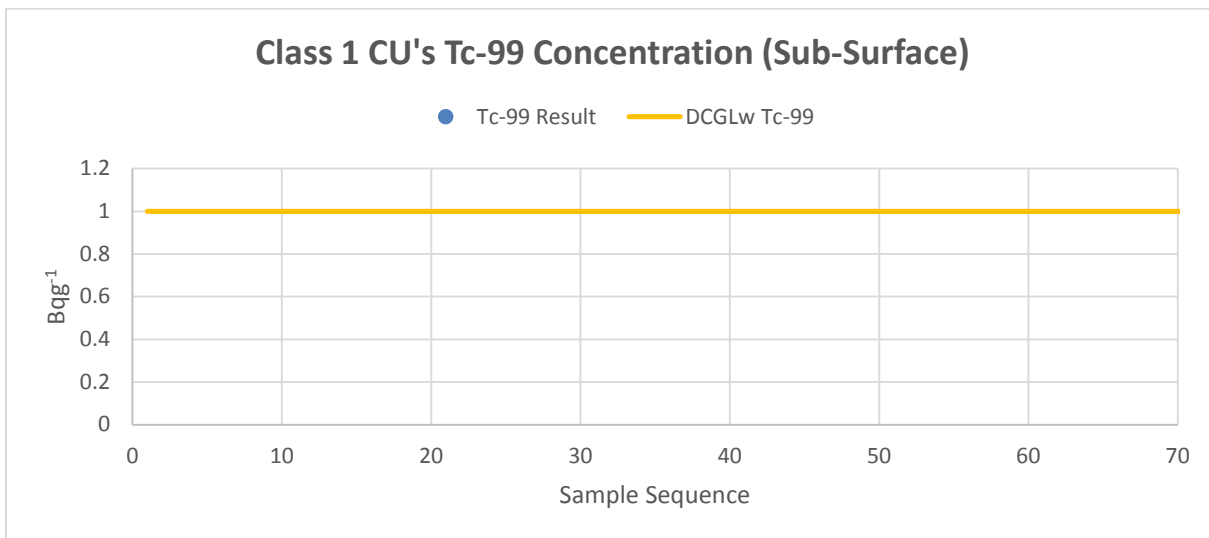
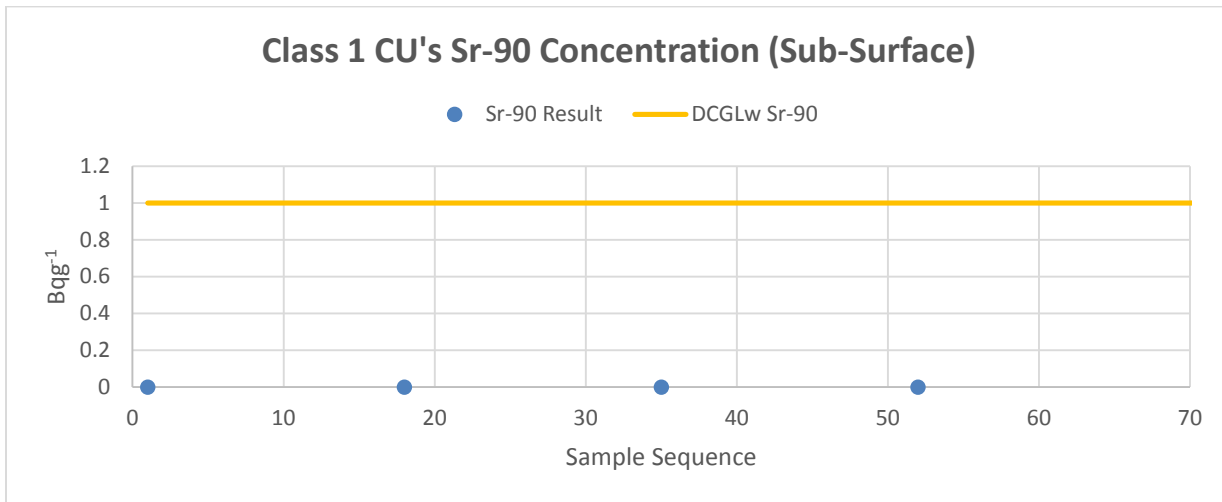
Appendix J

Class 1 CUs Scatter Plots for Sample Concentration Comparison with UCLs (Sub-Surface)









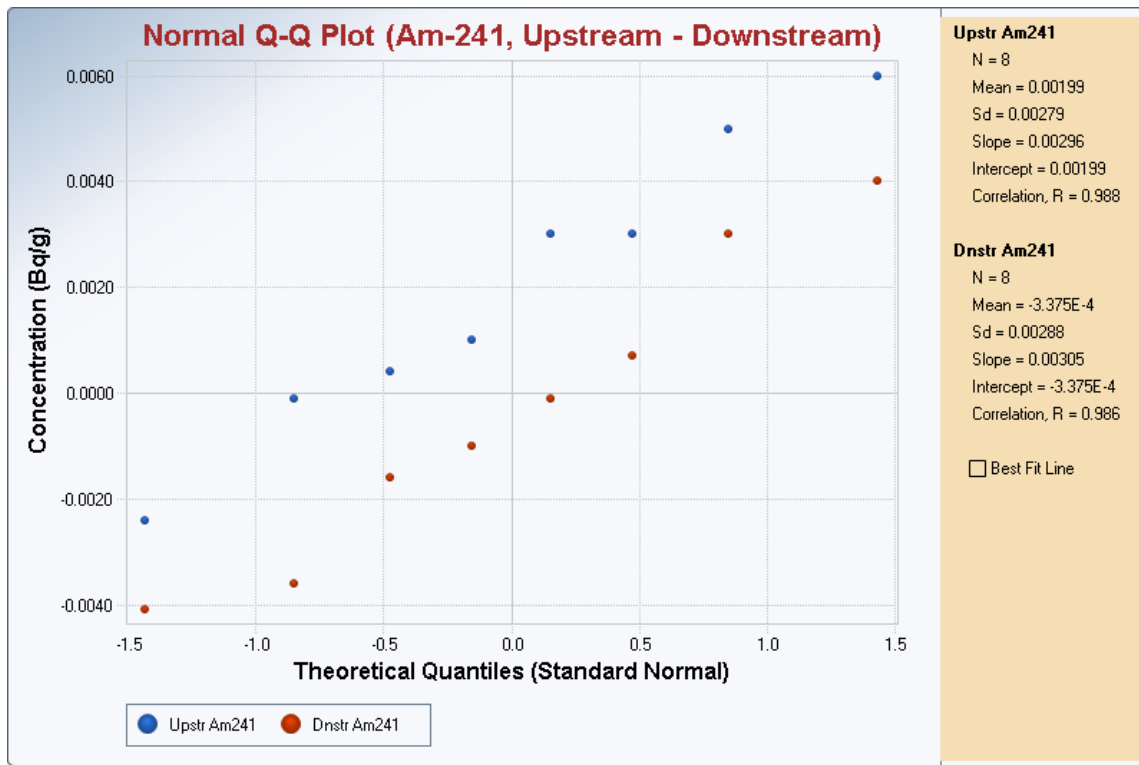
OFFICIAL USE ONLY

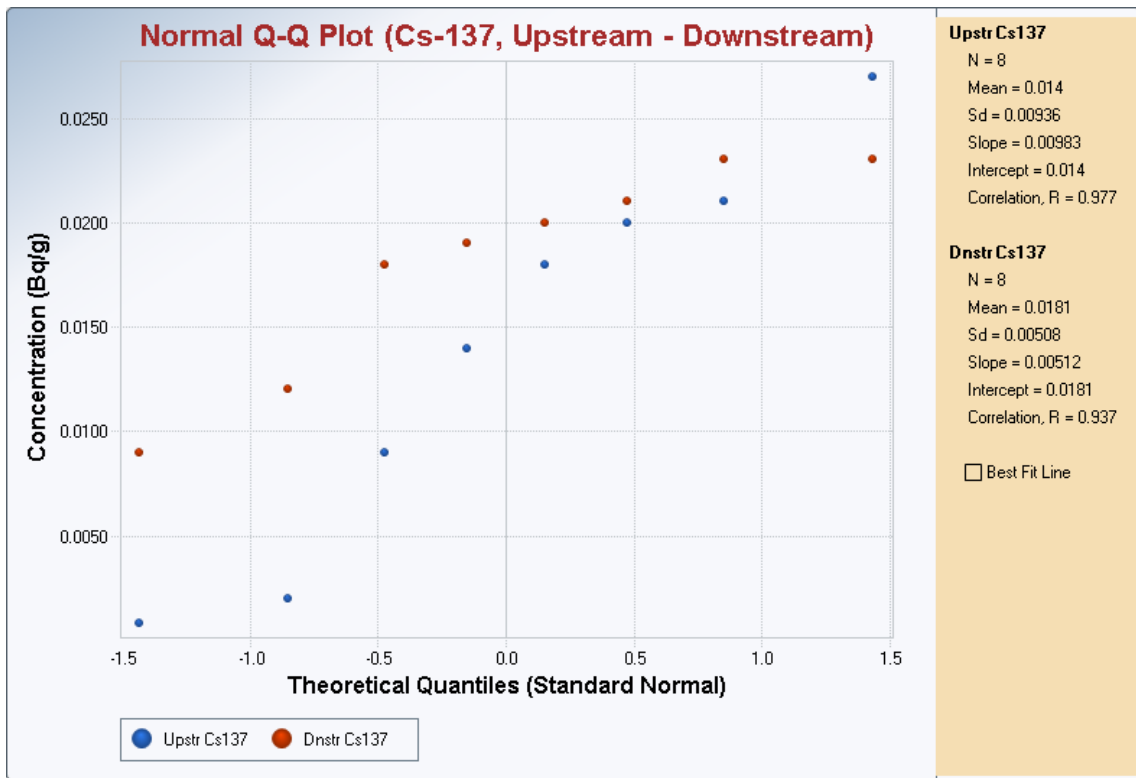
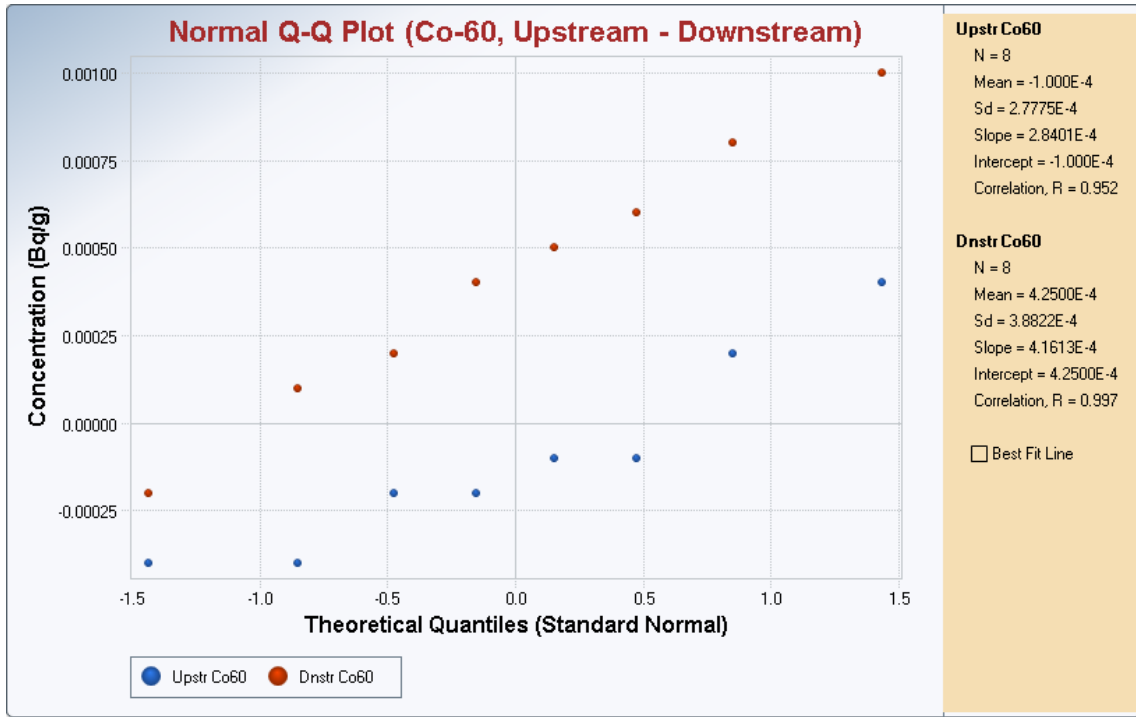
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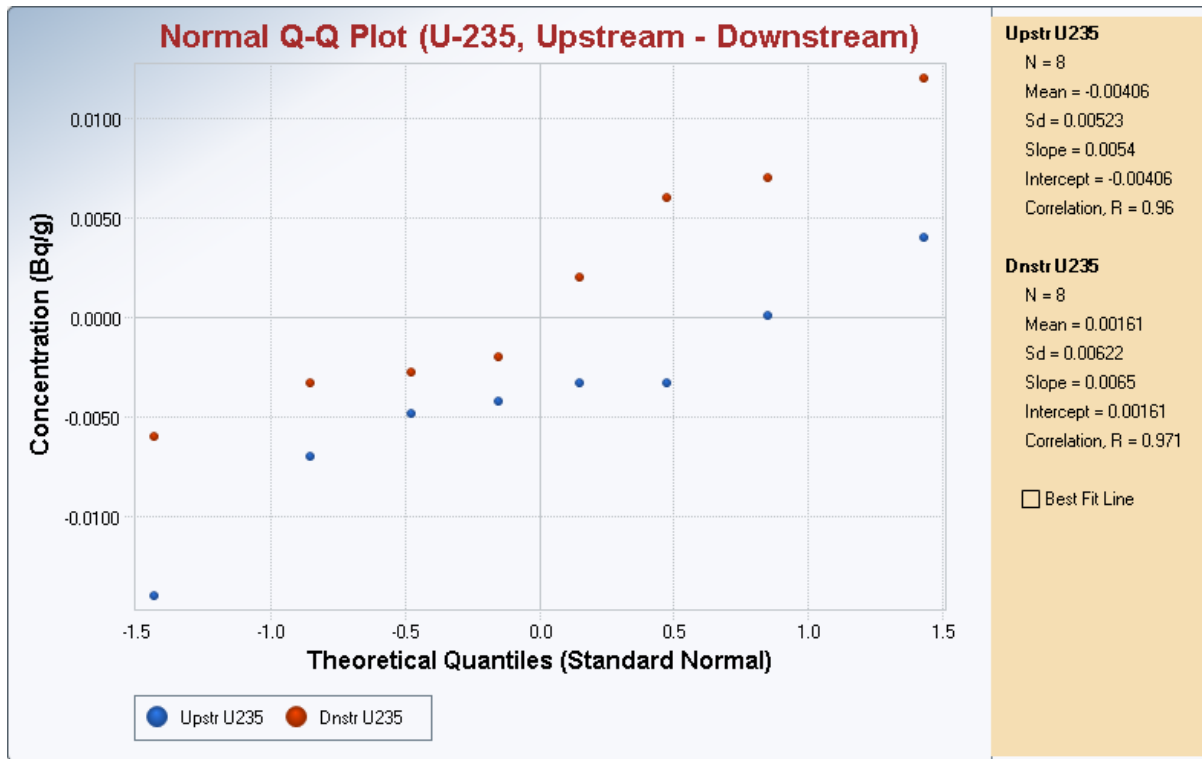
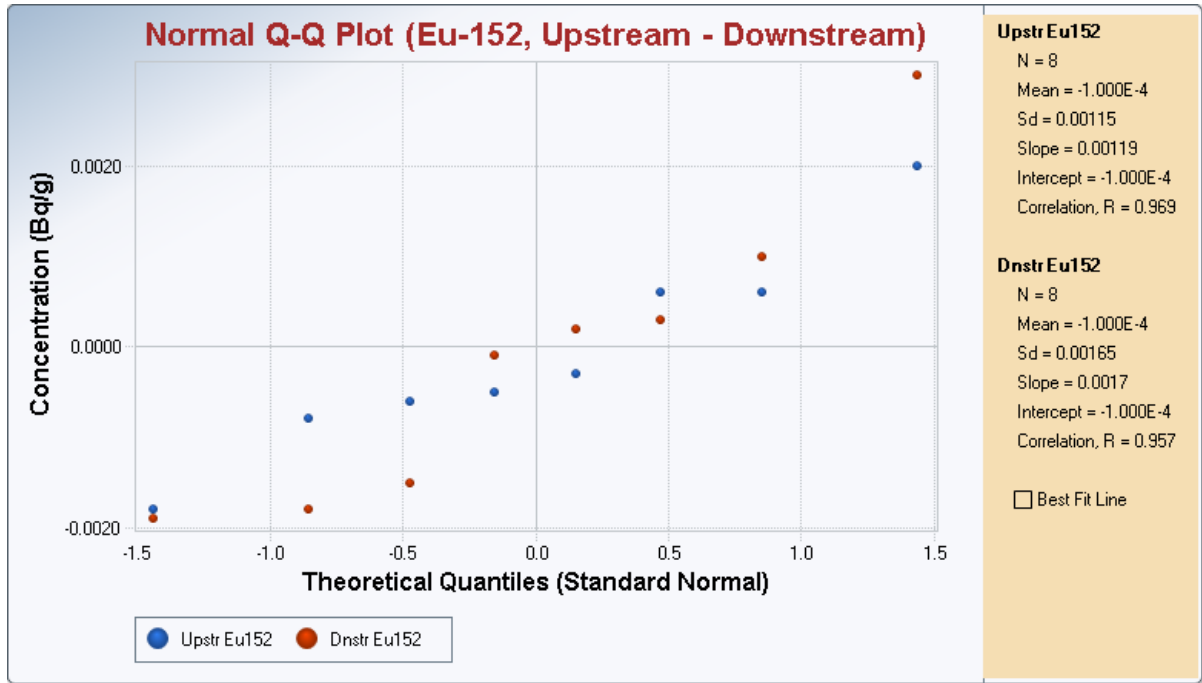
Rev. 0

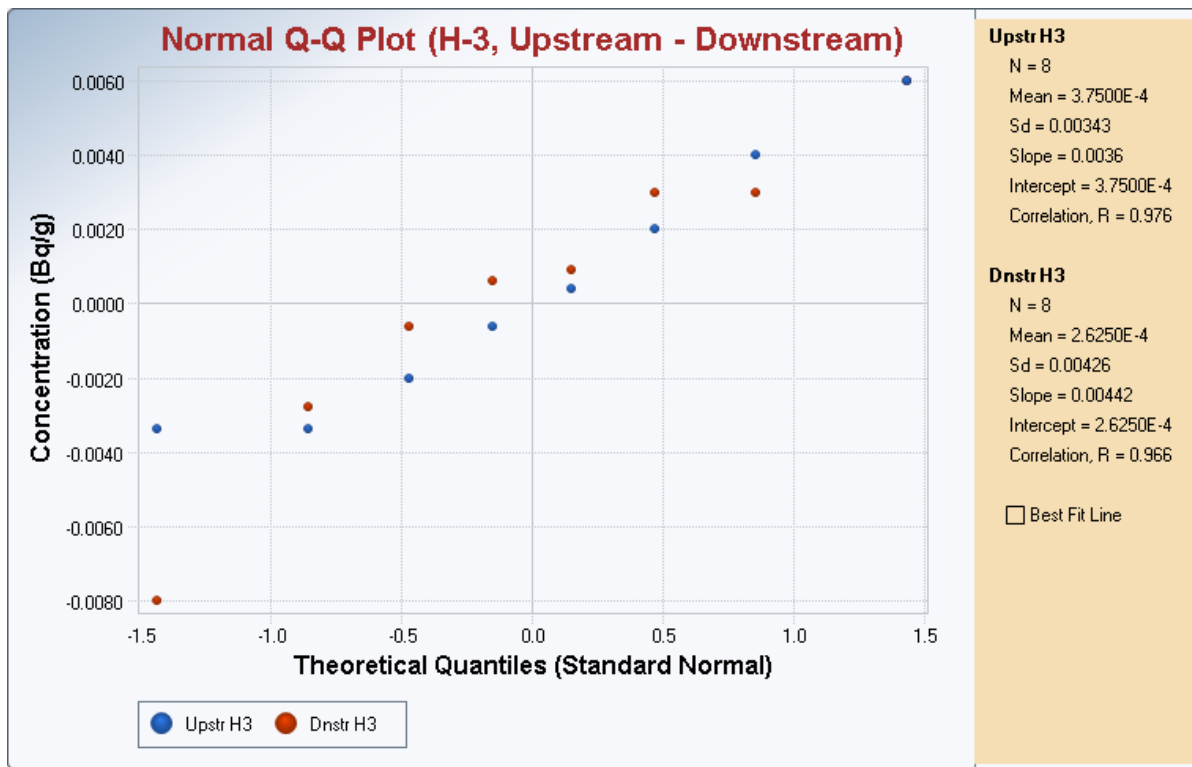
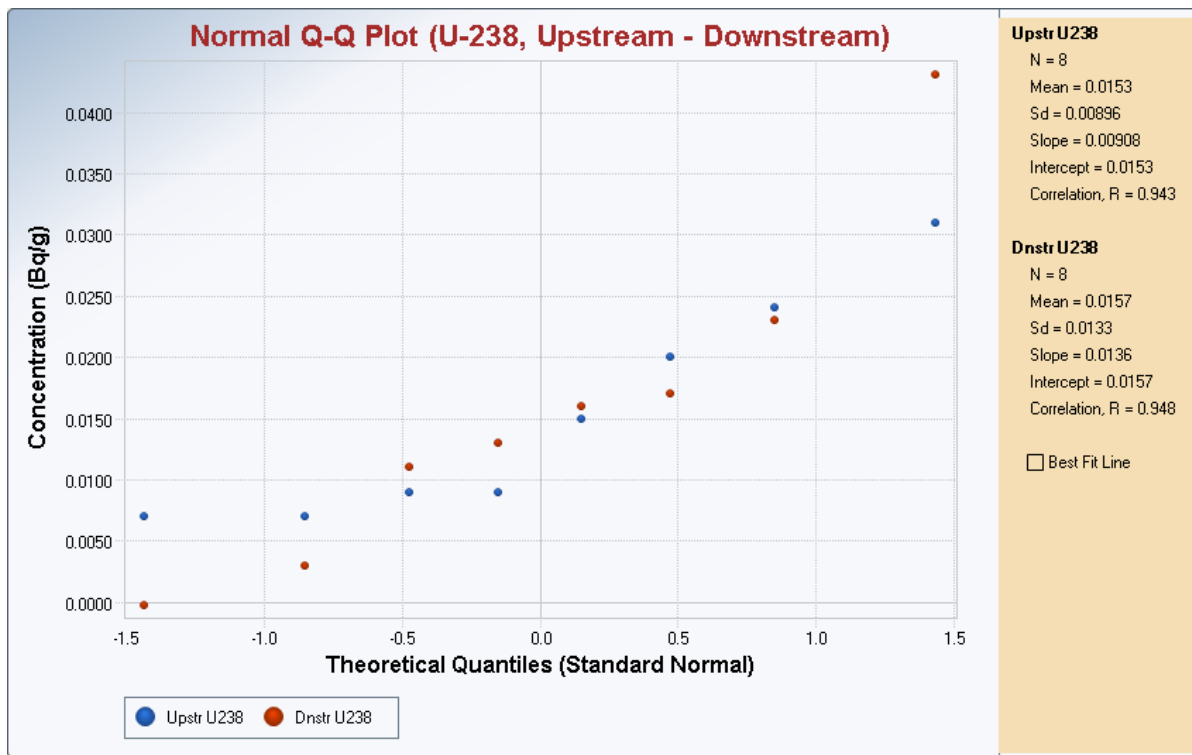
Appendix K

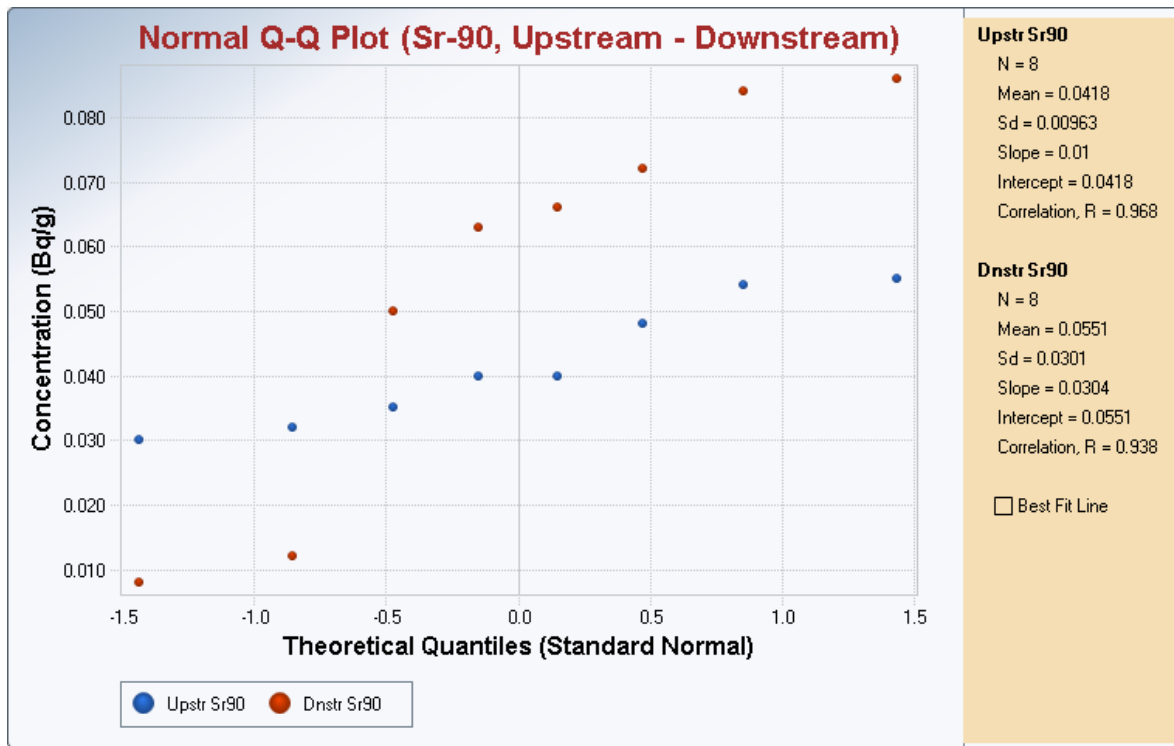
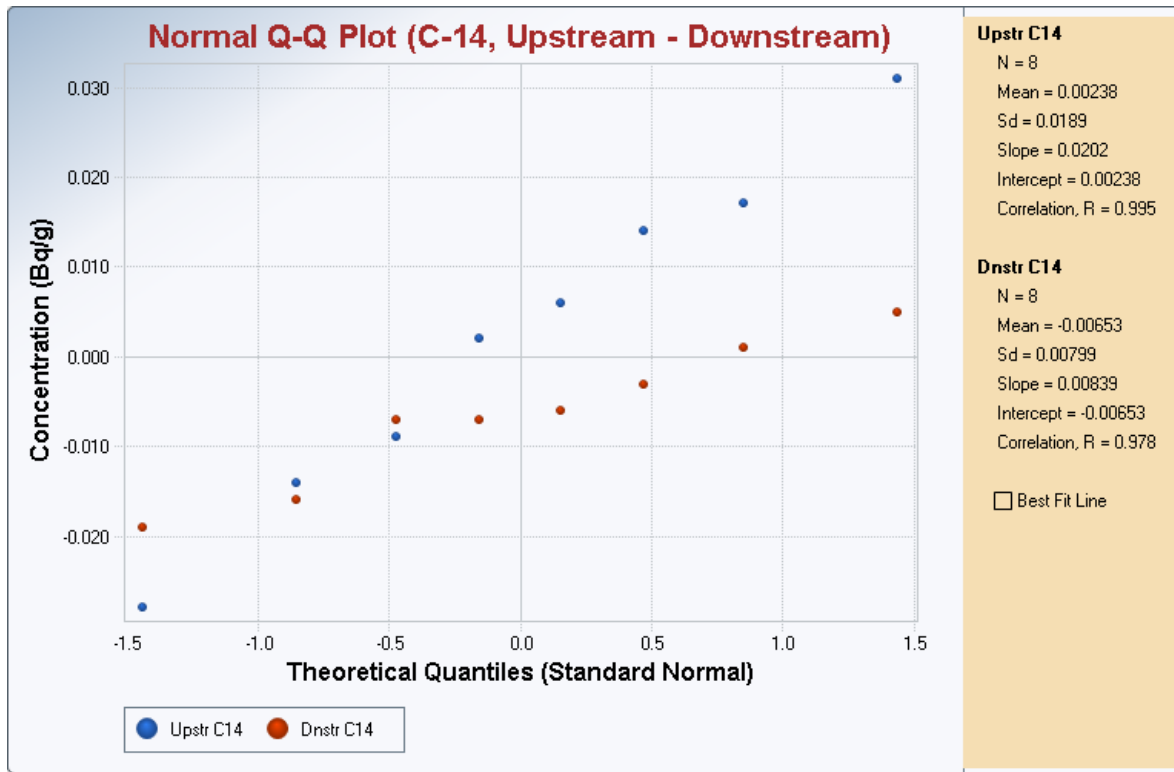
Ottawa Riverbed Sediment Quantile Plots for Sample Distribution Comparison

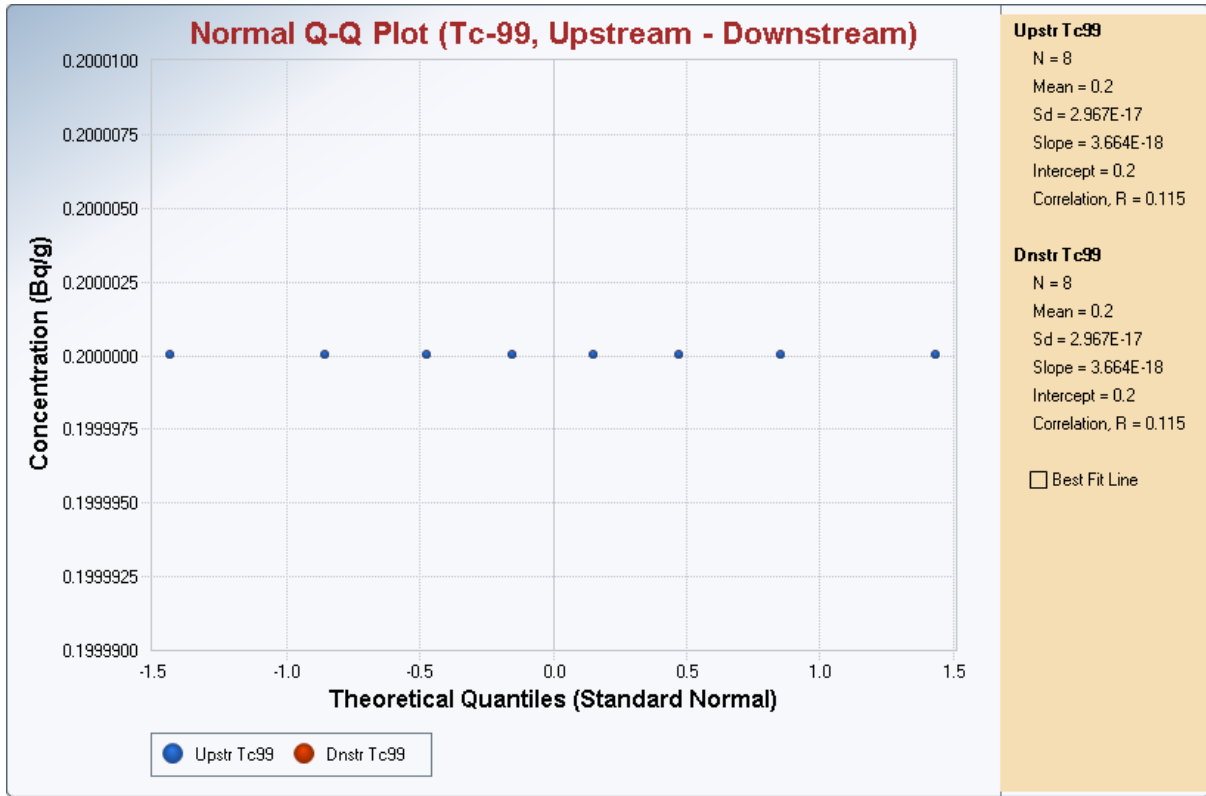








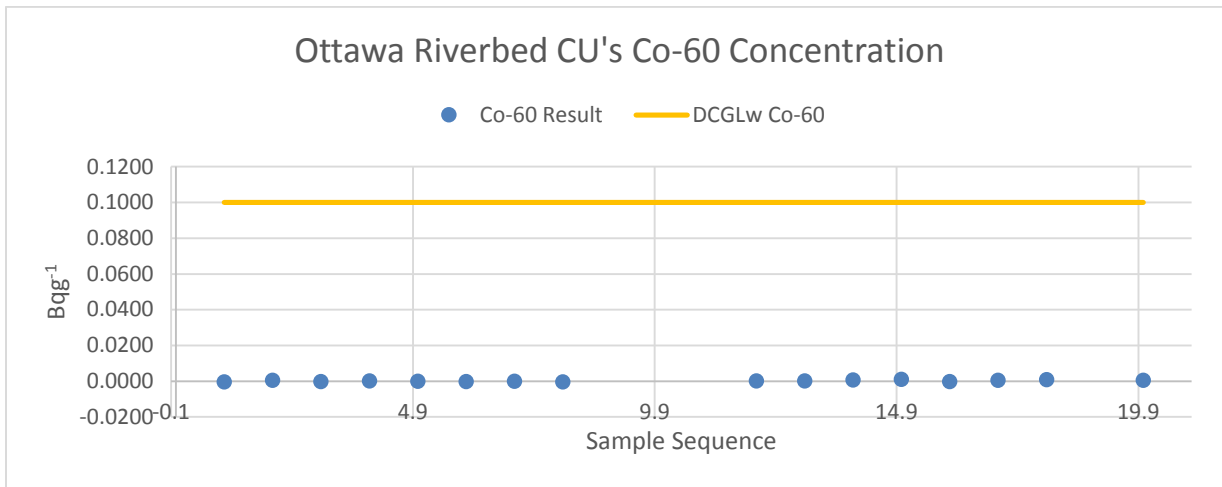
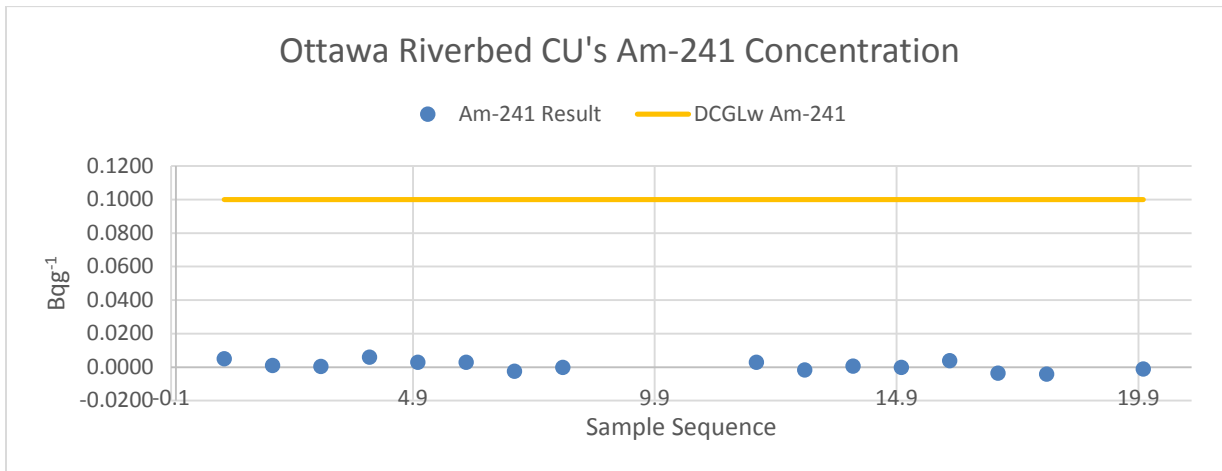


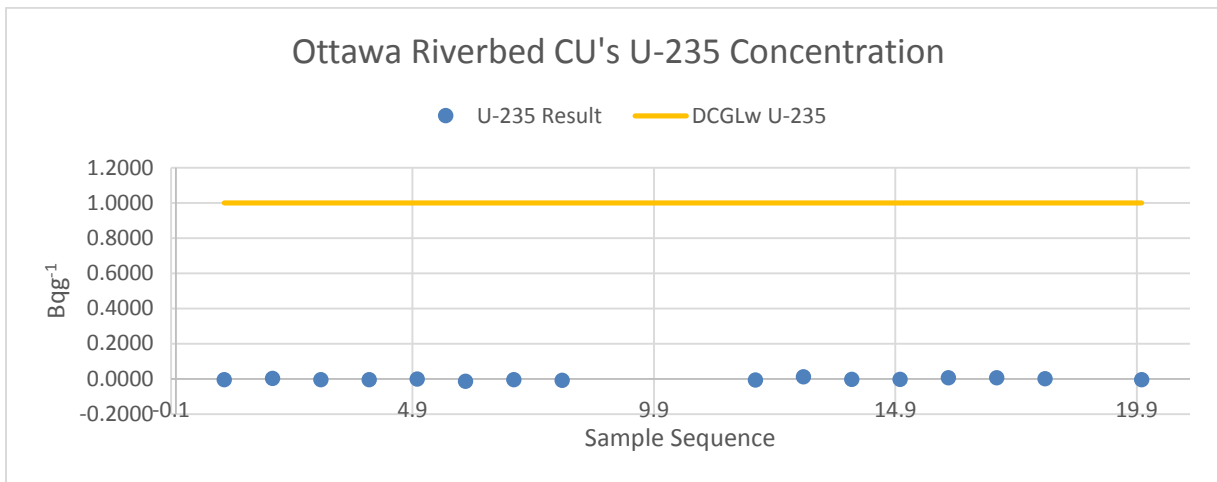
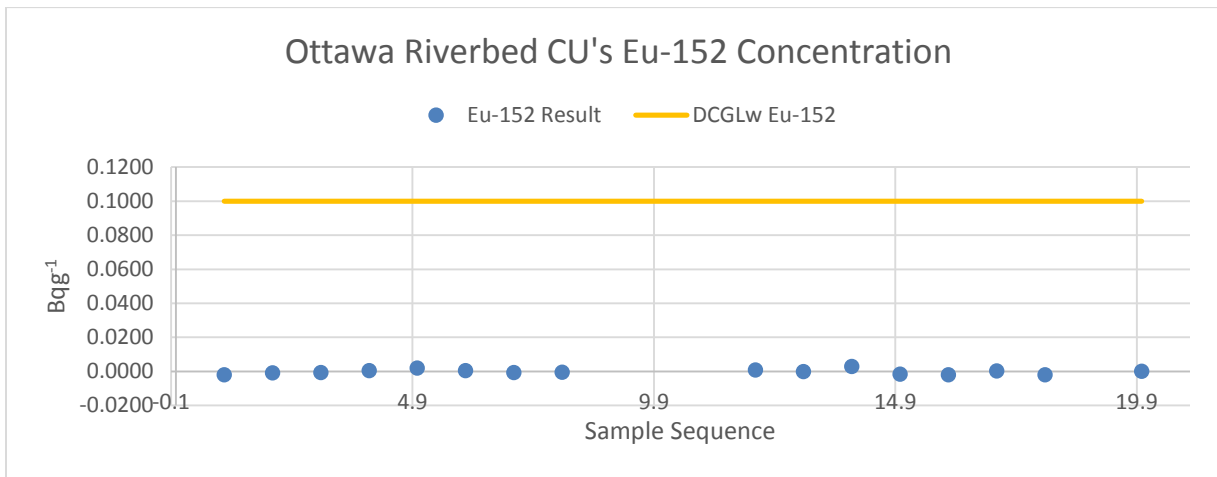
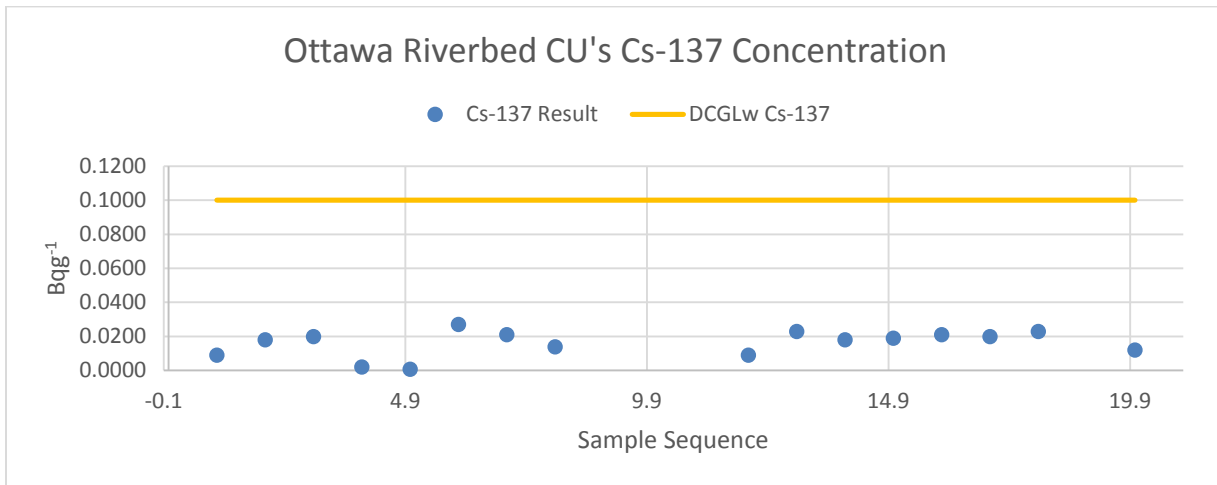


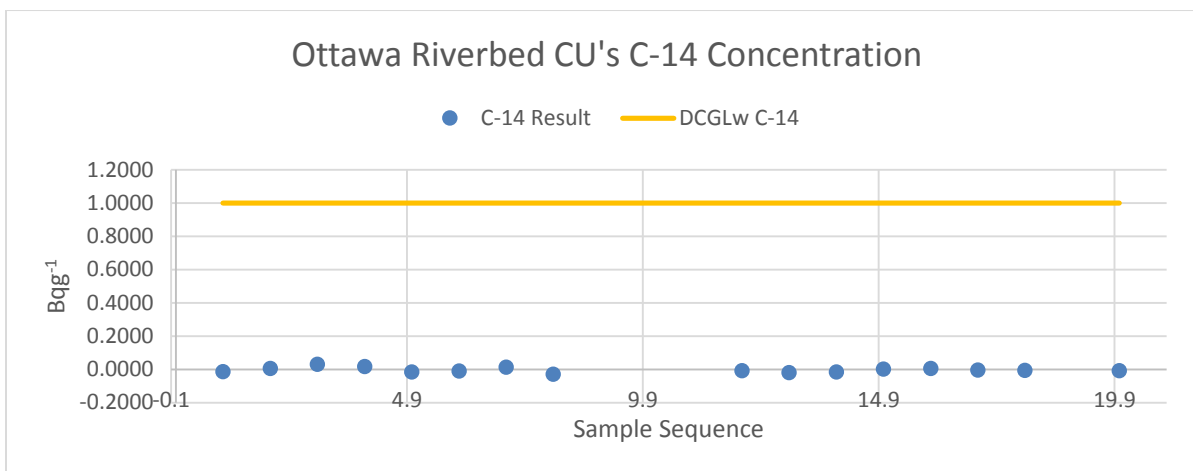
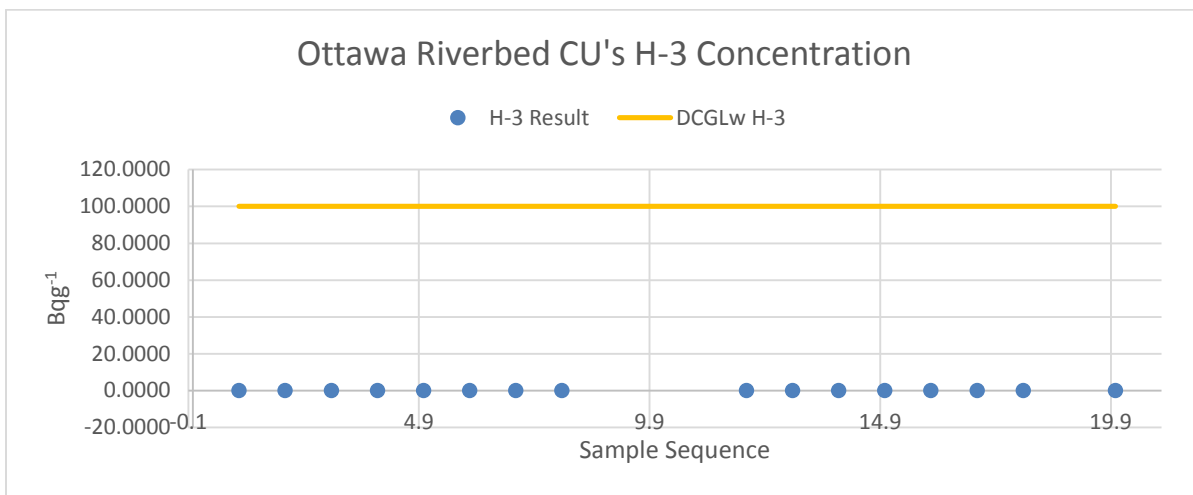
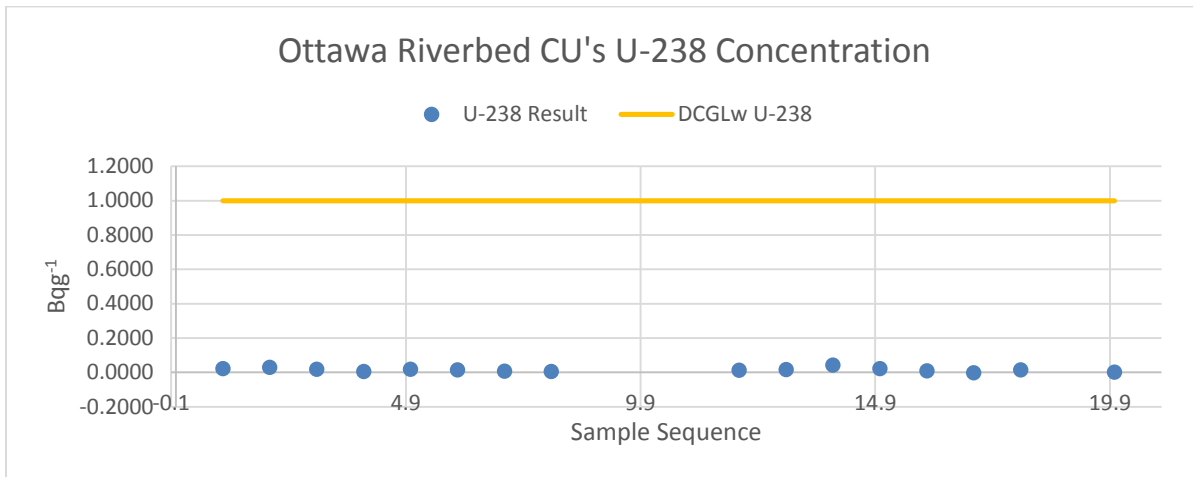
Appendix L

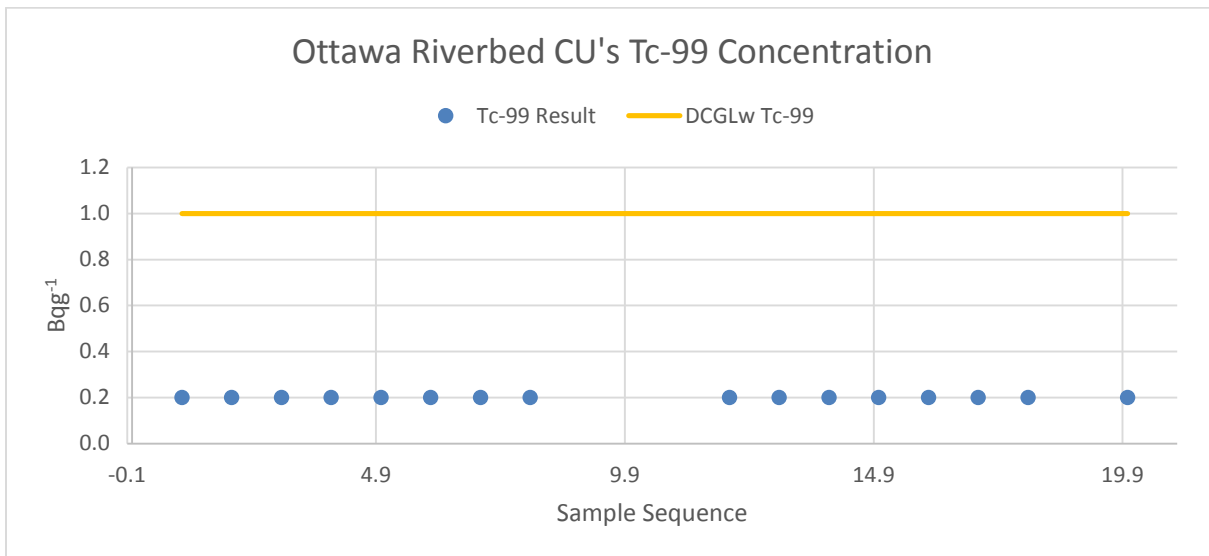
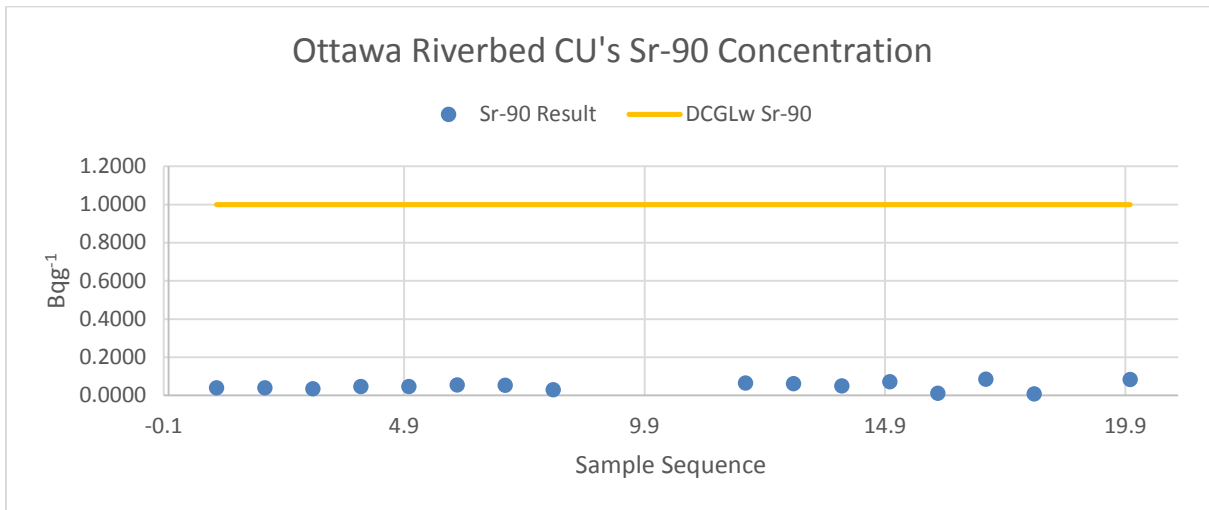
Ottawa Riverbed Sediment Scatter Plots for Sample Concentration Comparison with UCLs

Note: Upstream samples are those plotted on the left of the scale with downstream on the right.









Appendix M

Example Field Check-Out Form for the Ludlum 44-10 NaI Detector

Gann

Checkout Information			
Site and Task	5287 - NPD	Today's Date/Time	2017/05/03
Ratemeter Model	2221	Detector Model	44-10
Ratemeter Number	1144	Detector Number	636
		Threshold (mV)	10
		Window (mV)	0
		Operating Voltage (V)	1075
Calibration Due	2017/09/16	Calibration Due	2017/09/22
Calibration ID	1227	Calibration ID	1236

Source Reproducibility (cpm)	
Source Number	935
Isotope	Lantern mantel
	43,052
	42,751
	42,733
	43,054
	43,157
	43,105
	43,143
	43,246
	43,240
	42,633
Average (cpm)	43,011
3σ range (cpm)	
Low	High
42,343	43,680
5% range (cpm)	
Low	High
40,861	45,162
PASS: 3σ < 10% of average.	

Background Establishment (cpm)	
10,232	
10,420	
10,130	
10,422	
10,265	
10,416	
10,453	
10,388	
10,153	
10,333	
Average (cpm)	
10,321	
20% range (cpm)	
Low	High
8,257	12,385

Technician D. Yuke

LM# 2

Operational Check Out EJS

Site: 5287 - NPD
 Ratemeter Model: 2221 Ratemeter #: 1144 Cal. Due Date: 9/16/2017
 Detector Model: 44-10 Detector #: 636 Cal. Due Date: 9/22/2017
 Voltage (V): 1,075 Threshold (mV): 10 Window (mV): 0

Check Out Date/Time	Background (cpm)	Lantern mantel	935	Checked Out By	Comments (see reverse)
5/3/17 14:30	10,321	43,011		D. Yuke	
5-4-17 10:05	10086	42949		J. MARTIN	S.C. Start of Day
5-4-17 14:45	10373	43141		D. Festerini	End of Day
05/08/17 8:20	9988	43488		P. Y. K. D. Festerini	BOP checks
05/08/17 14:30	9987	43308		D. Yuke	EOD checks
05/09/17 0900	9921	44494		D. Festerini	Start of day check
05/09/17 1600	10087	44501		D. Yuke	EOD checks
05/10/17 8:15	9856	43478		D. Festerini	Start of day
05/10/17 3:40	9838	44788		D. Festerini	End of day
05/11/17 8:20	9823	44945		D. Yuke	BOP checks
05/11/17 8:30	9713	44069		D. Yuke	EOD checks
05/11/17 2:00	8783	43791		D. Festerini	EOD check
05/16/17 8:00	8593	43280		E. Biggs	
05/16/17 3:30	10643	44501		E. Biggs	EOD
05/17/17 7:45	10322	45042		E. Biggs	
05/17/17 3:30	10932	44654		E. Biggs	EOD
05/18/17 7:30	9594	44528		E. Biggs	EOD
05/18/17 1600	9653	43460		KJ	
5/23/17 0800	9812	42,181		KJ	
5/23/17 1600	9492	42,789		KJ	
5/24/17 0800	9718	43,829		KJ	
5/24/17 1600	9984	43,812		KJ	
06/07/17 1500	8752	43,318		DL	

Cal. Background (20%): 8257 to 12385
 Site Background (20%): _____ to _____
 Source Range (5%): 40861 to 45162

Pre-survey Data Reviewed K. Tilton
 Date May 9/17
 Post-survey Data Reviewed _____
 Date _____

Operational Check Out

Site: 5287 - NPD

Rateometer Model: 2221 Rateometer #: 1144 Cal. Due Date: 9/16/2017

Detector Model: 44-10 Detector #: 636 Cal. Due Date: 9/22/2017

Voltage (V): 1,075 Threshold (mV): 10 Window (mV): 0

Check Out Date/Time	Background (cpm)	<u>#2</u> LANTERN MANTLE	Checked Out By	Comments (see reverse)
05-30-17 7:30	12,257	43,505	JM	START OF DAY.
(A.M.) 05-30-17 7:30	12,257	43,505	JM	START OF DAY.
(P.M.) 05-30-17 4:45	11,926	42,554	JM	END OF DAY.
(A.M.) 05-31-17 7:30	12,176	43,167	JM	START OF DAY.
(P.M.) 05-31-17 4:45	12,018	42,652	JM	END OF DAY.
(A.M.) 06-01-17 7:30	9,358	43,416	JM	START OF DAY.
(P.M.) 06-01-17 7:30	11,837	44,311	EB	EOD
06-2-17 7:15	11,523	43,969	EB	SOD
06-2-17 14:30	11,628	43,984	EB	EOD
(A.M.) 06-07-17 7:30	11,933	41,219	JM	START OF DAY.
(P.M.) 06-07-17 3:30	12,155	42,417	JM	END OF DAY.
(A.M.) 06-08-17 7:30	11,857	42,041	JM	START OF DAY.
6-21-17 14:30	9,924	42,068	JM	
6-28-17 10:10	10,027	44,190	JM	START OF DAY.
6-28-17 16:00	10,138	43,791	JM	

Cal. Background (20%): 8257 ~~12385~~ Pre-survey Data Reviewed _____

Site Background (20%): _____ to _____ Date _____

#DIV/0! 40861 ~~45162~~ Post-survey Data Reviewed _____

Date _____

Checkout Information			
Site and Task	5287 - NPD	Today's Date/Time	
Ratemeter Model	2221	Detector Model	44-10
Ratemeter Number	1144 1139	Detector Number	636 1150
		Threshold (mV)	10
		Window (mV)	0
		Operating Voltage (V)	-1075750
Calibration Due	2017/09/16	Calibration Due	2017/09/22
Calibration ID	1227	Calibration ID	1236

Source Reproducibility (cpm)	
Source Number	0940
Isotope	Tn Mantle
	12942
	12858
	12486
	12845
	13088
	13027
	12759
	12628
	12515
	12722
Average (cpm) 12793 #DIV/0!	
3σ range (cpm)	
Low	High
#DIV/0!	#DIV/0!
5% range (cpm)	
Low	High
#DIV/0!	639.68
#DIV/0!	#DIV/0!
#DIV/0!	

Background Establishment (cpm)	
	27431
	27267
	27949
	27351
	27366
	27444
	27615
	27563
	27293
	27682
Average (cpm) #DIV/0! 27496.1	
20% range (cpm)	
Low	High
#DIV/0!	#DIV/0!

5% 1374.81

Technician

12154 B 13432 S
June 7/17 8593 23646

NAppendix N
Example Field Check-Out Form for the Ludlum 43-37 Large Area Gas Proportional Detector
(Floor Monitor)

FLOOR MONITOR

Checkout Information			
Site and Task	5287 - NPD	Today's Date/Time	5/4/17 12:42
Ratemeter Model	2221	Detector Model	43-37
Ratemeter Number	393	Detector Number	382
		Threshold (mV)	10
		Window (mV)	0
		Operating Voltage (V)	1850
Calibration Due	16/09/2017	Calibration Due	23/09/2017
Calibration ID	1223	Calibration ID	1246

Group
 ③

Source Reproducibility (cpm)	
Source Number	940
Isotope	Thorium mantle
	22,997
	23,853
	24,702
	22,145
	24,144
	23,372
	22,356
	22,300
	21,854
	22,328
Average (cpm)	
23,005	
3σ range (cpm)	
Low	High
20,094	25,916
10% range (cpm)	
Low	High
20,705	25,306
PASS: 3σ < 15% of average.	

Background Establishment (cpm)	
	2,613
	2,764
	2,694
	2,664
	2,707
	2,595
	2,718
	2,698
	2,745
	2,605
Average (cpm)	
2,680	
2σ range (cpm)	
Low	High
2,562	2,799
3σ range (cpm)	
Low	High
2,503	2,858
Technician	

21504
 2338
 23385

215011

1 or 2 pass?

Operational Check Out

Site: 5287 - NPD

Ratemeter Model: 2221 Ratemeter #: 393 Cal. Due Date: 9/16/2017

Detector Model: 43-37 Detector #: 382 Cal. Due Date: 9/23/2017

Voltage (V): 1,850 Threshold (mV): 10 Window (mV): 0

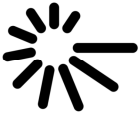
Check Out Date/Time	Background (cpm)	Thorium mantle 940	Checked Out By	Comments (see reverse)
5/4/17 12:42	2,680	23,005	0	
Apr 06/17 0920	2426	22 241	E. Biggs	
Apr 06/17 1425	2129	23563	D. Muizelaar	
Apr 10/17 1335	1921	22 226	E. Biggs	Did not use today
Apr 11/17 1020	2135	21 351	E. Biggs	
Apr 11/17 1050	4000 ⁺	STCP		fix and redo
Apr 11/17 1111	2214	21 926	E. Biggs	
Apr 11/17 1120	2236	21 195	D. Muizelaar	
Apr 17/17 1300	2712	23681	K. Tilton	
Apr 17/17 1500	2618	23084	K. Tilton	
Apr 19/17 1300	2393	23060	K. Tilton	
Apr 19/17 1500	2271	22102	K. Tilton	
Apr 26/2017 8:30	2270	22602	EP	
Apr 26/2017 15:00	2269	23142	EP	
Jan 8/17 1400	2024	23774	KT	malfunctioned later
Jan 12/17 0800	2018	24212	KJ	11
Dec 13, 0800	1978	23,712	KJ	

Cal. Background (2σ): 2562 to 2799 Pre-survey Data Reviewed _____

Site Background (2σ): _____ to _____ Date _____

Source Range (3σ): 20094 to 25916 Post-survey Data Reviewed _____

Date _____



**ENVIRONMENTAL SITE
ASSESSMENT REPORT - NPD
CLOSURE PROJECT**

NPD DECOMMISSIONING

64-509410-REPT-006

Revision 0

<input type="checkbox"/>	CNL	LNC
<input type="checkbox"/> ACCEPTED AS NOTED	<input checked="" type="checkbox"/> ACCEPTED	<input type="checkbox"/> NOT ACCEPTED
Signature	Representing	Date
<i>Meggen Vukob</i>	gen	2017/11/09
<p>"The use and meaning of "ACCEPTED" is governed by the terms and conditions of the P.O. CNL Ref. No 488645 and in any event its use does not relieve the manufacturer of any of its obligations to CNL and/or to its Client"</p> <p>OFFICIAL USE ONLY À USAGE EXCLUSIF</p>		



October 2017



REPORT ON

Phase Two Environmental Site Assessment Nuclear Power Demonstration Site Canadian Nuclear Laboratories

Submitted to:
Meggan Vickard
Canadian Nuclear Laboratories
Nuclear Demonstration Property (NPD)

REPORT

Report Number: 1666131

Distribution:

- 1 e-copy - Canadian Nuclear Laboratories
- 1 e-copy - Golder Associates Ltd.





EXECUTIVE SUMMARY

Golder Associates Ltd. (Golder) was retained by Canadian Nuclear Labs (CNL) to conduct a Phase Two Environmental Site Assessment (Phase Two ESA) of the Nuclear Power Demonstration (NPD) property located in Deep River, Ontario, (the “Site”) in accordance with the *Characterization Plan for Nuclear and Conventional Hazards of the Nuclear Power Demonstration Waste Facility (NPD) NPD Decommissioning 64-509410-PLA-001 Revision 0* (accepted by CNL July 19, 2016), prepared by Oak Ridge Associated Universities (ORAU) (“Characterization Plan”). Prior to creating the Characterization Plan, ORAU conducted a Historical Site Assessment (HSA) for the Site (report title: *Historical Site Assessment for the Nuclear Power Demonstration Waste Management Facility Rolphton, Ontario 64-509410-ASD-001 Revision 0, accepted by CNL July 18, 2016*). The HSA was conducted based on the Phase One ESA CSA Standard Z678-01 (R2012) and on nuclear industry site characterization guidance (Multi-Agency Radiation Survey and Site Investigation Manual, referred to as “MARSSIM”). The scope of the field investigation program is described in *Environmental Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories* (November 21, 2016) (“CNL NPD Sampling Plan”), which was prepared by Golder and reviewed by CNL to ensure that that all requirements of the Characterization Plan were met. The Phase Two Environmental Site Assessment (ESA) was completed in May 2017 by Golder staff to characterize the environmental condition of soil and groundwater in the Class 1 area, Class 2 area, and the Background Reference Area (BRA) at the Site.

Based on the Characterization Plan, the Phase Two ESA investigated the four class areas:

- **Class 1:** Includes the fenced in “Licensed Area” around the former reactor building, as well as the concrete pad which extends past the fence to the north.
- **Class 2:** Includes the current, and historically developed sections of the Site, with the exception of the Class 1 Area, as well as the entrance roadways and former landfill.
- **Class 3:** Includes the NPD property bounded by Highway 17 to the south, the Ottawa River to the North, the termination of Cutler Lane to the East, and Swisha Road to the West, with the exception of the Class 1 and 2 Areas as well as the Background Reference Areas.
- **Background Reference Area:** The BRA includes the land approximately 1 km south of Highway 17 south of the NPD Property, as well as the southwest portion of the NPD Property bounded by Swisha Road to the North and Highway 17 to the South.

Within each Class and the BRA, soil samples were collected at the locations prescribed in the Characterization Plan (i.e., using the MARSSIM approach to statistically select locations based on a 95 percent upper confidence level) and screened for Conventional Contaminants of Concern (CCOCs). Soil sample depths varied by class but were generally 0 to 0.15 metres below ground surface (mbgs) at the Class 2, Class 3 and BRA areas, 0 to 0.15 mbgs and 0.15 to 0.30 mbgs at Class 1 areas and deeper where waste was identified at the Class 2 Landfill #1. All soil samples were submitted for one or more selected CCOCs where indications of CCOC field impact were present. Soil samples were submitted for one or more of the following: metals, Petroleum Hydrocarbons Fractions F1-F4 (PHC F1-F4), Polycyclic Aromatic Hydrocarbons (PAHs), and Volatile Organic Compounds (VOCs).



**PHASE TWO ENVIRONMENTAL SITE ASSESSMENT
NPD SITE, CANADIAN NUCLEAR LABORATORIES**

In addition to the areas on Site, the Phase Two ESA also included the assessment of sediment quality at 16 locations in the Ottawa River upstream, adjacent to and downstream (and east) of the Site. Finally, judgemental sediment sampling (intended for shallow on-site ditches) as described in the Characterization Plan was not identified during the field program and as such, two areas identified by CNL where suspected historic unauthorized dumping had occurred and one area where vehicle maintenance had occurred historically were investigated in place of this task (“J” series soil samples).

The high-level summary of Phase Two Investigation conducted is provided as follows:

Primary Decision Unit	Sample Class	Overview of Conventional Contaminant of Concern (CCOC) Investigation
Exclusion Zone	All Class 3 locations and a number of Class 2 locations within the Station Area of the Exclusion Zone	Surface soils sampling, 0 to 0.15 metres below ground surface (mbgs) Landfill #1 sampling (soil samples from 0 to 0.5 and 0.5 to 1.0 metre intervals within waste layer) Groundwater sampling
Ottawa River	Class 3 locations	Sampling of upper 0.15 m of sediment at 16 locations, varying from a few metres off-shore to approximately 90 metres off-shore
Licensed Area	Class 1 locations	Surface soils sampling (0 to 0.15 mbgs) Subsurface soil sampling (0.15 to 0.30 mbgs) Groundwater sampling Mercury Smear Analysis at Characterization of Effluent Process Lines

The Phase Two ESA was consistent with requirements defined in Ontario Regulation (O. Reg.) 153/04 (as amended) and was undertaken with the general objective of determining the environmental condition of the Site in terms of CCOCs relative to federal and provincial environmental standards for more sensitive land uses (i.e., Residential/Parks/Institutional Property). It is understood that there are no planned changes from less sensitive to more sensitive land uses at the Site, so there is no mandatory requirement for the filing of a Record of Site Condition (RSC) pursuant to *Ontario Regulation 153/04 – Records of Site Condition – Part XV.1 of the Act*, made under the *Environmental Protection Act* (“O.Reg 153/04”). As described in the CNL NPD Sampling Plan, the investigation was completed in general accordance with both the Canadian Council Ministers of the Environment (CCME) Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment (CCME Guidance Manual) and the Ontario Ministry of Environment and Climate Change (MOECC) Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario (MOECC Sampling Guidance). The investigation included a borehole drilling and test pit excavation program for the collection of soil samples, and groundwater samples were collected from existing monitoring wells at the Site. Samples were submitted for analysis of CCOCs as well as radiological parameters; however, only the results for the CCOCs are considered in the Phase Two ESA. The analytical results for soil were compared to both the MOECC Table 2 generic site condition standards (residential/parkland/institutional property use, potable groundwater, coarse-grained) presented in the MOECC “*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*”, dated April 15, 2011, and the CCME Soil Quality Guidelines for residential/parkland land use.



The analytical results for groundwater were compared to the MOECC Table 2 generic site condition standards and the Health Canada Canadian Drinking Water Quality Guidelines (Health Canada “*Guidelines for Canadian Drinking Water Quality – Summary Table*”, dated February 2017).

The Phase Two ESA indicated the following:

- The Site is generally underlain native alluvial material. Much of the developed portions of the Site is built on a thick layer of sand and gravel fill. The bedrock consists of crystalline Precambrian assemblages primarily of granitic and granodioritic gneisses, with mafic bedrock in the southeast portion of the Site.
- Based on both historical boreholes and boreholes completed during the current investigation, the majority of subsurface data was from the Class 1 licenced area where the former NPD reactor building is located. The subsurface materials in the Class 1 area consist of a thin surficial layer of topsoil or asphalt, which is underlain by sand and gravel fill. This sand and gravel fill material extends from the bottom of the topsoil/asphalt layer to black-coloured bedrock, which is reportedly present at depths of approximately 5.7 to 8.0 metres below ground surface (mbgs) in the area near the reactor building.
- A summary of the soil conditions at the Site based on the results of the Phase Two ESA by area is as follows:
 - *Class 1 area* – A total of 68 locations were investigated, with stratigraphic delineation, at the following depths: 0 to 0.15 mbgs and 0.15 to 0.3 mbgs. Samples were collected if evidence of impact was detected by Photo-Ionization Detector (PID) readings or by visual assessment. Of the 68 locations investigated, seven (7) soil samples and one (1) field duplicate were submitted for CCOC analysis based on field evidence of potential impacts.
 - Two (2) of the seven (7) soil samples analyzed for PHCs, BTEX, and PAHs exceeded CCME Soil Quality Guidelines for the PAH phenanthrene. One sample, in the northwest of the area, also exceeded both MOECC Table 2 and/or CCME Soil Quality Guidelines for six other PAHs. No PHC or BTEX exceedances were identified in the Class 1 area.
 - *Class 2 area* – A total of 255 locations were investigated as well as an additional 13 locations for the limited historic unauthorized dumping or vehicle maintenance (“J” series samples) and one (1) location where debris was noted by the Ottawa River. Locations were investigated generally at 0 to 0.15 mbgs and in some cases from 0.15 to 0.3 mbgs; and, at Landfill #1 soil cores were advanced deeper to investigate for the presence of historical waste. CCOC Samples were collected if evidence of impact was detected by PID readings or by visual assessment. Within the Class 2 samples prescribed by the Characterization Plan seven (7) samples and one (1) field duplicate were submitted for CCOC analysis. Within “J” series, 16 samples and one (1) field duplicate were submitted for CCOC analysis. One soil sample where debris was noted by the Ottawa River was submitted for CCOC analysis.
 - The concentrations of PHCs in two of the samples analyzed exceeded MOECC Table 2 Standards and CCME Guidelines;
 - Two of samples analyzed for PAHs exceeded CCME Soil Quality Guidelines for phenanthrene; and,
 - Two samples analyzed for metals exceeded MOECC Table 2 Standards and/or CCME Soil Quality Guidelines for select metals.
 - *Class 3 and BRA*– A total of 96 investigations were located at 0 to 0.15 mbgs. No field indication of impacts were observed and no CCOC samples were submitted for analysis.



PHASE TWO ENVIRONMENTAL SITE ASSESSMENT NPD SITE, CANADIAN NUCLEAR LABORATORIES

- Five new groundwater wells were installed as part of Phase Two ESA activities in December 2016. These wells were installed for the assessment of hydraulic conductivity and were not sampled as part of the monitoring program.
- Groundwater sampling was completed using 24 previously existing monitoring wells at the Site. The results of the groundwater testing indicated that the concentrations of the PHCs F1 to F4, BTEX, and PAHs in each of the groundwater samples were below the applicable MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines. An exception was the sample from BH14-01, which had levels of benzo[a]pyrene that exceeded both MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines; however, it is considered likely that this was due to disturbed sediment in the groundwater sample as a result of low groundwater yield in the well, which was pumped dry four times during the sample collection process.
- Sediment sampling was completed at 16 locations in the Ottawa River both upstream and downstream from the NPD Site. Based on the results of the CNL sediment sampling, it was concluded that elevated levels of select metals, PAHs, and PCBs above the applicable standards and/or guidelines were found in the sediment both upstream and downstream of the CNL NPD Site. Based on the type, magnitude and distribution of exceedances, it is considered unlikely that the CNL NPD Site has contributed to the elevated levels of select contaminants in the Ottawa River sediment. No further sediment sampling is recommended at this time.
- The results of the Phase Two ESA indicated that metal and PHC impacts in soil in excess of MOECC Table 2 Standards and/or CCME Soil Quality Guidelines exist in the area of two historic unauthorized dumping sites in the south portion of the Class 2 area. Four soil samples had PAH exceedances, primarily for phenanthrene, but also for six other PAHs at SA-411-B, at locations in the northern and southern portions of the Class 1 area, as well as at two locations along the Ottawa River. No soil impacts at the depths investigated were encountered in the former Landfill #1 site, or in the areas of the former training centre, vehicle maintenance yard, or undeveloped areas around the Class 1 area.

Not all of the Potentially Contaminating Activities (PCAs) and Areas of Potential Environmental Concern (APECs) identified from previous work by others were investigated. The Phase Two ESA did indicate concentrations of CCOCs in soil exceeding the MOECC Table 2 Standards and/or CCME Soil Quality Guidelines for select PAHs, metals and PHCs, in the vicinities of APECs 2 to 7 (former ASTs and USTs in the northwest and southeast portions of the Class 1 area and near the former pumphouse), APEC 11 (suspected former dump sites in the southeast portion of the Class 2 area), and APEC 12 (fill across the Site).

The Phase Two ESA was consistent with requirements defined in O. Reg 153/04. Should CNL seek to file a Record of Site Condition with the MOECC, the following additional work would be required:

- Phase One Environmental Site Assessment pursuant to O.Reg. 153/04, including a Chain of Title for the Site
- Potential additional specific investigation of APECs identified in the Phase One ESA.
- Further investigation including horizontal and vertical delineation of impacts detected during this Phase Two ESA.
- Completion of a Plan of Survey or equivalent for the Site.



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Environmental Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories (November 21, 2016)

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Canadian Nuclear Laboratories. (CNL) to conduct a Phase Two Environmental Site Assessment (Phase Two ESA) of the Nuclear Power Demonstration Waste Facility (NPDWF) property located in Deep River, Ontario, (the "Site").

The Phase Two ESA scope of work for Site was based on the requirements as listed in the *Characterization Plan for Nuclear and Conventional Hazards of the Nuclear Power Demonstration Waste Facility (NPD) NPD Decommissioning 64-509410-PLA-001 Revision 0* (accepted by CNL July 19, 2016), prepared by Oak Ridge Associated Universities (ORAU) ("Characterization Plan"). The Characterization Plan was developed based upon the findings of the Historical Site Assessment for the Nuclear Power Demonstration Waste Management Facility Rolphton, Ontario 64-509410-ASD-001 Revision 0 (accepted by CNL July 18, 2016, prepared by Oak Ridge Associated Universities (ORAU) ("Historical Site Assessment"). Golder understands that the Historical Site Assessment was based on CSA Z678-01 and nuclear industry site characterization guidance (MARSSIM) and is equivalent to the requirements of a Phase One ESA. Details on implementing the work are described in *Environmental Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories* (November 21, 2016) ("CNL NPD Sampling Plan"), which was prepared by Golder and reviewed by CNL to ensure that that all requirements of the Characterization Plan were met. The Phase Two Environmental Site Assessment (ESA) was completed in May 2017 by Golder staff to characterize the environmental condition of soil and groundwater at the CNL NPD Site.

The scope of this Phase Two ESA report was developed to provide a broad overview of environmental conditions based on the discretionary samples collected during implementation of the CNL NPD Sampling Plan. Additional Areas of Potential Environmental Concern ("APECs"), which were identified during this process, were not necessarily addressed within the scope, and may require further investigation.

The Phase Two ESA was consistent with requirements defined in Ontario Regulation (O. Reg.) 153/04 (as amended) and is sufficient for the purposes of due diligence. Should CNL seek to file a RSC with the MOECC, the following additional work must be completed and included:

- Phase One ESA pursuant to O.Reg. 153/04, including a Chain of Title for the Site.
- Specific investigation of APECs identified in the Phase One ESA.
- Further investigation including horizontal and vertical delineation of impacts detected during this Phase Two ESA.
- Completion of a Plan of Survey or equivalent for the Site.

1.1 Site Description

The Nuclear Power Demonstration Nuclear Generating Station (NPDNGS) consisted of a 20 MW CANDU (short for Canada Deuterium Uranium) reactor, which entered service in 1962 and was operated by Ontario Hydro until 1987. Following permanent shutdown of the station, the operating and compliance responsibilities were transferred from Ontario Hydro to Atomic Energy of Canada Limited (AECL) and the facility is now renamed the Nuclear Power Demonstration (NPD) Site. The site owner is Atomic Energy of Canada Limited and operated by Canadian Nuclear Laboratories under a Government Owned Contractor Operated (GoCo). The facility has now been renamed the Nuclear Power Demonstration Waste Facility (NPDWF). The NPDWF is presently in the Storage with Surveillance (SWS) phase of decommissioning and CNL is planning for the final stage of decommissioning. The preferred decommissioning approach for NPD is in-situ decommissioning, and an Environmental Impact Assessment (EIA) in support of this option is currently underway.



The NPD site is on the south bank of the Ottawa River, about 3 km downstream from the Des Joachims Dam and approximately 25 km upstream from the Chalk River Laboratories (CRL) site. The facility comprises parts of lots 43 and 44 in Rolphton Township, in the Town of Laurentian Hills in Renfrew County Ontario. The Site is surrounded by undeveloped land controlled by CNL to the south, west, and north, with the Ottawa River located to the east.

The Site is divided into four class areas based on the Historical Site Assessment completed by ORAU for CNL, which can be seen in Figure 1A. This report used rules to classify areas, structures, systems, etc., based on the potential for containing contamination above clearance levels (CLs) or other action thresholds. The general rules, and the approximate areas classified as such on the Site, are as follows:

- **Class 1:** An area of structure that is impacted by site operations, and has a moderate-to-high probability of containing contamination above action threshold. Includes the fenced in “Licensed Area” around the former reactor building, as well as the concrete pad which extends past the fence to the north.
- **Class 2:** An area or structure that is impacted by site operations, but has a low-to-moderate probability of containing contamination above action thresholds. Includes the current, and historically developed sections of the Site, with the exception of the Class 1 Area, as well as the entrance roadways and former landfill.
- **Class 3:** An area or structure that is impacted by site operations, but has a low probability of containing contamination above action thresholds. Includes the NPD property bounded by Highway 17 to the south, the Ottawa River to the North, the termination of Cutler Lane to the East, and Swisha Road to the West, with the exception of the Class 1 and 2 Areas as well as the Background Reference Areas.
- **Background Reference Area (BRA):** The Background Reference Area is an area that is not considered to be impacted by site operations and includes the land approximately 1 km south of Highway 17 south of the NPD Property, as well as the southwest portion of the NPD Property bounded by Swisha Road to the North and Highway 17 to the South.

1.2 Property Ownership

The Property owner is CNL. The contact information for the Property owner is:

Site Owner	Address	Contact Information
Atomic Energy of Canada Limited (Operated by Canadian Nuclear Laboratories under a GoCo contract)	36510 Highway 17 Rolphton, ON K0J 2H0	Ms. Meggan Vickerd Canadian Nuclear Laboratories Tel: (613) 584-3311 x. 44288 Email: Meggan.vickerd@cnl.ca

1.3 Current and Proposed Future Uses

Land adjacent to the Site is currently comprised of undeveloped forest, which is controlled by CNL, surrounds the NPD facility. At the present time, no alternative land use plans have been developed for the Site. Under the Provincial framework O.Reg 153/04, Mandatory filing of an RSC would be required for the Site if a change to a more sensitive land use is intended.



1.4 Applicable Site Condition Standards

The Site owner is Atomic Energy of Canada Limited and is operated by Canadian Nuclear Laboratories under a Government Owned Contractor Operated (GoCo) contract. Further, the site is currently designated as Federal crown land and is an industrial site with a Class 1 nuclear facility licence under the Nuclear Safety Control Act. As such, under the Federal framework the following guidelines apply:

- Soil: Canadian Council Ministers of the Environment (CCME) Soil Quality Guidelines. CCME Soil Quality Guidelines
- Groundwater: Health Canada Canadian Drinking Water Quality Guidelines (given that groundwater at the Site would potentially be considered potable)

Although Provincial Ontario regulations do not apply to the Site, CNL is applying O.Reg 153/04, as amended for the purposes of the Phase Two ESA as best practice/due diligence. Ontario standards described in the document entitled "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act*" dated April 15, 2011 (the Standard Document) are currently used for the assessment of potentially contaminated sites in the context of O. Reg. 153/04.

The following rationale was used for the selection of the standards to be used to evaluate the environmental condition of soil and groundwater:

- Drinking water supply wells are not known to be present on the Site or within 250 m of the Site. However, after the Site is returned to crown land, it is possible that drinking water wells will be installed.
- Based on the information obtained from the Phase Two ESA and previous investigations completed at the Site, bedrock was not encountered at 21 boreholes completed to depths ranging from 3.1 to 16.8 metres below ground surface (mbgs), while bedrock was encountered at eight boreholes at depths ranging from 1.3 to 7.9 mbgs. According to O.Reg.153/04 as amended, "shallow soil property" is defined as property where 1/3 or more of the area consists of soil 2 metres or less in depth beneath the soil surface, excluding any non-soil surface treatment such as asphalt, concrete or aggregate. As such, the Site is not a shallow soil property.
- Only a portion of the Site boundaries are within 30 m of a water body.
- In order to meet the objective of demonstration of the alternate potential land reuses, the more sensitive land use designation of residential/parkland/institutional was selected by CNL over the more restrictive criteria of agricultural given that the agricultural designation of the site is unlikely due to the existing environmental conditions such as soil quality.
- Based on observed soil conditions in the boreholes and test pits completed at the Site, soil and fill material of variable composition is present on the Site. As such, the criteria associated with coarse textured soil was used for the Site (conservative approach).

Based on the above considerations, the soil analytical results were compared to the Ontario Ministry of Environment and Climate Change (MOECC; formerly Ontario Ministry of the Environment (MOE)) Table 2 generic site condition standards (residential/parkland/institutional property use, potable groundwater, coarse-grained) presented in the MOECC "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the *Environmental Protection Act*", dated April 15, 2011 (MOECC Table 2 Standards) and the Canadian Council of Environmental Ministers (CCME) Guidelines for residential/parkland land use (CCME Soil Quality Guidelines). The CCME Guidelines for industrial land use are referenced as CCME Soil Quality Industrial Guidelines.



The analytical results of the groundwater samples were compared to the MOECC Table 2 Standards and the Canadian Drinking Water Quality Guidelines for human health (Health Canada “*Guidelines for Canadian Drinking Water Quality – Summary Table*”, dated February 2017; Health Canada Canadian Drinking Water Quality Guidelines).

The analytical results of the sediment samples were compared to the CCME Sediment Quality Guidelines (SQG; 2011), MOECC sediment standards for sediment in generic site conditions, and the Atlantic Risk-Based Corrective Action (RBCA; 2012) sediment screening benchmark for total PHCs.

1.5 Phase Two ESA Objectives

The overall objective of the Project was to provide an authoritative and unbiased assessment of the conventional, non-radiological sources of contamination that could have impacted the land areas on the NPD site.

Data were to be acquired to identify, quantify, and determine whether Conventional Contaminants of Concern (CCOC) for the NPD site land areas to satisfy federal and provincial environmental regulations for more sensitive land uses. The primary objective of the Phase Two ESA was there to assess the environmental condition of soil and groundwater at the Site in terms of CCOCs relative to federal and provincial environmental standards for residential/parkland, commercial/industrial land uses.

The objectives of the Phase Two ESA were achieved by:

- Developing an understanding of the geological and hydrogeological conditions at the Site.
- Conducting field sampling of soil, sediment, and groundwater and analysis for all potential CCOCs at target locations across the Site.

2.0 BACKGROUND INFORMATION

This section presents the background conditions of the Site including a description of the physical setting and a summary of past investigations conducted.

2.1 Physical Setting

The Ottawa River is located adjacent to the northeastern boundary of the Site. The ground surface of the Site and the surrounding lands have a downward slope to the northeast (towards the Ottawa River). During the construction of the NPD generating station, numerous man-made terraces and steep interconnecting benches were created for construction and security purposes. This activity resulted in a highly modified landscape at the NPD site. Overland flow of surface water runoff is generally towards the Ottawa River, while groundwater discharge at the base of the overburden is intercepted by a tile drain system which discharges water to the Ottawa River. Limited quantities of surface water runoff may enter the tile drain system at manhole covers.

Based on the Ontario Geological Survey base maps and previous investigations completed for the Property, the overburden at the Site is original native alluvial material, and much of the developed portions of the Site are built on thick layer of sand and gravel fill. The bedrock at the Site consists of crystalline Precambrian assemblages primarily of granitic and granodioritic gneisses, with mafic bedrock in the southeast portion of the Site. Bedrock depth is unknown across much of the Site, but in the Class 1 study area, bedrock was generally encountered between 5.7 and 8.0 mbs. The water table is in the sand and gravel overburden. The groundwater flow direction is generally to the northeast towards the Ottawa River.



The properties surrounding the Site are primarily comprised of undeveloped land controlled by CNL, as summarized below:

- **North:** Undeveloped land (forested) with the Ottawa River to the northeast.
- **West:** Undeveloped land (forested) with Swisha Road located beyond the Site boundary.
- **South:** Ontario Highway 17 and undeveloped land (forested).
- **East:** Undeveloped land (forested) and the Ottawa River.

2.2 Past Investigations

The Historical Site Assessment completed in July 2016 is understood to meet the requirements of a Phase One ESA. There have been a number previous investigations undertaken at the Site, and these have been used to identify Potentially Contaminating Activities (PCAs), APECs, and potential CCOCs. Applicable historical investigations are summarized below. Where the environmental condition of soil or groundwater are identified as parameter exceedances, these are described as presented within each report, based upon the applicable guidelines at the time of publication. Records of the number and location of USTs within the former Training Centre area of the NPD site are not consistent between reports. The findings of each report are summarized in Sections 2.2.1 through 2.2.7, while Golder's understanding of the site conditions, based upon existing reports as well as discussions with CNL staff, is presented in Section 3.3.

2.2.1 Hydrogeologic Investigation of the NPD Landfill Site (1988)

In 1988, eight monitoring wells were installed as part of a hydrogeologic investigation of the NPD landfill site. The wells were screened at depths ranging from 7 to 15 mbgs. Analysis of radiological contaminants of concern (ROCs) did not indicate any radiological contamination of groundwater in the landfill site. Analysis of CCOCs indicated elevated concentrations of nitrate, nitrite, manganese, and phenol, although manganese and phenol concentrations were also elevated in upgradient background wells. The report findings concluded that long-term monitoring was unlikely to be required, nor were remediation or infiltration control measures recommended, and that a simple vegetated cover would be sufficient upon closure of the landfill.

2.2.2 Rolphton NPD Waste Management Facility Site Characterization and Facility Evaluation (1990)

A study in 1990 was completed to characterize the conditions of the NPD site. The study included a review of regional and local geologic conditions, site history and land use, site surveys, evaluation of hazardous materials on site, drilling, excavation of test pits, sample collection and analysis, interpretation of soils and groundwater results, and recommendations relating to remediation of the Site prior to a change in land use. The facility evaluation identified the presence of asbestos in a variety of forms in multiple buildings, while confirming that the presence of polychlorinated biphenyls (PCBs) was limited to fluorescent lighting ballasts. Five underground storage tanks (USTs) were identified, including a septic tank associated with the NPD station, a septic tank associated with the training centre, a 3315 L diesel tank, a 36,000 L fuel oil tank, and one tank of unknown purpose. Four above ground storage tanks (ASTs) were identified, including a 4,500 L AST for transformer oil, a 2,000 L AST for diesel, a 2,000 L AST for gasoline, and a water tank. Landfill #1 (located approximately 300 metres to the south west of the NPD building) was also identified. A total of ten boreholes were advanced and completed as monitoring wells (MT-1 through MT-10), although water samples were only collected from five wells. Bedrock was encountered at depths ranging from 1.8 m to 12.1 mbgs. A total of twenty test pits were excavated to characterize shallow soil conditions, with depths ranging from 3.0 to 3.7 mbgs.



Analysis of soil samples recovered from boreholes indicated little to no evidence of contamination from organic or inorganic contaminants, and exceedances of the guideline criterion for pH in shallow soils were considered to be due to natural sources. Trace levels of organic contaminants including dichloromethane and methyl ethyl ketone were detected at levels below applicable guidelines. Two tests pits were found to contain contamination exceeding guidelines; at Test Pit C, which was located adjacent to the NPD septic tank, exceedances were identified for aluminum, cadmium, and 1,2-dichlorobenzene. At Test Pit N, which was located adjacent to the landfill, soil analyses indicated metal concentrations greater than guidelines for copper, lead, and zinc. Groundwater analyses indicated elevated concentrations of iron and manganese, which were attributed to natural sources, as well as chloride, which was attributed to application of road salt on Highway 17.

2.2.3 Preliminary Site Characterization and Environmental Assessment – NPD Waste Management Facility – Underground Storage Tank (1993)

Characterization of potentially impacted soil was conducted following the observation of visually contaminated soils during removal of an UST. The tank was described as having 4,500 L of capacity and was used for the storage of diesel fuel. In the 1990 report discussed in Section 2.2.2 above, there was no reference to a 4500 L diesel UST, although a 3315 L diesel UST was identified in the same general location as the cleanup of a UST referenced in later reports; it is interpreted that these are the same tank and that one of the reported volumes was incorrect. Three boreholes were augured to depths ranging from 5.2 to 7.8 mbgs, with one borehole completed as a monitoring well. Two test pits were excavated to assess the extent of contamination. Three soil samples and ten water samples (pre-existing monitoring wells were also sampled) were submitted for analysis of total petroleum hydrocarbons (TPH) and phenols. All three soil samples were found to contain concentrations of TPH greater than applicable criteria, while four water samples also exceeded criteria for TPH. Initial remediation was conducted by excavation of contaminated soils in January 1993, and two recovery wells were installed to extract residual free product from groundwater. Remediation through periodic pumping of groundwater was conducted each summer for five years until 1997 to flush and extract residual hydrocarbons from the subsurface.

2.2.4 Phase II Environmental Site Assessment & Groundwater Monitoring Program (2002)

A Phase II ESA was conducted to investigate the soil and groundwater conditions in the vicinity of the underground storage tank contamination zone, as previously described in Section 2.2.3. The Phase II ESA sought to assess the soil and groundwater conditions after source zone remediation was conducted through soil excavation and periodic recovery well pumping. The report noted that impacted soil was known to have been left in place during the remediation, due to the inaccessibility of soil underneath building foundations. In November 2001, eleven boreholes were advanced to delineate the extent of residual contamination between the source zone and the Ottawa River. The boreholes ranged in depth from 3.1 to 10.1 mbgs and all were completed as monitoring wells. A total of twenty soil samples were recovered. Three of the new monitoring wells were dry. Nine soil samples and 13 groundwater samples were submitted for analysis of TPH content. Of the nine soil samples submitted for analysis, one sample (BH 16-01 G-20) had concentrations of TPH that exceeded the Ministry of the Environment criteria of the time. The borehole was an angled hole adjacent to the generator building where impacted soil was known to be left in place, and the sample was collected at a depth of approximately 5.5 to 6.1 mbgs. Five of 13 groundwater samples submitted for analysis had concentrations of TPH in excess of MOE criteria of the time, including four from RW#1, the recovery well which had been used for groundwater extraction as part of source zone remediation, and one sample from a monitoring well at an intermediate down-gradient location between the source area and river. Installation of additional monitoring wells to improve contaminant plume delineation was recommended.



2.2.5 2012 Groundwater Monitoring

A groundwater monitoring program was conducted in 2012 to collect samples from pre-existing monitoring wells on Site. Wells BH6-01, BH7-01, BH8-01, BH9-01, BH10-01, BH14-01, and BH15-01 contained insufficient water to be samples. Wells BH12-01, MT-9, RW#1, and RW#2 contained insufficient volume to meet the planned purge volume; however, samples were collected. Wells MT-5, BH13-01, and two Ottawa River locations were sampled as planned. Samples were submitted for laboratory analysis of petroleum hydrocarbon fractions 1 to 4 (PHC F1 to F4), and were compared with MOECC Table 2 Standards. Results from 2005 to 2012 were compiled to assess long-term trends, and indicated that during this period, only wells MT-9 (1/13 samples), RW#1 (1/13 samples), and RW#2 (2/14 samples) produced samples containing detectable concentrations of PHC F1 and F2, all were below MOECC Table 2 Standards. From 2005 to 2012, only wells MT-8 (1/14 samples), MT-9 (1/13 samples), BH12-01 (1/15 samples), BH13-01 (1/15 samples), RW#1 (5/12 samples), and RW#2 (2/14 samples) contained detectable concentrations of PHC F3 and F4, and all were below MOECC Table 2 Standards. Based on these results, the report indicated that the site was in compliance with MOECC Table 2 Standards.

2.2.6 2014 Groundwater Monitoring

In 2014 pre-existing monitoring wells were sampled by CNL staff as part of a comprehensive review of groundwater conditions at the Site. Twenty-seven wells were located, out of a total of 34 known to have been installed at the Site through various investigations and sampling campaigns. Eighteen wells had sufficient water to be sampled. Apart from elevated concentrations of chloride associated with road salt contamination, major ion chemistry was consistent with natural conditions. Trace element results did not indicate the presence of any parameters at concentrations greater than drinking water quality guidelines. None of the samples contained detectable concentrations of PCBs or volatile organic compounds (VOCs). Trace concentrations of TPH were detected in samples from BH 12-01 and BH 09-01, which were downgradient of the previously documented UST diesel contamination. PHCs F2, F3, and F4 were detected in wells MT-8, MT-9, BH 09-01, BH 12-01, and BH 13-01, although concentrations were generally only slightly above detection limits. The report concluded that the groundwater investigation of the Site did not yield any instances of groundwater contamination in excess of applicable regulatory guidelines.

2.2.7 2016 Historical Site Assessment (CSA Phase I)

In July 2016, a Historical Site Assessment was completed by Oak Ridges Associated Universities (ORAU). The HSA was conducted based on the Phase One ESA CSA Standard Z678-01 (R2012) and on nuclear industry site characterization guidance (Multi-Agency Radiation Survey and Site Investigation Manual, referred to as "MARSSIM"). The HSA divided the Site into four class areas using rules to classify areas, structures, and systems, based on the potential for containing contamination above clearance levels (CLs) or other action thresholds.

The HSA investigated and characterized site history, activities, geologic conditions, potential contaminant sources, interview summaries, and summarized the findings of previous investigations. Data gaps in the existing characterization of the site and potential zones of contamination were identified. Where previous investigations investigated potential contamination, the HSA assessed the completeness of the investigation, both spatially and in terms of contaminant characterization. In the vicinity of the former Training Centre, the HSA indicates the presence of three USTs of unknown purpose and two USTs known to be septic tanks, although variability in the reported number of USTs is noted between differing data sources.



The primary CCOCs identified include lead, PCBs, and petroleum hydrocarbons. Potential contaminant sources include USTs, septic fields, Landfill #1, soil adjacent to roads and the Training Centre, and uncontrolled surface dumping along the south access road. The findings of the HSA were the primary basis used in development of the Characterization Plan, which guided the investigation of this Phase Two ESA.

2.3 Site Interviews

Following the review of existing information in preparation for the Phase Two ESA, Site Representative, Meggan Vickard of CNL, informed Golder of a former vehicle maintenance yard on-Site (identified as 'Heavy Equipment Parking' in historical reports), as well as two suspected former dumping sites located to the east of the vehicle maintenance yard. The maintenance yard was located south of the facility on the west side of the entry road. Upon investigation, the area was found to have waste consisting of aerosol cans, drums, and other waste associated with vehicle maintenance. Both the vehicle maintenance yard and two suspected former dumping sites are considered to be APECs for the Site.

2.4 APECs Identified Through Past Investigations

Class 1 Area

Based on a review of the reports, including multiple historical groundwater sampling campaigns as described in Sections 2.2.2 to 2.2.6, groundwater at the Site meets the MOECC Table 2 Standards (current data collected during this report supports this conclusion). Limited information was available to review with regards to the soil quality and historical hydrocarbon impacts were documented at some locations including underneath the building. As such, although there were no groundwater impacts documented at the Site, residual hydrocarbons may be present at the Site, within the Licensed Area. In accordance O.Reg 153/04, these ASTs and USTs would constitute APEC(s) for the Site and additional work including further delineation of soil impacts (if present) and remediation/Risk Assessment would be required in order to file for a RSC. From a due diligence perspective, the historical data indicates that potential hydrocarbon impacts associated with the ASTs and USTs appear to be contained within the Licenced Area.

Class 2, 3, BRA Areas

The presence of unknown USTs (understood to now be former USTs) at the Training Centre was identified in historical reports. No historical information was available to provide insight as to the potential soil or groundwater quality at this location and these historical USTs are considered APECs.

The presence of a landfill on the Site (Landfill #1) was identified as an APEC for Site.

Class 2, 3 and BRA area APECs (along with the PCA as listed in O.Reg 153/04 are summarized in the following table.



**PHASE TWO ENVIRONMENTAL SITE ASSESSMENT
NPD SITE, CANADIAN NUCLEAR LABORATORIES**

APEC or PCA for the Phase One Property	Location of Area of Potential Environmental Concern in relation to the Site	Is the PCA identified for the Property considered an APEC for the Site? Reasoning	Potentially Contaminating Activity (PCA) and Description of the Activity	Contaminants of Potential Concern	Media Potentially Impacted (groundwater, soil and/or sediment)
APEC 1 – Landfill #1	~300 m southwest of NPD station.	Yes, on site.	#58 Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Former landfill.	PHC F1-F4, BTEX, PAH, metals.	Soil and groundwater.
APEC 2 - USTs of Unknown Purpose	Training Centre	Yes, on site.	Storage tanks (2) of unknown purpose.	PHC F1-F4, BTEX, PAH	Soil and groundwater.
APEC 3 – Vehicle Maintenance Yard	~300 m south of NPD station.	Yes, on site.	#52. Storage, Maintenance, Fuelling and repair of equipment, vehicles, and material used to maintain transportation systems.	PHC F1-F4, BTEX, PAH, Metals	Soil and groundwater.
APEC 4a, APEC 4b - Suspected Historic Unauthorized Dumping Sites	250 - 300 m south of NPD station.	Yes, on site.	#58 Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Former landfill.	PHC F1-F4, BTEX, PAH, metals.	Soil and groundwater.

Notes

PHC F1-F4 - petroleum hydrocarbon fractions F1 to F4
 BTEX- benzene, toluene, ethylbenzene, xylenes
 VOC – volatile organic compounds (include BTEX)
 PAHs-Polycyclic Aromatic Hydrocarbons
 UST - underground storage tank
 AST – above ground storage tank



3.0 SCOPE OF THE PHASE TWO ESA INVESTIGATION

3.1 Overview of Site Investigation

The Phase Two ESA work was completed at sample locations in the Class 1, 2, 3, and the BRA sample locations as defined in the Characterization Plan. Class 1 locations are located within the licensed area, Class 2 locations are located within the exclusion zone adjacent to the licensed area, Class 3 in the undeveloped lands surrounding the Class 2 area, and the BRA locations which are located at the boundaries of the Site where there is assumed to be no impacts.

To achieve the objectives of the Phase Two ESA, the location of the boreholes and shallow test pits and the parameters for chemical analysis of soil and groundwater samples were selected to assess the quality of soil and groundwater at the Site. The rationale for the soil and groundwater sampling locations and the parameters for analysis in soil and groundwater samples was guided by the Characterization Plan by ORAU and further detailed in the CNL NPD Sampling Plan by Golder provided in Appendix A.

The scope of work included the following tasks:

- **Preparing a Health and Safety Plan.** A Health and Safety Plan for internal and subcontractor use was prepared prior to initiating any fieldwork at the Site.
- **Utility Clearance and Equipment Used.** Prior to drilling and the excavation of shallow test pits for the Phase Two ESA, Golder arranged for the completion of utility clearances. A private utility location contractor (USL-1 Inc.) was retained to identify utilities within the work area, to mark the locations of the utilities and clear the proposed drilling and test pit locations. The drilling equipment used for borehole drilling was a track mounted Geoprobe 6680GT (Geoprobe).
- **Develop CNL NPD Sampling Plan** - The CNL NPD Sampling Plan outlined the schedule, procedures including test pits and boreholes, and analytical requirements for the Phase Two ESA.
- **Test Pit Excavations** – 238 shallow test pits were manually dug across the Site at Class 2 locations, 96 in the Class 3, 16 in the BRA, and 13 at both a former vehicle maintenance yard and two former dumping sites. Shallow test pits were dug to a depth of 0.15 mbgs and in some cases, where anomalies were detected, to 0.30 mbgs. Soil samples were collected from each location for headspace screening using a Photo-Ionization Detector (PID), which was used to select samples for CCOC analysis.
- **Borehole Drilling and Monitoring Well Installation (Class 1)** – 68 shallow boreholes were drilled across the Site at Class 1 locations. Samples were collected at the following depth intervals: 0 to 0.15 mbgs and 0.15 to 0.3 mbgs. Samples were assessed through headspace screening by PID to select samples for laboratory analysis.
- **Borehole Drilling and Monitoring Well Installation (Landfill #1 / Class 2)** – 17 shallow boreholes were drilled at Landfill #1. Samples were collected at the following depth intervals: 0 to 0.15 mbgs and within the waste layer (where present). Samples were assessed through headspace screening by PID to select samples for laboratory analysis.



- **Soil Sampling and Analysis.** Selected soil samples collected from the shallow test pits, boreholes, and judgemental sampling locations were submitted for chemical analysis of the following parameters: PHCs F1 to F4, BTEX, PAHs, PCBs, and in the case of judgemental samples, metals (including mercury and hexavalent chromium). Samples collected from the Class 1, 2, and 3 areas as well as the BRA are labelled SA-###. Samples collected at CNL's request from the former vehicle maintenance yard and two historic unauthorized dumping sites are labelled J-##.
- **Sediment Sampling and Analysis.** Selected sediment samples collected from the Ottawa River were submitted for chemical analysis of PCBs, PHCs, PAHs, and metals. The laboratory analyses were completed by Maxxam.
- **Laboratory Analysis:** All laboratory analyses completed by Maxxam Analytics of Ottawa, Ontario (Maxxam), were accredited by the Standards Council of Canada (SCC)
- **Groundwater Monitoring, Sampling and Analysis.** Water levels were measured at each of 25 pre-existing monitoring wells, one of which was found to be dry. Groundwater samples were collected from 24 monitoring wells and submitted for laboratory analysis of PAHs, PHCs, and BTEX. The laboratory analyses were also completed by Maxxam. Five groundwater wells were also installed as part of Phase Two ESA activities in December 2016. These wells were installed for the assessment of hydraulic conductivity and were not sampled as part of the monitoring program.
- **Surveying.** An elevation survey was not completed as part of this Phase Two ESA.
- **Reporting.** Golder prepared this report summarizing the results of the Phase Two ESA.

The Phase Two ESA was conducted in accordance with CSA Z769 (Phase II Environmental Site Assessment) and O. Reg. 153/04 and followed the framework of the CNL NPD Sampling Plan. Subsurface investigation activities as summarized in this report were carried out in accordance with Golder's Standard Operating Procedures (SOPs), which conform to the requirements of O. Reg. 153/04 and Golder's Quality Assurance Program. The applicable SOPs are provided in the Sampling and Analysis Plan. The information provided herein follows the Phase Two ESA report format required under O. Reg. 153/04.

The rationale for selecting the borehole and shallow test pit locations, sampling procedures, selection of samples, chemical analysis, and SOPs, as required under O. Reg. 153/04, is provided in the CNL NPD Sampling Plan.

3.2 Media Investigated

The Phase Two ESA field program included sampling of subsurface and surface soil from boreholes and shallow test pits, sampling of groundwater from pre-existing monitoring wells screened within the overburden on the Site, and sampling of sediment from the Ottawa River at locations upstream, adjacent to and downstream of the Site.

The Characterization Plan outlines the rationale for the field investigation activities carried out at the Site and the CNL NPD Sampling Plan outlines the work plan and methodologies used to meet the objectives of this Phase Two ESA. Soil and groundwater were sampled and analysed for one or more of the CCOCs (PAHs, PHCs, BTEX, metals, and/or PCBs) to assess for potential soil and/or groundwater impacts.



3.3 Conceptual Site Model

A Conceptual Site Model (“CSM”) was compiled using available information in a desktop review. The Phase One ESA CSM for the Site described below was based on the Golder review of findings of reports prepared by others between 1989 and 2016, including both consultant reports and internal reports by CNL and its predecessors. The NPDWF consists of a 20 MW CANDU reactor, which entered service in 1962 and was operated by Ontario Hydro until 1987. Following permanent shutdown of the station, the operating and compliance responsibilities were transferred from Ontario Hydro to AECL and the facility is now referenced as NPD. The NPD Site is presently in the SWS phase of decommissioning and CNL is planning for the final stage of decommissioning. The preferred decommissioning approach for NPD is in-situ decommissioning, and an EIA in support of decommissioning is currently underway.

- The Site is on the south bank of the Ottawa River, about 3 km downstream from the Des Joachims Dam and approximately 25 km upstream from the CRL site. The facility comprises parts of lots 43 and 44 in Rolphton Township, in the Town of Laurentian Hills in Renfrew County Ontario.
- There are limited off-Site influences or PCAs on the environmental condition of the Site due to its isolated location surrounded by undeveloped lands controlled by CNL.
- The ground surface of the Site and the surrounding lands have a downward slope to the northeast, towards the Ottawa River, which forms the northeastern boundary of the Site.
- During the construction of the NPD generating station, numerous man-made terraces and steep interconnecting benches were created for construction and security purposes. This activity has resulted in a highly modified landscape at the NPD site.
- Four septic tanks were identified on the Site. They were located at the NPD station, the guardhouse, and two at the training centre. These septic tanks are not considered to be PCAs.
- Five USTs (in addition to septic tanks) were identified on the Site, all of which have been removed. Three USTs located adjacent to the NPD station were used for diesel fuel storage, gasoline storage, and liquid waste storage, respectively. Two USTs located adjacent to the training centre had unknown purposes. The diesel UST is a known source of historic contamination, which was remediated; long-term monitoring has confirmed no contaminants are present in groundwater in the vicinity of the release at concentrations in excess of applicable guidelines. The HSA indicates the presence of three USTs of unknown purpose and two septic tanks in the vicinity of the Training Centre, which is a greater count than other sources have indicated. The total site-wide count of five USTs (plus septic tanks) noted above is Golder’s opinion based on a comprehensive review of literature regarding the site and discussions with CNL staff; however, this is an area of uncertainty.
- Four ASTs were identified on the site, all of which have been removed. Two ASTs located adjacent to the pump house were used for the storage of diesel fuel and gasoline, and two located adjacent to the NPD station were used for the storage of transformer oil and waste oil.
- Two former landfills were identified within 500 m of the Site:
 - Landfill #1 (which was investigated during this Phase Two ESA) is located to the west of the NPD station and was used for miscellaneous disposal of wastes generated on Site. Records indicate that waste materials were periodically burned within the landfill. The landfill is reported to contain a waste volume of approximately 6,000 m³. Previous investigations have drilled boreholes, excavated test pits, and installed



monitoring wells to characterize the conditions and impacts associated with the landfill. Operation of the landfill was conducted under Ontario Provisional Certificate of Approval No. A413107, which was amended effective November 25, 1998 to recognize approval from the Ontario Ministry of Environment to close the landfill. Landfill #1 is considered an APEC for the Site as it is located within the Site boundaries, has expected downgradient groundwater flowpaths which will interact with other Site components, and past monitoring has indicated relatively minor exceedances of regulatory guidelines.

- Landfill #2 (which was not investigated during this Phase Two ESA) is located northeast of the NPD station and was used during construction of the station for disposal of construction material and debris. More recently, the general area of Landfill #2 has been used for uncontrolled tree and brush disposal. The approximate volume of Landfill #2 is 14,000 m³. Previous investigations have not found any records indicating hazardous waste disposal or evidence of contamination associated with Landfill #2, and is therefore not considered an APEC for the site.
- There is one industrial site near the Site. The Des Joachims hydroelectric dam, which is 2km upstream from the Site, is not anticipated to impact the sediments on-Site.
- Surface water runoff flows overland towards the Ottawa River.
- Potable water on the Site is provided by bottled water. No drinking water wells are present on the Site.
- At the time of the Phase Two ESA, the neighbouring properties south, west and north of the Property were undeveloped land controlled by CNL, and the Ottawa River is located to the east.
- The subsurface conditions at the Site consist of sand and gravel fill, underlain by silty clay and clayey silt, overlying glacial till. The thickness of the fill is reportedly approximately 7 to 8 metres at the southeast part of the Site. The fill at the Site locally contains evidence of ash, cinders and pieces of asphalt, brick, concrete, wood and/or metal and potentially some refuse. Depth to the bedrock reportedly ranges from less than 2 mbgs to as much as 25 mbgs. The depth to the water table is expected to be between 3 and 8 mbgs and to generally be in the upper portion of the native overburden.
- Groundwater flow is to the northeast towards the Ottawa River, located east of the Site. Groundwater discharge in the vicinity of the NPD station is intercepted by a tile drain system which discharges to the Ottawa River.

With respect to the Class 1 Licenced Area, based on a review of the reports (see Section 2.2.2 to 2.2.6) groundwater impacts were not documented at the Site however residual hydrocarbons may be present at the Site, within the Licensed Area. In accordance O.Reg 153/04, the former diesel, fuel oil, waste oil, and active waste storage ASTs and USTs in the Class 1 area would constitute APECs for the Site.

With respect to the Class 2, 3 and BRA areas, the following APECs for the Site have been identified:

- APEC 1 (PCA 58) – Former Landfill #1
- APEC 2 (Potentially PCA 52) – Former USTs with an unknown purpose
- APEC 3 (PCA 52) – Vehicle Maintenance Yard
- APEC 4a and 4b (PCA 58) – Suspected Historic Unauthorized Dumping Sites



3.4 Deviations from Sampling and Analysis Plan

The Phase Two ESA work program followed the CNL NPD Sampling Plan with one deviation. Judgemental sediment sampling (intended for shallow on-site ditches) as described in the Characterization Plan was not identified during the field program and as such, two areas identified by CNL where historic unauthorized dumping had occurred and one area where vehicle maintenance had occurred historically were investigated in place of this task (“J” series soil samples). Radiological screening was removed from Golder and ISR’s scope following the initial fall deployment. Subsequently, radiological screening was performed by CNL and is reported under a separate cover. Field work was carried out in general accordance with the CNL NPD Sampling Plan and Golder’s SOPs with no material deviations.

3.5 Impediments

The full field investigation was originally scheduled to be conducted during fall 2016; however, due to earlier than anticipated onset of winter conditions, the schedule was delayed and only the portion of the program covering the Class 3 area (Characterization Units (CU) 1-5) and Ottawa River sediments (CU 24-25) were completed. The remainder of the sampling program (CU9-19 and CU20-21) was conducted in May 2017. No additional impediments to the Phase Two ESA investigation were encountered.

4.0 INVESTIGATION METHOD

4.1 General

The following sections describe the pre-field work activities and field investigation methodology employed during the Phase Two ESA conducted at the Site. The field investigation methods were carried out in accordance with the Golder Quality Assurance Program and the SOPs included in the CNL NPD Sampling Plan (Appendix A). Field methodology described below includes borehole drilling, excavation of test pits, soil sampling, field screening for contaminants, measurement of groundwater levels, well purging, and groundwater sampling. Details of analytical testing, residue management, elevation surveying and Quality Assurance / Quality Control (“QA/QC”) measures are also included below.

4.1.1 Site Specific Health and Safety

Prior to initiating the fieldwork, Golder developed and implemented a Site-specific Health and Safety Plan to protect the health and safety of its employees and subcontractors. Assessment of potential health and safety hazards at the Site, and those associated with the proposed work, were completed each day of the field program. Additionally, prior to any intrusive investigations, including drilling, Golder retained USL-1 Inc. of Ottawa, Ontario to coordinate clearances with the local utility companies, and to confirm borehole locations were clear of underground utilities.

4.2 Drilling and Excavation

Consistent with the CNL NPD Sampling Plan, boreholes were advanced by Strata Drilling Group (“Strata”) using a track mounted Geoprobe drill rig. The Phase Two ESA included the drilling of 17 environmental boreholes to depths of as much as 4.57 mbgs and 78 shallow (0.3 meter) surface holes. The Geoprobe operated under the direct-push drilling mode, and employed a 100 mm diameter soil core sampling system. The core-barrel was 1.5 m in length, and was lined with disposable polycarbonate sample sleeves, which isolated the soil core from the core barrel and prevented cross-contamination between cores.



Test pits were advanced using a shovel or hand trowel. The samples of surface soil were retrieved directly from the shovel/trowel using a clean, gloved hand at regular depth intervals (0 to 0.15 mbgs). The trowel/shovel was cleaned with Alconox[®] soap and methyl hydride then rinsed with distilled water between each use to prevent cross-contamination between samples.

The locations of the boreholes, surface samples, and test pits are shown in Figure 1. The Record of Boreholes is included in Appendix B.

4.3 Soil: Sampling

As indicated above, soil samples collected as part of the surface drilling program in the Class 1 area were retrieved at 0.15 m intervals to a depth of 0.3 m. Soil samples collected as part of the environmental borehole drilling program in the landfill area were retrieved from 0 – 0.15 mbgs and, if a waste layer was encountered, at intervals of 0.5 m in the waste layer to a depth of 1 m into the waste layer. Finally, soil samples collected as part of the shallow test pitting were retrieved from 0 – 0.15 mbgs. In all cases, if field screening or gamma scans indicated potential for contamination, additional samples were taken in 0.15 m intervals until screening no longer indicated potential for contamination.

Disposable nitrile gloves were worn by Golder personnel during soil sampling, and a new set of gloves was used for the collection of each discrete sample.

All soil samples collected were scanned for gamma radiation at their surface and termination for gamma radiation by CNL Radiation Protection Staff. Any anomalies in radioactivity were further investigated through additional drilling and the collection of supplementary samples.

Soil conditions encountered in the landfill boreholes were logged in terms of soil materials, texture and the presence of staining, odour and debris, if any, following SOP6 – *Soil Logging*. Field observations made during the advancement of boreholes are summarized on the Record of Borehole sheets in Appendix B and additional details of the subsurface conditions encountered are provided in Section 5.1.

Following logging, the soil samples were placed in glass jars, supplied by the analytical laboratory, for possible chemical analysis. Where sufficient soil volume was recovered from the Geoprobe, representative portions of each sample were collected in sealed plastic bags for headspace organic vapour testing using a RKI Eagle 2 PID as described further in Section 4.4 below. Samples to be submitted for PHC F1 or BTEX analysis were placed in 40 ml glass vials containing methanol preservative using pre-measured syringes to obtain 6 grams of soil sample. Soil samples were placed in coolers and kept on ice in the field. The coolers were brought to the Golder Ottawa office and kept refrigerated until samples were selected for submission to the analytical laboratory. Soil samples selected for chemical analysis of PHC F1 to F4, BTEX, PAHs, metals, and/or PCBs were placed in a cooler with ice, and delivered under chain-of-custody procedures to Maxxam. Soil samples were selected for analysis based on visual and olfactory evidence; headspace vapour concentrations; soil type; borehole and test pit location; and target depth, and included samples considered to have the highest potential for impact. Details regarding the soil samples submitted for laboratory analysis, including samples for QA/QC, are provided in Table 2 (Soil Data Summary Table) following the text of the report. At each location, samples were also collected for ROC analysis.

The selection of inferred “worst case” soil samples was based on visual and olfactory observations, PID readings, and/or from depth horizons at which potential contamination was considered most likely to have occurred, such as from fill material or near the water table.



A summary of the soil samples submitted for laboratory analysis, including QA/QC samples, is included in Table 2 (Summary of Soil Samples Submitted for Analysis).

4.3.1 Soil Sample Requirements

All soil samples collected and submitted for chemical analysis were obtained from in-place fill and soil using the sampling methods and equipment as described. When handling soil samples, a clean gloved hand, with a dedicated glove, was used and equipment in contact with soils (the trowel/shovel) were washed between sample locations to prevent the potential of cross contamination.

As per the CNL NPD Sampling Plan, if distinct layers of potential impact were identified at a sample location, soil from the layer(s) were placed in sample containers for CCOC analysis. Field screening and observations were used to assess the selection of soil samples for analysis of one or more of the CCOCs (PHC F1 to F4, BTEX, PAHs, metals, and/or PCB).

4.4 Field Screening Measurements

Soil headspace measurements for organic vapour concentrations were conducted on the soil samples collected from the surface and boreholes using an RKI Eagle 2.

The soil headspace measurements were conducted following SOP4 - *Headspace Screening*. Details regarding the equipment and calibration procedure are described in the table below:

Equipment	Make and Model	Parameters Detected	Detection Limits	Precision	Reading Accuracy	Calibration Standard	Calibration Procedure
Photo-ionization detector (PID) RKI Eagle 2	RKI Eagle 2	Organic vapours	0%	N/A	+/- 5%	100 ppm Isobutylene	The PID was calibrated by PINE Environmental prior to the field work, and bump checked during the field program
		Combustible Vapours	0%	N/A	+/- 5%	100 ppm Hexane	

The PID was used to provide an estimate of the relative concentrations of organic and combustible vapours in the headspace of each soil sample, where sufficient volume of soil had been recovered, and was used to support selection of soil samples for submission for laboratory analysis. The results of soil headspace organic and combustible vapour measurements for submitted samples are presented in Table 4A.

The selection of inferred “worst case” soil samples submitted for laboratory analysis of the CCOCs was based on: consideration of the highest organic and combustible vapour readings, visual and olfactory evidence of potential contamination (PHC odour, presence of ashes or debris/waste), and the depths of the soil sample collection (depth horizons at which potential impact would most likely have occurred, such as from the upper fill layer or near the water table).



4.5 Groundwater: Sampling

As part of the Phase Two ESA, a groundwater sampling event was completed between May 30, 2017 and June 6, 2017. The event included the measurement of water levels, preparation of the wells for sampling, and the collection of groundwater samples from 24 monitoring wells that had been installed previously at the Site. The water level measurements were taken relative to the top of the pipe on May 29, 2017. Results of the water level measurements are presented in Table 1 and Figure 2.

Prior to the groundwater sampling, the wells were purged using dedicated Waterra® inertial samplers or a peristaltic pump. During the well purging, qualitative observations were made of water colour, clarity, the presence or absence of any hydrocarbon sheen and any odours present.

Low flow groundwater sampling techniques using dedicated Waterra™ inertial pumps (polyethylene tubing and foot valve) or a peristaltic pump with dedicated Waterra™ polyethylene tubing was used to collect groundwater samples during the Phase Two ESA.

Groundwater samples were collected from the monitoring wells into the laboratory-provided sample bottles and submitted to Maxxam under chain-of-custody procedures for chemical analysis of one or more of the following: PHCs F1 to F4, BTEX, and/or PAHs. In addition, three duplicate groundwater samples were collected for QA/QC purposes.

A summary of the groundwater samples submitted for laboratory analysis, including QA/QC samples, is included in Table 3.

Five new groundwater wells were also installed as part of Phase Two activities in December 2016. These wells were installed for the assessment of hydraulic conductivity and were not sampled as part of the monitoring program.

4.6 Sediment: Sampling

Sediment sampling at the Ottawa River was conducted on November 30 and December 1, 2016. Grab samples using a Ponar were collected from the top 0.15 metres of sediment in the Ottawa River, specifically at CU24 (upstream) and CU25 (downstream). 16 Sample locations were accessed via a non-inflatable rigid hull boat, which was launched from the public boat launch in Village Des Joachims. Sediment samples were collected into laboratory supplied jars and submitted for analysis of select CCOCs including PCBs, PHCs, PAHs, and metals.

4.7 Pipe Sampling

As part of the Phase Two ESA, International Safety Research Inc. (ISR) completed an assessment of two tile drain pipes and one former water intake pipe line at the Site using a small, specialized remote-controlled vehicle operated by Drain-All Ltd. (Drain-All). The vehicle entered the process lines and completed a visual inspection of the pipes by camera, while also completing a radiological scan using a mounted Geiger Muller handheld detector. Following its removal from the pipe, the surface of the vehicle body was sampled using swabs on a 100 cm² grid. Each swab was then placed in a small container and submitted for analysis of mercury levels.



4.8 Analytical Testing

Analytical testing of CCOCs in soil, sediment, and groundwater was conducted by Maxxam. The contact information for Maxxam was:

Maxxam Analytics
32 Colonnade Rd. N
Ottawa, ON K2E 7J6
Laboratory Contact: Ms. Alison Cameron
613 868 6079

Maxxam is a SCC accredited laboratory and all analyses completed by Maxxam are SCC accredited. Maxxam meet the International Standard ISO/IEC 17025 (General requirement for Competence of Calibration and Testing Laboratories).

The review of the soil and groundwater analytical results indicated that the method detection limits for all parameters met the requirements for evaluation with the MOECC Table 2 Standards, CCME Soil Quality Guidelines, and Health Canada Canadian Drinking Water Quality Guidelines.

4.9 Residue Management Procedures

Soil cuttings from the drilling program, purged groundwater and fluids from equipment cleaning were collected and placed in sealed 205-litre drums on-Site and left in place for disposal by CNL.

4.10 Elevation Surveying

An elevation survey was not completed as part of this Phase Two ESA. General elevation data from Land Information Ontario (LIO) was obtained at 5 m intervals.

4.11 Quality Assurance and Quality Control Measures

Golder's quality assurance program for environmental investigations was implemented to ensure that analytical data obtained during the investigation were valid and representative. Quality assurance and quality control measures employed during each stage of Phase Two ESA generally followed the Golder internal document "Quality Assurance Program for Environmental Investigations". The quality assurance program included the following measures:

- The use of SOPs for all field investigation activities.
- In preparation for groundwater sampling, monitoring wells were appropriately purged to remove stagnant water from the well bore, minimizing sample agitation and aeration to the extent practicable. The groundwater that entered the well bore following purging was assumed to be representative of in situ groundwater conditions in the vicinity of the well.
- The collection of field duplicate samples at a minimum frequency of one duplicate for every ten samples. Field duplicates were labelled by the field technician at the time of collection and included the FIELD DUP-# series, SA-DUP-## series and the SA-## DUP series.
- Initial calibration of field equipment was performed at the start of each field week.



- The collection of soil and groundwater samples in pre-cleaned, labelled, laboratory-supplied bottles with preservation (as necessary). New dedicated nitrile gloves were worn for the collection of each sample. Samples were put in ice-filled coolers following collection and prior to submission to the laboratory. Soil samples of approximately 6 grams mass were collected using pre-measured syringes and placed in 40 ml glass vials with methanol preservative for the analysis of PHC F1 or BTEX.
- The handling and storage of soil and groundwater samples in accordance with the sample collection and preservation requirements of the MOECC *Protocol for Analytical Methods Used in the Assessment of Properties Under Part XV.1 of the Environmental Protection Act*, July 1, 2011.
- The collection of groundwater samples using dedicated Waterra™ polyethylene tubing and a foot valve or a peristaltic pump with dedicated tubing at each location. Sampling personnel wore nitrile gloves while sampling and changed the gloves between each sample collected. All non-dedicated sampling equipment (e.g. water level meters) was decontaminated between sampling locations. Sampling equipment in contact with soil and groundwater was: cleaned by mechanical means; washed with a laboratory-grade detergent (Alconox) and, if necessary, an appropriate desorbing wash solution; and thoroughly rinsed with distilled water.
- The preparation at detailed field records documenting the methods and circumstances of collection for each field sample at the time of sample collection. Each sample was assigned a unique sample identification number recorded in the field notes, along with the date and time of sample collection, the sample matrix, and the requested analyses.
- The submission of samples to the analytical laboratory in accordance with standard chain of custody procedures.

As noted, laboratory analyses for CCOCs were completed by Maxxam, a laboratory accredited by the SCC.

Details of the parameters analysed for the duplicate soil and groundwater samples are also presented in Tables 2 and 3.

5.0 REVIEW AND EVALUATION

This section of the report presents a review and evaluation of the results of the drilling, monitoring and sampling activities conducted as part of the Phase Two ESA described herein.

5.1 Geology

The subsurface conditions, based on historical boreholes and boreholes drilled during the current field program are illustrated by stratigraphic layer and/or in cross-section view on Figures 6A, 6B, 7A, and 7B. The Record of Boreholes for boreholes drilled during the current Phase Two ESA are included in Appendix B.

The Site is generally underlain by native alluvial material. Much of the developed portions of the Site are built on a thick layer of sand and gravel fill. The bedrock at the Site consists of crystalline Precambrian assemblages primarily of granitic and granodioritic gneisses, with mafic bedrock in the southeast portion of the Site.

Based on both historical boreholes and boreholes completed during the current investigation, the majority of subsurface data was from the Class 1 licenced area where the former NPD reactor building is located. The subsurface materials in the Class 1 area consist of a thin surficial layer of topsoil or asphalt, which is underlain by sand and gravel fill. This sand and gravel fill material extends from the bottom of the topsoil/asphalt layer to black-coloured bedrock, which is reportedly present at depths of approximately 5.7 to 8.0 mbgs, in the area of the reactor building.



Boreholes were also completed in the former landfill located southwest of the Class 1 area. In this area, pit run aggregate fill material had been used to form a cover for the landfill. This fill material consisted mostly of sand with some gravel and cobbles. Pockets of waste were also encountered at three locations, SA-187, SA-189, and SA-192, within the landfill at depths ranging from 1-3 meters below ground surface. The fill cover over the waste varied in depth from 0.5 to 1.5 mbgs, and the waste layer itself was found to be approximately 2 m thick.

Based on the subsurface conditions encountered in boreholes and monitoring wells, the shallow groundwater was encountered in the sand and gravel fill layer which covered much of the area investigated at the Site.

5.2 Groundwater: Elevations and Flow Direction

Groundwater elevations were calculated using the depth to water table (from the ground surface) from the elevation of the ground surface. Elevation of ground surface was based on publicly available data with 5 m resolution accuracy from LIO.

During the Phase Two ESA, the static water levels in 25 accessible wells were measured using a Heron water level meter on May 29, 2017. Water levels were measured more than 24 hours after purging of the wells in preparation for sampling. The measured water levels of the monitoring wells, descriptors, and the standpipes are summarized in Table 1. The hydrogeological data associated with all wells were assumed to be representative of the shallow groundwater bearing unit at the Site.

Shallow groundwater elevations and interpreted shallow groundwater flow direction are presented in Figure 2. The shallow groundwater flow direction was interpreted to be to the northeast towards the Ottawa River. The regional groundwater flow direction was also interpreted to be to the northeast, towards the Ottawa River.

5.3 Groundwater: Hydraulic Conductivity, Hydraulic Gradients and Velocity

5.3.1 Hydraulic Conductivity

Estimates of hydraulic conductivity of the sand and gravel and bedrock units at the Site were calculated by Golder using 13 wells in the Class 1 area and are provided in Appendix C. Based on the calculations, the range of estimates of hydraulic conductivity for each unit included:

- 2×10^{-4} to 2×10^{-2} centimeters per second (cm/s), but generally less than 5×10^{-3} cm/s for the sand and gravel unit.
- 1×10^{-7} to 3×10^{-6} cm/s for the bedrock.

5.3.2 Horizontal Hydraulic Gradient

The average horizontal hydraulic gradient for shallow groundwater zone was estimated from the water level contours presented in Figure 2. The hydraulic gradient in the area near the reactor building was approximately 0.057 m/m. The maximum estimate of horizontal hydraulic gradient for this area was 0.080 m/m and the minimum estimate of hydraulic gradient in the Class 1 area was 0.040 m/m.

5.3.3 Vertical Hydraulic Gradients

The vertical hydraulic gradients were not calculated as part of this Phase Two ESA.



5.3.4 Groundwater Velocity

Based on an assumed hydraulic conductivity of 2×10^{-4} to 2×10^{-2} cm/s for the sand and gravel fill unit, horizontal hydraulic gradient of 0.057 m/m and a porosity of 38% (for poorly graded sands, gravelly sand, with little or no fines), the estimates of average linear shallow groundwater velocity ranged from 3×10^{-3} cm/s to 3×10^{-5} cm/s, which corresponded to approximately 2.5 cm/day to 2.5m/day. However, groundwater velocities of metres/day are uncommon, and the upper end of this range likely reflects the influence of gravel lenses. Local zones of high hydraulic conductivity, and therefore high groundwater velocity, may be present in the immediate vicinity of select wells, but it is unlikely that groundwater velocity of this magnitude would be present over significant portions of the Site. Based on the data collected, it is more probable that the groundwater velocity was of the order of tens to several tens of centimetres per day.

5.4 Soil: Texture

Based on the field observations, soil and fill materials on-Site primarily consist of sand and gravel with some silt and clay. Thus, a criteria associated with a coarse textured soil was used for the Property (conservative approach) and, as such, no grain size analysis was performed as part of the Phase Two ESA.

5.5 Soil: Field Screening

Where sufficient soil volume was recovered, headspace organic and combustible vapour measurements were conducted on the soil samples collected from the test pits and boreholes. The measured organic vapour concentrations in each of the soil samples were between 0 ppm and 68 ppm in soil sample J-1-B (0.15 to 0.30 mbgs) collected from shallow test pit J-1, which were submitted for laboratory analysis of PHCs F1-F4, BTEX, PAHs and metals. The measured combustible vapour concentrations in each of the soil samples were between 0 ppm and 185 ppm in soil sample J-2 (0 to 0.15 mbgs) collected from shallow test pit J-2, which was submitted for laboratory analysis of PHCs F1-F4, BTEX, PAHs and metals.

The results of headspace vapour measurements for each sample are presented in Table 4A - 4C (Soil Analytical Results).

5.6 Soil: Quality

A summary of the soil samples submitted for analysis and the analytical parameters is provided in Table 4. Soil analytical results from each of the stages of the Phase Two ESA compared to the MOECC Table 2 Standards and CCME Soil Quality Guidelines, are summarized in Tables 4A to 4C and presented in Figure 3. Laboratory Certificates of Analysis are provided in Appendix D.

The soil analytical results are discussed below in terms of the CCOCs below.

Metals

Of the 35 soil samples collected, 17, including one duplicate sample, were analysed for metals. One soil sample (J-1) exceeded the applicable MOECC Table 2 Standard for vanadium, and one soil sample exceeded the CCME Soil Quality Guidelines for arsenic and zinc.

Both samples with exceedances of metals/hydride metals were collected from 0 – 0.15 mbgs in areas that Site Representative suspected as being associated with former dumping sites.

No other metal exceedances were found in the soil samples collected.



PHC F1 to F4 and BTEX

Of the 35 soil samples, including three duplicates submitted for PHC F1 to F4 and BTEX analysis, two soil samples contained PHCs at concentrations that exceeded the MOECC Table 2 and CCME Soil Quality Guidelines.

Both soil samples with PHC exceedances were collected in areas that the Site Representative suspected were associated former dumping sites, the same locations as the samples with exceedances for arsenic, vanadium and zinc. The exceedances detected in sample J-1-B were for PHC fractions F1 (exceeding both MOECC Table 2 and CCME Soil Quality Guidelines) and F1-BTEX (exceeding MOECC Table 2 only). The exceedances present in sample J-6 were for PHCs F2-F4 (exceeding both MOECC Table 2 Standards and CCME Soil Quality Guidelines).

No other PHC or BTEX exceedances were found in the soil samples collected.

PAHs

Of the 35 soil samples, including three duplicates, submitted for PAH analysis, the concentrations of select PAHs exceeded the CCME Soil Quality Guidelines for PAHs in four samples and the MOECC Table 2 Standards in one of these samples.

PAH exceedances were detected in soil samples collected from various locations on the Site and did not appear to be local to specific historical practices. Exceedances were found to the north and the east of the facility along the river, and to the north and south of the facility in the Class 1 area. Three of the four samples had only phenanthrene levels above CCME Soil Quality Guidelines. SA-411-B, near the north edge of the Class 1 area, had levels of phenanthrene, naphthalene, and benzo[a]pyrene that exceeded CCME Soil Quality Guidelines, as well as levels of benzo[a]anthracene, benzo[a]pyrene, dibenzo[a,h]anthracene, fluoranthene, and indeno[1,2,3-cd]pyrene that exceeded MOECC Table 2 Standards.

The concentrations of PAHs did not exceed MOECC Table 2 Standards or CCME Soil Quality Guidelines in any other soil samples.

PCBs

In 35 soil samples, including three duplicates, the concentrations of PCBs did not exceed the MOECC Table 2 Standards or CCME Soil Quality Guidelines.

Comparison of Soil with CCME Soil Quality Guidelines- Industrial

The Site is currently federal crown lands and is an industrial site with a Class 1 Nuclear Facility Licence under the Nuclear Safety Control Act. Thus, provincial regulations do not apply to the Site, however CNL has applied O. Reg 153 to the Phase Two ESA for the purposes of best practice and due diligence.

Based on the current use of Site, CCME Soil Quality Guidelines for Industrial land use would be applicable. Of the 35 samples submitted for analysis, six exceeded applicable CCME Soil Quality Industrial Guidelines compared to seven, which exceeded MOECC Table 2 Standards and/or CCME Soil Quality Guidelines. Vanadium in sample J-1 exceeded MOECC Table 2 Standards, but did not exceed the CCME Soil Quality Industrial Guidelines. The comparison of soil quality to the CCME Soil Quality Industrial Guidelines is summarized in Table 6.

As noted above, the concentrations select PHCs that exceeded MOECC Table 2 and CCME Soil Quality Guidelines in samples J-1-B and J-6 also exceeded the CCME Soil Quality Industrial Guidelines.



Concentrations of select PAHs exceeded the CCME Soil Quality Guidelines for PAHs in four samples and the MOECC Table 2 Standards in one of these samples. Except for SA-411-B, the concentrations of select PAHs that exceeded CCME Soil Quality Guidelines also exceeded the CCME Soil Quality Industrial Guidelines.

5.7 Groundwater: Quality

A summary of the groundwater samples submitted for analysis and the associated parameters analyzed is provided in Table 3. Groundwater analytical results are presented in Tables 5A and 5B, and visualized in Figure 4. Laboratory Certificates of Analysis are provided in Appendix D.

The concentrations of PHCs F1 to F4, BTEX, PAHs, and metals in the each of the groundwater samples (including the duplicates) collected from locations outlined on Table 3 were below the laboratory detection limit or were at measured concentrations below the applicable MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines. One exception was the sample from BH-14-01, which had levels of benzo[a]pyrene exceeding both MOECC Table 2 and Health Canada Canadian Drinking Water Quality Guidelines.

In addition to numerical standards, the MOECC Table 2 Standards sets out non-numerical (aesthetic) standards relating to the presence of free phase product and hydrocarbon sheen. Specifically, a property does not meet the site specific standard if there is evidence of free product, including but not limited to, visible petroleum hydrocarbon film or sheen present on groundwater, surface water or in any groundwater or surface water samples. Sheen was not observed in samples from any of the monitoring wells.

5.8 Sediment Quality

Elevated levels in both upgradient and downgradient sample locations of select metals, PAHs, and PCBs above the applicable standards and/or guidelines were found in the sediment both upstream and downstream of the CNL NPD Site. Specific information regarding the exceedances can be found in Appendix E – Ottawa Sediment River Sampling.

5.9 Pipe Quality

The concentrations of mercury in two of the three pipeline swab samples were below the minimum detectable limit (MDL) of the test, while the concentration of mercury in the other swab sample, SWIPE #3, was at the MDL. Analytical results are summarized in Table 7.

5.10 Quality Assurance and Quality Control Results

The data collected as part of the Phase Two ESA field program was evaluated according to the following criteria to evaluate its validity: precision, accuracy, completeness, representativeness and comparability. A discussion of each criterion as it relates to the QA/QC program is provided below.

5.10.1 Precision

Precision is a measurement of the repeatability of the methods employed, i.e., sampling methods. Precision is evaluated through the testing of blind field duplicate samples. Golder implemented the following laboratory analytical quality control measures:

- Collection of three duplicate soil samples from samples SA-312, SA-417-B, and J-4 for the analysis of PHC F1 to F4, BTEX, PAHs, PCBs, and/or metals.



- Collection of three duplicate groundwater samples with samples NPD-7, NPD-4, and BH-10-01 for the analysis of PHC F1 to F4, BTEX, and PAHs.

To determine the precision of the analyses of the original and duplicate soil and groundwater samples, the relative percent difference (RPD) for specific parameters was calculated according to the following equation:

$$RPD = \frac{|x_2 - x_1|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100$$

Where, x_1 and x_2 are the concentrations of the parameter in the original and duplicate samples. RPDs are calculated only if the concentrations of a parameter are greater than the analytical reportable detection limit (RDL) in both the duplicate and original samples. In addition, lower precision in the RPD calculation is expected when concentrations of the analytes are less than ten times the RDL. Therefore, RPDs were calculated for the original and duplicate groundwater and soil samples only in cases where the measured concentrations of analytes in both samples were ten times greater than the RDL.

The commonly accepted industry standard data quality objective (DQO) for the RPD in soil between a sample and its duplicate is 50% for VOCs, 40% for PHCs and PAHs, and 30% for metals, and in groundwater between a sample and its duplicate is 30% for PHCs, VOCs, and PAHs and 20% for metals.

Soil RPD

The calculated RPDs for the original and duplicate soil samples for metals were in general within the acceptable DQO (30%) or the concentrations of the analytes were less than ten times the RDL, with the following exception:

- In sample J-4 and its duplicate, DUP-J-4, the RPD for nickel was 31%.

The RPDs for PHCs F1 to F4, BTEX, PAHs, and PCBs for the original and duplicate soil samples were within the acceptable DQO (40%) or the concentrations of the analytes were less than ten times the RDL.

The RPD in sample J-4 and its duplicate for nickel is interpreted to be due to the non-heterogeneous nature of soil.

Groundwater RPD

The calculated RPDs for the original and duplicate groundwater samples for PHCs, BTEX, and PAHs were within the acceptable DQO (30%), were within the acceptable DQO (20%) for metals, or the concentrations of the analytes were less than ten times the RDL.

5.10.2 Accuracy

Accuracy is a measure of how close a measured value is to the true value. The accuracy of the laboratory data is generally evaluated by the laboratory through the use of matrix spikes or surrogate recoveries. The Maxxam QA/QC program included lab duplicates, spiked blanks and method blanks, and is described in the Certificates of Analysis (Appendix D). Maxxam indicated that the overall data quality met acceptability criteria, and the laboratory data presented herein were considered to be accurate.



5.10.3 Completeness

Completeness is evaluated by comparing the planned sampling program with the sampling program that was actually completed and evaluating discrepancies. Golder completed the planned sampling and analytical work described in the CNL NPD Sampling Plan, and the investigation was considered to be complete.

5.10.4 Representativeness

Representativeness is the degree to which the samples collected during the Phase Two ESA program represent the soil and groundwater conditions from which they were collected. As part of the Phase Two ESA, and consistent with the CNL NPD Sampling Plan, Golder implemented the following measures to ensure that representative data was obtained:

- An appropriate and representative number of samples were analysed from each distinct overburden unit, and from the shallow water bearing unit.
- Use of dedicated or cleaned sampling equipment between sampling events.
- Use of calibrated field monitoring equipment (RKI Eagle 2).
- Use of appropriate laboratory supplied sampling jars and bottles.
- Analysis within an acceptable holding time as specified in the MOECC document “*Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act*”, March 9, 2004 (amended as of July 1, 2011).
- Delivery of samples under a Chain of Custody.
- Laboratory analysis by SCC accredited laboratory (Maxxam).

Based on the above, it is considered that the data collected at the Site during the Phase Two ESA were representative of the environmental conditions at the time the work was completed.

5.10.5 Comparability

Comparability describes how well collected data can be compared to other sample results (current and previous investigations) or criteria. Consistent field procedures and analytical methods were used throughout each of the stages of the Phase Two ESA sampling program to allow for comparison of the data obtained in different sampling locations at the Property. Field procedures and analytical methods followed industry-approved standards to allow for comparison of data with the MOECC Table 2 Standards.

Based on the above information, data collected as part of the Phase Two ESA field program are considered to be comparable.

Accordingly, the analytical data generated during the investigation are valid and representative and may be used in this Phase Two ESA without further qualification.



5.11 Phase Two Conceptual Site Model

The Phase Two ESA CSM was developed on the basis of data from previous investigations and on the results of this Phase Two ESA. The CSM consists of diagrams, cross-sections and figures that show the current condition of the RSC Property. A narrative description is provided to explain the contents of the figures and an interpretation of the contaminant distribution.

The figures that comprise the Phase Two CSM include:

- Figure 1A: Site Plan (All Investigation Locations)
- Figure 1B: Detailed Site Plan (All Investigation Locations)
- Figure 1C: Detailed Site Plan (Locations with CCOC Samples Analysis)
- Figure 1D: Layout of NPD Site, Buildings, and Foundations
- Figure 1E: Site Plan Divided by Class
- Figure 2: Groundwater Elevations Interpreted Shallow Groundwater Flow Direction
- Figure 3: Summary of Soil Analysis and Exceedances
- Figure 4: Summary of Groundwater Analysis and Exceedances
- Figure 5: Cross Section Summary
- Figure 6A: Cross-Section A1-A1'
- Figure 6B: Cross-Section B1-B1'
- Figure 7A: Cross-Section A2-A2'
- Figure 7B: Cross-Section B2-B2'

Physical Setting

The Site is on the south bank of the Ottawa River, about 3 km downstream from the Des Joachims Dam and approximately 25 km upstream from the CRL site. The Site and the surrounding lands have a downward slope to the northeast (towards the Ottawa River). The Ottawa River is located adjacent to the northeastern boundary of the Site.

Based on the Ontario Geological Survey base maps and previous investigations completed for the Property, the overburden at the Site is original native alluvial material, and much of the developed portions of the Site are built on thick layer of sand and gravel fill. The bedrock material is primarily magmatic rocks and gneisses, with mafic bedrock found in the southeast portion of the Site.

The surrounding properties to the Site are primarily comprised of undeveloped land controlled by CNL, as summarized below:

- **North:** Undeveloped land (forested) with the Ottawa River to the northeast.
- **West:** Undeveloped land (forested) with Swisha Road located beyond the Site boundary.
- **South:** Ontario Highway 17 and undeveloped land (forested).
- **East:** Undeveloped land (forested) and the Ottawa River.



Topography and Drainage

During the construction of the NPD generating station, numerous man-made terraces and steep interconnecting benches were created for construction and security purposes. This activity resulted in a highly modified landscape at the Site. Regional surface water and groundwater runoff flows towards the Ottawa River. Some groundwater is intercepted by a tile drain system, but this also discharges water to the Ottawa River. The tile drains are below grade and can provide a preferential pathway for drainage. These drains are sampled regularly by CNL at the effluent discharge points to the Ottawa River.

Environmentally Sensitive Areas

Golder is not aware of the confirmed presence of an area of natural significance on or within 30 m of the Site. As such, the Site is not considered an environmentally sensitive area as defined by O.Reg. 153/04.

Shallow Soil Property or Water Body

Based on the information obtained from previous investigations and this Phase Two ESA completed at the Site, the depth to bedrock more than 2 metres across most of the Site. As such, the Site is not considered a shallow soil property.

The Ottawa River is located within 30 metres of the northeast boundary of the Site. However, as most of the Site does not include all or part of a water body and is not adjacent to a water body or include land that is within 30 metres of a water body, this is not considered to be relevant.

Summary of Historical Site Use

The NPDNGS was operated at the Site by Ontario Hydro between 1962 until 1987. Prior to 1962 the Site was undeveloped forested land. Following permanent shutdown of the station, the operating and compliance responsibilities were transferred from Ontario Hydro to AECL, and the facility was renamed the Nuclear Power Demonstration Waste Facility (NPDWF). The NPDWF Site is presently in the SWS phase of decommissioning, and CNL is planning for the final stage of decommissioning.

Several former buildings on Site have been demolished since decommissioning began, including the former administration wing of the reactor building in the Class 1 area, the former pump house along the Ottawa River, and the former training centre in the southeast quadrant of the Class 2 area.

Several former ASTs and USTs were operated in conjunction with the Site. In the Class 1 area around the reactor building and its former administration wing, there were formerly diesel, fuel oil, and transformer oil USTs located to the northwest of the building, a waste liquid/septic UST located to the southeast of the building, and a waste oil UST to the northeast of the building. In the area of the former pump house there were two USTs, one diesel and one gasoline. Finally, two USTs were identified in the area of the former training centre, however their contents are unknown.

While the Site was in full operation several sections of the forested land in the Class 2 and 3 areas were used as dumping sites (various small sites, and at least two major sites: 300 m to the southwest of the Class 1 area and another 400 m to the northwest), vehicle maintenance areas (300 m south of the Class 1 area), and hydro easements (200 m west of the Class 1 area). None of these sites continue to be used or maintained.

Potable Water Wells

No potable water wells are located on or within 250 metres of the Phase Two Property, however given that the Site's future use is uncertain at this time, a potable groundwater standard was applied.



Subsurface Utilities

Utility drawings are available for the Site. However, given that the groundwater impact identified is believed to be due to sediment impacts, it is considered that there are no preferential pathways for contaminant migration on the Site associated with the presence of subsurface utilities.

Geological Conditions

The NPD Site is underlain by native alluvial material, and much of the developed portions of the Site are built on thick layer of sand and gravel fill. The fill at the Site locally contains evidence of ash, cinders and pieces of asphalt, brick, concrete, wood and/or metal and potentially some refuse. The bedrock at the Site consists of crystalline Precambrian assemblages primarily of granitic and granodioritic gneisses, with mafic bedrock in the southeast portion of the Site. Depth to bedrock across the Site ranged from 5.7 to 8 mbgs.

Based on both historical boreholes and boreholes completed during the current investigation, the majority of subsurface data is from the Class 1 licenced area where the former NPD reactor building is located. The Class 1 area consists of a thin layer of topsoil or asphalt which is underlain by sand and gravel fill. This sand and gravel fill material extends from the bottom of the topsoil layer to black magmatic bedrock which, in the area around the reactor building, occurs at depths of approximately 5.7 to 8.0 mbgs.

In the current Phase Two ESA, boreholes were also completed in the former landfill located southwest of the Class 1 area. In this area, pit run aggregate fill material had been used to form a cover for the landfill. This fill material consisted mostly of sand with some gravel and cobbles. Pockets of waste were also encountered at three locations within the landfill. The fill cover over the waste varied in depth from 0.5 to 1.5 mbgs, and the waste layer was found to be approximately 2 m thick.

Based on the subsurface conditions encountered in boreholes and monitoring wells the shallow groundwater was encountered in the sand and gravel layer which covers most of the Site.

Physical Hydrogeology

■ Groundwater Levels

During the Phase Two ESA, the depths to static water level were measured in all 25 accessible wells on May 29, 2017. As summarized in Table 1, the water levels of the monitoring wells, ranged from near ground surface to as much as approximately 10 mbgs. The groundwater levels were assumed to be representative of those in the shallow groundwater-bearing unit at the Site.

■ Groundwater Flow Directions

The elevations of the groundwater at all monitoring wells were plotted on Figure 2. Based on the contoured elevations, the shallow groundwater flow direction for May 29, 2017 was interpreted to be to the northeast towards the Ottawa River. While there may be some seasonal fluctuations in water levels at the Site, the trend of groundwater flow towards the Ottawa River is expected to be consistent. The regional groundwater flow direction is also anticipated to be towards the Ottawa River.

■ Hydraulic Conductivity

The ranges of estimates of hydraulic conductivity included:

- 2×10^{-4} to 2×10^{-2} cm/s for the sand and gravel unit, but generally less than 5×10^{-3} cm/s.
- 1×10^{-7} to 3×10^{-6} cm/s for the bedrock.



■ **Horizontal Hydraulic Gradient**

The average horizontal hydraulic gradient for shallow groundwater was estimated from the water level contours presented in Figure 2, primarily from the groundwater data in the Class 1 area in the vicinity of the former NPD reactor building for May 29, 2017. The hydraulic gradient in this area averaged approximately 0.057 m/m, and ranged between approximately 0.080 m/m and 0.040 m/m.

■ **Vertical Hydraulic Gradients**

The vertical hydraulic gradients were not calculated as part of this Phase Two ESA.

■ **Groundwater Velocity**

Based on an assumed hydraulic conductivity of 2×10^{-4} to 2×10^{-2} cm/s for the sand and gravel fill unit, horizontal hydraulic gradient of 0.057 m/m and a porosity of 38% (for poorly graded sands, gravelly sand, with little or no fines), the average linear shallow groundwater velocity is estimated to range from 3×10^{-3} m/s to 3×10^{-5} m/s, which corresponds to approximately 2.5 cm/day to 2.5m/day. However, groundwater velocities of metres/day are uncommon, and the upper end of this range likely reflects the influence of gravel lenses. Local zones of high hydraulic conductivity, and therefore high groundwater velocity may be present in the immediate vicinity of select wells, but it is unlikely that groundwater velocity of this magnitude would be present over significant portions of the Site. Based on the data collected, it is more probable that the groundwater velocity was of the order of tens to several tens of centimetres per day.

Potentially Contaminating Activities and Areas of Potential Environmental Concern

With respect to the Class 1 Licenced Area, based on a review of the reports (see Section 2.2.2 to 2.2.7) groundwater impacts were not documented at the Site however residual hydrocarbons may be present at the Site, within the Licensed Area. In accordance O.Reg 153/04, these ASTs and USTs would constitute APEC(s) for the Site.

With respect to Class 2, 3 and BRA areas, based on the results of the Phase Two ESA, updated APECs are summarized in the following table.

APEC or PCA for the Phase One Property	Location of Area of Potential Environmental Concern in relation to the Site	Is the PCA identified for the Property considered an APEC for the Site? Reasoning	Potentially Contaminating Activity (PCA) and Description of the Activity	Contaminants of Potential Concern	Media Potentially Impacted (groundwater, soil and/or sediment)
APEC 1 – Landfill #1	<p>Operation of the landfill was conducted under Ontario Provisional Certificate of Approval No. A413107, which was amended effective November 25, 1998 to recognize approval from the Ontario Ministry of Environment to close the landfill.</p> <p>No soil impacts were identified in the landfill area, and no groundwater impacts have been identified in the wells surrounding the landfill historically or during this Phase Two ESA.</p>				



**PHASE TWO ENVIRONMENTAL SITE ASSESSMENT
NPD SITE, CANADIAN NUCLEAR LABORATORIES**

APEC or PCA for the Phase One Property	Location of Area of Potential Environmental Concern in relation to the Site	Is the PCA identified for the Property considered an APEC for the Site? Reasoning	Potentially Contaminating Activity (PCA) and Description of the Activity	Contaminants of Potential Concern	Media Potentially Impacted (groundwater, soil and/or sediment)
APEC 2 - USTs of Unknown Purpose	Training Centre	Yes, on site.	Storage tanks (2) of unknown purpose.	PHC F1-F4, BTEX, PAH	Soil and groundwater.
APEC 3 – Vehicle Maintenance Yard	No soil impacts identified, potential groundwater impacts are not anticipated based on the lack for field evidence of staining and soil sampling which did not indicate impacts from the former vehicle maintenance.				
APEC 4a, APEC 4b - Suspected Historic Unauthorized Dumping Sites	250 - 300 m south of NPD station.	Yes, on site.	#58 Waste Disposal and Waste Management, including thermal treatment, landfilling and transfer of waste, other than use of biosoils as soil conditioners. Former landfill.	PHC F1-F4, BTEX, PAH, metals.	Soil and groundwater.

Notes

PHC F1-F4 - petroleum hydrocarbon fractions F1 to F4
 BTEX- benzene, toluene, ethylbenzene, xylenes
 VOC – volatile organic compounds (include BTEX)
 PAHs-Polycyclic Aromatic Hydrocarbons
 UST - underground storage tank
 AST – above ground storage tank

Findings of the Phase Two ESA

Soil conditions at the Site: The Phase Two ESA involved the collection of soil samples from boreholes and test pits across the Site, including the Class 1, 2, and 3 areas and BRA. Class 1 locations were within the licensed area, Class 2 locations were within the exclusion zone adjacent to the licensed area, Class 3 locations were in the undeveloped lands surrounding the Class 2 area, and the BRA locations were at the boundaries of the Site where there is assumed to be no impacts. Groundwater samples were collected from 24 monitoring wells, which had been installed previously at the Site. The analytical program of the Phase Two ESA addressed CCOCs only (ROC analysis is reported under separate cover by Others). The environmental condition of soil samples was evaluated using the MOECC Table 2 Standards and the CCME Soil Quality Guidelines. Groundwater quality was assessed using MOECC Table 2 Standards and the Health Canada Canadian Drinking Water Quality Guidelines. Sediment quality was assessed using the CCME Sediment Quality Guidelines, MOECC sediment in generic site conditions, and Atlantic Risk-Based Corrective Action.



The results of the Phase Two ESA indicated that PHC impacts were identified in soil at two locations, J-1 and J-6, in the area of two suspected historic unauthorized dumping sites in the south of the Class 2 area above MOECC Table 2 Standards and both CCME Soil Quality Guidelines and CCME Soil Quality Industrial Guidelines (i.e. at APECs 4a and 4b). Metals impacts were also identified at these locations which exceeded MOECC Table 2 Standards and/or CCME Soil Quality Guideline, but were within CCME Soil Quality Industrial Guidelines. Although sample J-1 and J-6 had exceedances, the sampling program included a cluster of three samples at each of these locations. The other two samples within each of these clusters did not have exceedances, thus indicating the impact may be localized. Further sampling would be required to delineate the vertical and horizontal extent of metals in soil at these locations.

In addition, two soil samples in the Class 1 area, SA-379-B and SA-411-B, contained select PAHs at concentrations above the MOECC Table 2 Standards and in excess of CCME Soil Quality Guideline and CCME Soil Quality Guidelines- Industrial in the Licenced Area. Golder understands, that this area will eventually be designated as a waste disposal facility as a result of in-situ decommissioning approach for the CNL NPD. This approach would include placing an engineered barrier over the entire licensed area, which would isolate this contamination from the environment and precipitation, and minimize leaching processes, as part of a risk mitigation measure.

No soil impacts greater than the MOECC Table 2 Standards were encountered in the former landfill site (APEC 1), vehicle maintenance yard (APEC 3), or undeveloped areas around the Class 1 area.

Groundwater conditions at the Site: Groundwater sampling completed at the Site indicated that the concentrations of the PHCs F1 to F4, BTEX, PAHs and metals in each of the groundwater samples were below the applicable MOECC Table 2 Standards and Canadian Drinking Water Quality Guidelines for Human Health. One possible exception to this was the sample from BH14-01, which had levels of benzo[a]pyrene that exceeded both standards: however, it is likely that this occurrence was due to suspended sediment in the groundwater sample as a result of very low yield in the well. As such, the groundwater was not considered to be contaminated.

Based on the results of the sediment sampling program, it was concluded that elevated levels of select metals, PAHs, and PCBs above the applicable standards and/or guidelines were found in the sediment both upstream and downstream of the CNL NPD Site. Based on the type, magnitude and distribution of exceedances, it is considered unlikely that the CNL NPD Site has contributed to the elevated levels of select contaminants in the Ottawa River sediment. No further sampling is recommended at this time.

The concentrations of mercury in the three pipeline swab samples were at or below the MDL for the test, indicating little to no mercury content in the pipeline.

Arsenic and cadmium were present in concentrations that exceeded the CCME ISQG in the three samples from east of the Class 1 area in the Ottawa River. There were no exceedances of the CCME ISQG for metals in the five samples from locations to the west and north of the Class 1 area.



Potential Exposure Pathways and Receptors

Potential human receptors at the Site might include outdoor workers and construction workers, and visitors to the Site. Potential ecological receptors might include terrestrial plants, mammals, birds and soil invertebrates. Exposure pathways for potential human receptors include ingestion, dermal contact with contaminated soil, inhalation of soil particulates, inhalation of indoor and outdoor air or inhalation of air in trenches for construction worker receptors. The exposure pathways for potential ecological receptors include direct/dermal contact, root/direct uptake and/or ingestion.

Groundwater quality generally met the MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines, so no potential exposure pathways associated with contaminated groundwater were identified.

The potential exposure pathways and receptors were identified by a preliminary evaluation only, detailed evaluation of potential exposure pathways and receptors was beyond the scope of the Phase Two ESA work and was not performed.

6.0 CONCLUSIONS

A Phase Two ESA was carried out by Golder in 2017 to provide an overview of the environmental condition of soil and groundwater at the Site. The scope of the field investigation and selection of sampling locations were described in the ORAU Characterization Plan. The Phase Two ESA was consistent with requirements defined in O. Reg. 153/04 and the CCME Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk. The general objective of the Phase Two ESA was to assess the environmental condition of soil and groundwater at the Site in terms of CCOCs relative to federal and provincial environmental standards for more sensitive land uses. The Phase Two ESA included a review of historical investigations, the implementation of soil sampling from drilled boreholes and hand-dug test pits across the Site and the collection of groundwater samples from existing and accessible monitoring wells at the Site. A summary of all locations investigated as part of field activities can be found in Table 8 following the body of this report.

Based on the completed scope of work and results of the Phase Two ESA, the following summary and conclusions are provided:

- Soil analytical results were compared to the MOECC Table 2 Standards (residential/parkland/institutional property use, potable groundwater, coarse-grained) presented in the MOECC “*Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*”, dated April 15, 2011, the CCME Soil Quality Residential/Parkland Guidelines and CCME Soil Quality Industrial Guidelines.
- The analytical results for groundwater were compared to the MOECC Table 2 Standards and the Health Canada Canadian Drinking Water Quality Guidelines.
- The analytical results for metals in sediment were compared to CCME ISQG.
- The NPD Site is underlain by native alluvial material, and much of the developed portions of the Site are built on thick layer of sand and gravel fill. The bedrock material is primarily magmatic rocks and gneisses, with mafic bedrock in the southeast portion of the Site.



- Based on both historical boreholes and boreholes completed during the current investigation, the majority of subsurface data is from the Class 1 licenced area where the former NPD reactor building is located. The subsurface stratigraphy in the Class 1 area consists of a thin layer of topsoil or asphalt, which is underlain by sand and gravel fill. This sand and gravel fill material extends from the bottom of the topsoil layer to black granite bedrock which, in the area around the reactor building, is located approximately 5.7 to 8.0 mbgs.
- A summary of the soil conditions at the Site based on the results of the Phase Two ESA by area is as follows:
 - *Class 1 area* – A total of 68 locations were investigated, with stratigraphic delineation, at the following depths: 0 to 0.15 mbgs and 0.15 to 0.3 mbgs. Samples were collected if evidence of impact was detected by Photo-Ionization Detector (PID) readings or by visual assessment. One field duplicate sample was collected for every ten samples. Of the 68 locations investigated, seven soil samples and one field duplicate were submitted for CCOC analysis based on field evidence of potential impacts.
 - Two of the seven soil samples analyzed for PHCs, BTEX, and PAHs exceeded CCME Soil Quality Guidelines for the PAH phenanthrene. One sample, in the northwest of the area, also exceeded both MOECC Table 2 and/or CCME Soil Quality Guidelines for six other PAHs. No PHC or BTEX exceedances were identified in the Class 1 area.
 - Golder understands, that this area will eventually be designated a waste disposal facility as a result of an in-situ decommissioning approach of CNL NPD. This approach will include placing an engineered barrier over the entire licensed area, which would isolate this contamination from the environment as part of a risk mitigation measure.
 - *Class 2 area* – A total of 255 locations were investigated as well as an additional 13 locations for the limited historic unauthorized dumping or vehicle maintenance (“J” series samples) and one location where debris was noted by the Ottawa River. Locations were investigated generally at 0 to 0.15 mbgs and in some cases from 0.15 to 0.3 mbgs; and, at Landfill #1 soil cores were advanced deeper to investigate for the presence of historical waste. CCOC Samples were collected if evidence of impact was detected by PID readings or by visual assessment. Within the Class 2 samples prescribed by the Characterization Plan seven samples and one field duplicate were submitted for CCOC analysis. Within “J” series, 16 samples and one field duplicate were submitted for CCOC analysis. One soil sample where debris was noted by the Ottawa River was submitted for CCOC analysis.
 - The concentrations of PHCs in two of the samples analyzed exceeded MOECC Table 2 Standards, CCME Soil Quality Guidelines and CCME Soil Quality Industrial Guidelines Guidelines;
 - Two of samples analyzed for PAHs exceeded CCME Soil Quality Guidelines and CCME Soil Quality Industrial Guidelines for phenanthrene; and,
 - Two samples analyzed for metals exceeded MOECC Table 2 Standards and/or CCME Soil Quality Guidelines, but were within CCME Soil Quality Industrial Guidelines for select metals.
 - *Class 3 and BRA area* – A total of 96 investigations were located at 0 to 0.15 mbgs. No field indication of impacts were observed and no CCOC samples were submitted for analysis.



- Groundwater sampling was completed using 24 previously existing monitoring wells at the Site. The results of the groundwater testing indicated that the concentrations of the PHCs F1 to F4, BTEX, and PAHs in each of the groundwater samples were below the applicable MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines. An exception was the sample from BH14-01, which had levels of benzo[a]pyrene that exceeded both MOECC Table 2 Standards and Health Canada Canadian Drinking Water Quality Guidelines; however, it is considered likely that this was due to disturbed sediment in the groundwater sample as a result of low groundwater yield in the well, which was pumped dry four times during the sample collection process.
- Sediment sampling was completed at 16 locations in the Ottawa River both upstream and downstream from the NPD Site. Based on the results of the sediment sampling, it was concluded that elevated levels of select metals, PAHs, and PCBs above the applicable standards and/or guidelines were found in the sediment both upstream and downstream of the CNL NPD Site. Based on the type, magnitude and distribution of exceedances, it is considered unlikely that the CNL NPD Site has contributed to the elevated levels of select contaminants in the Ottawa River sediment. No further sampling is recommended at this time.
- ISR completed an assessment of two tile drain pipes and one former water intake pipe line at the Site using a small, specialized remote-controlled vehicle operated by Drain-All Ltd. (Drain-All). The vehicle entered the process lines and completed a visual inspection of the pipes by camera, while also completing a radiological scan using a mounted Geiger Muller handheld detector. Following its removal from the pipe, the surface of the vehicle body was sampled using swabs on a 100 cm² grid. The analytical results for the three pipeline swabs submitted for mercury analysis, were all at or below the minimum detectable limit for the test indicating that there is little to no mercury content in the pipes.

Recommendations

APEC 1 (Landfill #1) –No chemical parameters exceeding the MOECC Table 2 Standards and CCME Soil Quality Guidelines were identified, however the presence of waste was documented in the borehole drilling program. Operation of the landfill was conducted historically under Ontario Provisional Certificate of Approval No. A413107, which was amended effective November 25, 1998 to recognize approval for closure of the landfill by MOE. long-term monitoring consistent with landfill closure report is required. It is recommended to close out this APEC.

APEC 2 (Unknown USTs at the former Training Centre) – Shallow soil samples in the reported vicinity of the USTs did not identify any impacts; however, the soil samples would not have been at a depth sufficient to assess the potential soil quality related to the USTs. Uncertainty exists in the number of USTs which may exist in the vicinity of the former Training Centre, and no historical information was available to confirm the presence or locations of these USTs. Further investigation would be required to close out this APEC.

APEC 3 (Vehicle Maintenance Yard) - No shallow soil impacts were identified in this area during the Phase Two ESA. Potential groundwater impacts are not anticipated based on the lack for field evidence of staining and the results of soil sampling, which did not indicate impacts from the former vehicle maintenance. It is recommended to close out this APEC.

APECs 4a and 4b (Suspected Historic Unauthorized Dumping Sites) – Shallow soil PHC and metal impacts were identified at APECs 4a and 4b. The sampling program in these areas included a cluster of three samples at each of these locations. The other samples within each of these clusters did not have exceedances thus indicating the impacts may be localized. Further sampling would be required to delineate the vertical and horizontal extent of metals in soil at these locations



The Phase Two ESA was consistent with requirements defined in O. Reg. 153/04 (as amended) and is sufficient for the purposes of due diligence. Should CNL seek to file a Record of Site Condition with the MOECC, the following additional work should include:

- Phase One Environmental Site Assessment pursuant to O.Reg. 153/04, including Chain-of-Title documentation.
- Specific investigation of APECs identified in the Phase One ESA.
- Further investigation including horizontal and vertical delineation of impacts detected during this Phase Two ESA.
- Completion of a Plan of Survey or equivalent for the Site.

7.0 LIMITATIONS

This report was prepared for the exclusive use of Canadian Nuclear Laboratories. The report, which specifically includes all tables, figures and appendices, is based on data and information collected during conducting the Phase Two ESA, and is based solely on the conditions of the property at the time of conducting investigations, supplemented by historical information and data obtained by Golder as described in this report.

The assessment of environmental conditions at this Site has been made using the results of field screening techniques and chemical analysis of soil and groundwater samples at a limited number of locations. The Site conditions between sampling locations have been inferred based on conditions observed at the sampling locations. Conditions may vary from these sample locations. Additional study, including further investigation, can reduce the inherent uncertainties associated with this type of study. Sample locations were selected using the MARSSIM approach to statistically select locations based on a 95 percent upper confidence level, however, it is never possible, even with exhaustive sampling and testing, to dismiss the possibility that part of a Site may be contaminated and remain undetected.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The content of this report is based on information collected during the drilling and soil sampling activities, our present understanding of the Site conditions, and our professional judgement in light of such information at the time of this report. This report provides a professional opinion and therefore no warranty is expressed, implied, or made as to the conclusions, advice and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.



The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, Golder should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

8.0 SIGNATURES

The undersigned Qualified Person confirms that he/she was responsible for conducting and/or supervising this Phase Two ESA and the associated findings and conclusions.

We trust that you will find the contents of this report satisfactory for your current needs. Should you require clarification of the information provided, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

Alex Wood, EIT.
Environmental Consultant

David Smyth, P. Geo., QPESA
Principal

AW/PH/DS/hw

[https://golderassociates.sharepoint.com/sites/10362g/10 Reporting/Phase II ESA/FINAL/1666131 - CNL NPD Phase Two ESA_FINAL Oct 2017.docx](https://golderassociates.sharepoint.com/sites/10362g/10%20Reporting/Phase%20II%20ESA/FINAL/1666131%20-%20CNL%20NPD%20Phase%20Two%20ESA_FINAL%20Oct%202017.docx)

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9.0 REFERENCES

- MOECC, 2011. Guide for Completing Phase Two Environmental Site Assessments under Ontario Regulation 153/04, dated June, 2011.
- MOECC, 2013. Report Template for Phase Two Environmental Site Assessment Conducted in Accordance with Ontario Regulation 153/04, as amended, prepared by Association of Professional Geoscientists of Ontario, dated October, 2013.
- MOECC. 2004. Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act, March 9, 2004 (amended in July 2009 and effective as of July 1, 2011).
- MOECC. 2011. Ontario Regulation 153/04, as amended, Record of Site Condition - Part XV.1 of the Environmental Protection Act, amended October 31, 2011.
- MOECC. 2011. Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, dated April 15, 2011.
- Ontario Geological Survey. *MRD 126 – Revision 1 1:250 000 Scale Bedrock Geology of Ontario*. Dated August 2009.
- Ontario Geological Survey. *MRD 128 – 1:50 000 Scale Surficial Geology of Southern Ontario*. Dated October 2003.
- Golder Associates. *Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories*. Dated November 21, 2016.
- Oak Ridge Associated Universities. *Nuclear and Conventional Hazards of the Nuclear Power Demonstration Waste Facility (NPD) NPD Decommissioning 64-509410-PLA-001 Revision 0*. Dated July 19, 2016.

**Table 1
Groundwater Monitoring Well Construction Details**

Monitoring Well	Well Install Date	Depth to Well Bottom (mbgs)	Screened Interval	Stick-Up	Depth to Water (mbgs)	Notes on Well Condition
NPD- 1	1988	10.55	9.79 - 10.55	0.8	6.604	
NPD- 2	1988	11.14	9.26 - 10.02	0.93	7.746	
NPD- 4	1988	13.62	11.90 - 12.66	0.55	9.824	
NPD- 5	1988	13.01	11.05 - 11.81	0.77	6.939	
NPD- 7	1988	9.46	7.31 - 8.08	0.99	4.899	
NPD- 8	1988	17.91	15.86 - 16.62	0.85	13.52	
NPD- 9	1989	4.55	2.41 - 3.93	0.84	0.102	
NPD- 10	1989	4.03	1.49 - 3.01	0.86	-0.07	Middle of pond
NPD- 11	1989	6.84	4.58 - 6.10	0.83	2.38	
NPD- 12	1989	4.12	2.73 - 4.25	0.95	0.488	
NPD- 13	1989	6.82	6.17 - 7.69	0.94	4.73	
NPD- 14	1989	7.06	4.78 - 6.30	0.92	2.396	
MT- 5	1989	7.35	5.75 - 7.35	0.63	1.882	
MT- 8	1989	2.94	1.53 - 3.05	0.58	-0.015	
MT- 9	1989	4.57	2.48 - 4.00	0.53	1.855	
BH- 06-01	1993	3.61	1.52 - 3.04	0.6	2.696	
BH- 07-01	1993	3.59	1.54 - 3.06	0.9	1.498	
BH- 09-01	1993	3.68	1.49 - 3.01	0.59	0.735	
BH- 10-01	1993	2.95	1.56 - 3.08	0.11	2.46	
BH-11-01	1993	9.09	6.04 - 9.09	-0.09	8.848	
BH- 12-01	1993	10.14	5.51 - 10.08	0.41	7.404	
BH- 13-01	1993	9.67	5.34 - 9.91	-0.08	7.244	
BH- 14-01	1993	5.14	2.98 - 4.50	0.88	3.77	
BH- 16-01	1993	7.45	3.95 - 7.00	0.59	6.126	
2" PVC					2.998	Missing well cover

Table 2
Summary of Soil Samples Submitted for Laboratory Analysis

Sample ID	Class / CU	Sample Depths (mbgs)	Sample Collection Date	Analytical Parameters	Sample Description	Exceedances
SA-379-B	Class 1 (CU 21)	0 - 0.15	May 31, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	Phenanthrene 0.34
SA-382-B	Class 1 (CU 21)	0.15 - 0.30	May 31, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
SA-405-B	Class 1 (CU 23)	0.15 - 0.30	May 30, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
SA-406-B	Class 1 (CU 23)	0.15 - 0.30	May 30, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
SA-407-B	Class 1 (CU 23)	0.15 - 0.30	May 30, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
SA-411-B	Class 1 (CU 23)	0.15 - 0.30	May 30, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	Benzo[a]anthracene 0.85 Benzo[a]pyrene 0.67 Dibenzo[a,h]anthracene 0.12 Fluoranthene 2.1 Indeno[1,2,3-cd]pyrene 0.49 Naphthalene 0.068 Phenanthrene 1.3
SA-417-B	Class 1 (CU 23)	0.15 - 0.30	June 1, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
DUP-417-B	Class 1 (CU 23)	0.15 - 0.30	June 1, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	FILL Sand with gravel	None
SA-154	Class 2 (CU 8)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
SA-192-A	Class 2 (CU 10 LANDFILL 1)	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
SA-202	Class 2 (CU 11)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
SA-215	Class 2 (CU 12)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
SA-281	Class 2 (CU 15)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
SA-312	Class 2 (CU 17)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	Phenanthrene 0.17
DUP-312	Class 2 (CU 17)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	Phenanthrene 0.19
SA-313	Class 2 (CU 17)	0 - 0.15	June 6, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs	Brown sand with gravel	None
DEBRIS BY RIVER	Class 2	0 - 0.15	May 31, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs		Phenanthrene 0.091
J-1	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	Vanadium 87
J-1-B	Class 2	0.15 - 0.30	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	PHCs - F1 (C6-C10) 660
				PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	PHCs - F1 - BTEX 660
J-2	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-2-B	Class 2	0.15 - 0.30	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-3	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-4	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
DUP-J-4	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-5	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-6	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Peat, twigs, some sand, some tar paper	Arsenic 15 Zinc 320 PHCs - F2 (C10-C16) 640 PHCs - F3 (C16-C34) 11000 PHCs - F4 (C34-C50) 47000
J-6-B	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-7	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand	None
J-8	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-9	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-10	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand with gravel	None
J-11	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand	None
J-12	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand	None
J-13	Class 2	0 - 0.15	June 7, 2017	PHCs (F1-F4), BTEX, PAHs, PCBs, Metals (inc Cr VI and Hg)	Coarse brown sand	None

Value
Value

Parameter is greater than CCME Soil R/P - Coarse Surface 10-5 (1)

Parameter is greater than REG153 (11) T2-R/P// SOIL COARSE (2)

(1)

Canadian Council of Ministers of the Environment (CCME) Soil Residential/Parkland - Coarse Surface 10-5

(2)

O.Reg 153 (2011) Table 2 Standards for residential/parkland/institutional property use for coarse textured soil in full depth generic site condition in a potable

Summary of Groundwater Samples Submitted for Laboratory Analysis

Sample ID	Sampling Date	Analyses	Field Observations	Exceedances
NPD- 1	May 30, 2017	PAHs, PHCs, and BTEX	Turbid, brown, some sediment, no sheen, no odour	None
NPD- 2	May 30, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 4 (DUP-2)	May 30, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 5	June 5, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
NPD- 7 (DUP-1)	May 30, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
NPD- 8	May 30, 2017	PAHs, PHCs, and BTEX	Slightly turbid, light brown, no sediment, no sheen, no odour	None
NPD- 9	June 5, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 10	June 5, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 11	June 5, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
NPD- 12	June 5, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 13	June 5, 2017	PAHs, PHCs, and BTEX	N/A	None
NPD- 14	June 5, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
MT- 5	June 2, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
MT- 8	June 6, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
MT- 9	June 6, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 06-01	June 5, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 07-01	June 5, 2017	PAHs, PHCs, and BTEX	N/A	None
BH- 09-01	June 6, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 10-01 (DUP-3)	June 6, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 12-01	June 2, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 13-01	June 2, 2017	PAHs, PHCs, and BTEX	Clear, colourless, no sediment, no sheen, no odour	None
BH- 14-01	June 2, 2017	PAHs, PHCs, and BTEX	Turbid, brown, no sediment, no sheen, no odour	Benzo[a]pyrene (3) 0.000080
BH- 16-01	June 2, 2017	PAHs, PHCs, and BTEX	Slightly turbid, brown, trace sediment, no sheen, no odour	None
2" PVC	June 5, 2017	PAHs, PHCs, and BTEX	Cloudy, brownish, organic odour	None

- Value** Parameter is greater than Canadian Drinking Water Quality Guidelines (CDWQG)(1) - Health Based
Value Parameter is greater than REG153 (11) T2-GW COARSE (2)
- (1) Canadian Drinking Water Quality Guidelines - HEALTH BASED
 - (2) O.Reg 153 (2011) Table 2 Standards for all types of property use for groundwater in coarse textured soil in full depth generic site condition in a potable ground water condition
 - (3) Removed >4 well volumes. Low yield well went dry while sampling, left it for 1hr at a time to obtain more samples.

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	DEBRIS BY RIVER		J-1	J-1	J-10	J-11
	Unit	m		31-May-2017	07-Jun-2017 ⁽³⁾	07-Jun-2017	07-Jun-2017	07-Jun-2017	
Sample Depth				DEBRIS BY RIVER	J-1-B	J-10	J-11		
				0 - 0.15	0.15 - 0.3	0 - 0.15	0 - 0.15		
Petroleum Hydrocarbons									
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.02	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.02	<0.010	<0.010	<0.010	<0.010	<0.010
m,p-Xylenes	ug/g	--	--	<0.04	<0.020	<0.020	<0.020	<0.020	<0.020
o-Xylene	ug/g	--	--	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	660 ⁽²³⁾	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	660	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	<50	<50	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	<50	<50	<50	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	--	--	--	--	--	--
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.02	<0.020	<0.020	<0.020	<0.020	<0.020
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.04	<0.020	<0.020	<0.020	<0.020	<0.020

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	J-12	J-13	J-2	J-2	J-3
	Unit	m		J-12	J-13	J-2	J-2	J-3
Sample Depth				J-12	J-13	J-2	J-2	J-3
Petroleum Hydrocarbons				0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.0060	<0.0060	<0.012	<0.0060	<0.0060
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.010	<0.010	<0.020	<0.010	<0.010
m,p-Xylenes	ug/g	--	--	<0.020	<0.020	<0.040	<0.020	<0.020
o-Xylene	ug/g	--	--	<0.020	<0.020	<0.040	<0.020	<0.020
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<20	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<20	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	12	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	100	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	67	<50	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	--	--	--	--	--
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.020	<0.020	<0.040	<0.020	<0.020
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.020	<0.020	<0.040	<0.020	<0.020

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	J-4	J-4	J-5	J-6	J-6
	Unit	m		07-Jun-2017 J-4	07-Jun-2017 J-5	07-Jun-2017 ⁽⁶⁾ J-6	07-Jun-2017 ⁽⁷⁾ J-6-B	
Sample Depth				0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0.15 - 0.3
Petroleum Hydrocarbons								
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.0060	<0.0060	<0.0060	<0.012	<0.0060
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.010	<0.010	<0.010	<0.020	<0.010
m,p-Xylenes	ug/g	--	--	<0.020	<0.020	<0.020	0.047	<0.020
o-Xylene	ug/g	--	--	<0.020	<0.020	<0.020	0.044	<0.020
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<10	<20	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<10	<20	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	<10	640	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	<50	11000	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	<50	47000	180
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	--	--	--	--	1500
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.020	<0.020	<0.020	<0.040	<0.020
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.020	<0.020	<0.020	0.090	<0.020

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	J-7	J-8	J-9	SA-154	SA-192 (LF-1)
	Unit	m		07-Jun-2017	07-Jun-2017	07-Jun-2017	06-Jun-2017 ⁽⁷⁾	07-Jun-2017
Sample Depth				J-7	J-8	J-9	SA-154	SA-192-A
Petroleum Hydrocarbons				0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.010	<0.010	<0.010	<0.010	<0.010
m,p-Xylenes	ug/g	--	--	<0.020	<0.020	<0.020	<0.020	<0.020
o-Xylene	ug/g	--	--	<0.020	<0.020	<0.020	<0.020	<0.020
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	<50	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	<50	110	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	--	--	--	--	--
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.020	<0.020	<0.020	<0.020	<0.020
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.020	<0.020	<0.020	<0.020	<0.020

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	SA-202	SA-215	SA-281	SA-312	SA-312
	Unit	06-Jun-2017		06-Jun-2017	06-Jun-2017	06-Jun-2017	06-Jun-2017	06-Jun-2017
Sample Depth	m			SA-202 0 - 0.15	SA-215 0 - 0.15	SA-281 0 - 0.15	SA-312 0 - 0.15	SA-312 0 - 0.15
Petroleum Hydrocarbons								
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.010	<0.010	<0.010	<0.010	<0.010
m,p-Xylenes	ug/g	--	--	<0.020	<0.020	<0.020	<0.020	<0.020
o-Xylene	ug/g	--	--	<0.020	<0.020	<0.020	<0.020	<0.020
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	11	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	58	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	<50	<50	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	---	---	---	---	---
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.020	<0.020	<0.020	<0.020	<0.020
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.020	<0.020	<0.020	<0.020	<0.020

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	SA-313		SA-379-B		SA-382-B		SA-405-B		SA-406-B	
	Unit	m		06-Jun-2017	31-May-2017	31-May-2017	31-May-2017	30-May-2017 ⁽¹⁷⁾	30-May-2017	30-May-2017	30-May-2017		
Sample Depth													
Petroleum Hydrocarbons													
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.0060	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.010	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
m,p-Xylenes	ug/g	--	--	<0.020	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
o-Xylene	ug/g	--	--	<0.020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	<10	17	<10	<10	<10	<10	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	<50	<50	<50	58	<50	<50	<50	<50	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	<50	<50	<50	860	<50	<50	150	<50	<50	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	---	---	---	---	---	---	---	---	---	---
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.020	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04

Table 4A: Soil Analytical Results PHCs and PCBs

Parameter	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	SA-407-B	SA-411-B	SA-417-B	SA-417-B
	Unit	SA 407-B		SA 411-B	SA 417-B	SA 417-B (Field Duplicate)	
Sample Depth	m			0.15 - 0.3	0.15 - 0.3	0.15 - 0.3	0.15 - 0.3
Petroleum Hydrocarbons							
Benzene	mg/kg	0.03 ⁽¹⁹⁾	0.21	<0.02	<0.02	<0.02	<0.02
Ethylbenzene	mg/kg	0.082 ⁽¹⁹⁾	1.1	<0.02	<0.02	<0.02	<0.02
m,p-Xylenes	ug/g	--	--	<0.04	<0.04	<0.04	<0.04
o-Xylene	ug/g	--	--	<0.02	<0.02	<0.02	<0.02
Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	30 ⁽²⁰⁾	55 ⁽²¹⁾	<10	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	ug/g	--	55 ⁽²¹⁾	<10	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	150	98	<10	<10	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	300	300	73	56	<50	<50
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	2800	2800	1200	<50	<50	<50
Petroleum Hydrocarbons - F4 Gravimetric	ug/g	--	2800	--	--	--	--
Toluene	mg/kg	0.37 ⁽²²⁾	2.3	<0.02	<0.02	<0.02	<0.02
Xylenes, Total	mg/kg	11 ⁽²²⁾	3.1	<0.04	<0.04	<0.04	<0.04

Parameter	Unit	CCME Soil RIP - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/PI SOIL COARSE ⁽²⁾	J-1		J-10		J-11		J-12		J-13		J-2		J-3		
				07-Jun-2017 J-1	07-Jun-2017 ⁽³⁾ J-1-B	07-Jun-2017 J-10	07-Jun-2017 J-11	07-Jun-2017 J-12	07-Jun-2017 J-13	07-Jun-2017 ⁽⁴⁾ J-2	07-Jun-2017 ⁽⁵⁾ J-2-B	07-Jun-2017 ⁽⁶⁾ J-3						
Sample Depth	m			0 - 0.15	0.15 - 0.3	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	
Metals																		
Aluminum	ug/g	--	--	14000	12000	8300	9000	10000	12000	7100	8300	12000	7100	8300	12000	7100	8300	12000
Antimony	mg/kg	20 ⁽⁸⁾	7.5	0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.24
Arsenic	mg/kg	12 ⁽⁹⁾	18	2.6	2.3	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0	1.2	<1.0	<1.0	<1.0	<1.0	2.3
Barium	mg/kg	500 ⁽¹⁰⁾	390	180	60	76	80	100	84	64	130	84	64	130	84	64	130	82
Beryllium	mg/kg	4 ⁽⁶⁾	4	0.32	0.36	0.27	0.43	0.47	0.47	0.24	<0.20	0.47	0.24	<0.20	<0.20	<0.20	<0.20	0.33
Bismuth	ug/g	--	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron	ug/g	--	120	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	mg/kg	10 ⁽¹¹⁾	1.2	0.17	0.13	<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium	ug/g	--	--	1800	1800	2500	3000	3400	3100	3600	4500	3100	3600	4500	3100	3600	4500	3000
Chromium	mg/kg	64 ⁽⁹⁾	160	33	25	17	22	26	28	19	13	28	19	13	28	19	13	26
Cobalt	mg/kg	50 ⁽⁸⁾	22	9.0	7.4	7.1	5.6	6.5	9.6	5.5	6.3	9.6	5.5	6.3	9.6	5.5	6.3	8.9
Copper	mg/kg	63 ⁽⁹⁾	140	37	26	26	25	37	49	18	24	49	18	24	49	18	24	47
Hexavalent Chromium	mg/kg	0.4 ⁽¹²⁾	8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Iron	ug/g	--	--	30000	25000	19000	16000	21000	23000	18000	21000	23000	18000	21000	23000	18000	21000	22000
Lead	mg/kg	140 ⁽⁸⁾	120	44	30	6.9	20	8.6	8.1	50	21	8.1	50	21	8.1	50	21	30
Magnesium	ug/g	--	--	6600	4700	5100	5900	7300	6600	4800	6000	6600	4800	6000	6600	4800	6000	7100
Manganese	ug/g	--	--	350	290	290	190	280	230	260	240	230	260	240	230	260	240	240
Mercury	mg/kg	6.6 ⁽⁹⁾	0.27	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	mg/kg	10 ⁽⁸⁾	6.9	1.6	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel	mg/kg	50 ⁽¹³⁾	100	17	16	12	13	15	21	10	8.2	21	10	8.2	21	10	8.2	19
Potassium	ug/g	--	--	4600	1600	2800	2000	2700	2200	2400	4400	2200	2400	4400	2200	2400	4400	2700
Selenium	mg/kg	1 ⁽⁹⁾	2.4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver	mg/kg	20 ⁽⁸⁾	20	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium	ug/g	--	-- ⁽¹⁴⁾	100	84	100	250	290	310	130	140	310	130	140	310	130	140	130
Strontium	ug/g	--	--	8.8	9.7	6.5	17	17	18	11	10	18	11	10	18	11	10	9.6
Thallium	mg/kg	1 ⁽¹⁵⁾	1	0.27	0.16	0.16	0.16	0.18	0.16	0.14	0.19	0.16	0.14	0.19	0.16	0.14	0.19	0.21
Tin	mg/kg	50 ⁽⁸⁾	--	6.1	9.3	<1.0	<1.0	<1.0	<1.0	23	7.7	<1.0	23	7.7	<1.0	23	7.7	3.6
Uranium	mg/kg	23	23	0.56	0.55	0.83	0.78	0.94	0.92	0.44	0.45	0.92	0.44	0.45	0.92	0.44	0.45	0.73
Vanadium	mg/kg	130 ⁽¹⁶⁾	86	87	43	35	33	41	42	29	40	42	29	40	42	29	40	44
Zinc	mg/kg	200 ⁽¹³⁾	340	91	67	49	52	57	57	41	52	57	41	52	57	41	52	62

Table 4B: Soil Analytical Results Metals

Parameter	Unit	CCME Soil RIP - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/PI SOIL COARSE ⁽²⁾	J-4		J-5		J-6		J-7		J-8		J-9	
		07-Jun-2017 J-4	07-Jun-2017 J-4 (Field Duplicate)		07-Jun-2017 J-5	07-Jun-2017 J-6	07-Jun-2017 ⁽⁶⁾ J-6-B	07-Jun-2017 J-7	07-Jun-2017 J-8	07-Jun-2017 J-9						
Sample Depth	m	0 - 0.15	0 - 0.15		0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0.15 - 0.3	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15
Metals																
Aluminum	ug/g	13000	12000	--	12000	12000	12000	7000	14000	10000	14000	14000	14000	14000	14000	9100
Antimony	mg/kg	<0.20	<0.20	7.5	<0.20	<0.20	<0.20	0.67	<0.20	0.77	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	mg/kg	1.0	1.0	18	1.0	1.4	1.4	15	3.8	<1.0	1.3	1.3	1.3	1.3	<1.0	<1.0
Barium	mg/kg	90	91	390	91	83	83	72	68	75	75	75	75	75	75	84
Beryllium	mg/kg	0.43	0.43	4	0.43	0.42	0.42	0.39	0.35	0.28	0.40	0.40	0.40	0.40	0.28	0.28
Bismuth	ug/g	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron	ug/g	<5.0	<5.0	120	<5.0	<5.0	<5.0	8.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	mg/kg	0.16	0.12	1.2	0.12	<0.10	<0.10	1.0	0.11	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Calcium	ug/g	2400	2300	--	2300	2300	2300	24000	2800	2200	3000	3000	3000	3000	3400	3400
Chromium	mg/kg	38	29	160	38	31	31	26	21	18	28	28	28	28	19	19
Cobalt	mg/kg	10	8.7	22	8.7	8.5	8.5	6.5	8.1	8.0	7.8	7.8	7.8	7.8	7.3	7.3
Copper	mg/kg	42	39	140	42	44	44	24	32	25	41	41	41	41	28	28
Hexavalent Chromium	mg/kg	<0.2	<0.2	8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Iron	ug/g	22000	19000	--	19000	21000	21000	13000	23000	24000	24000	24000	24000	24000	20000	20000
Lead	mg/kg	27	26	120	26	24	24	73	14	15	28	28	28	28	4.8	4.8
Magnesium	ug/g	8100	6800	--	6800	6900	6900	6500	5200	5800	6900	6900	6900	6900	5700	5700
Manganese	ug/g	330	290	--	290	250	250	520	210	290	240	240	240	240	290	290
Mercury	mg/kg	<0.050	<0.050	0.27	<0.050	<0.050	<0.050	0.17	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Molybdenum	mg/kg	<0.50	<0.50	6.9	<0.50	<0.50	<0.50	1.8	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Nickel	mg/kg	26	19	100	26	18	18	37	16	11	18	18	18	18	14	14
Potassium	ug/g	3000	2800	--	2800	2700	2700	990	2300	3100	2600	2600	2600	2600	2600	2600
Selenium	mg/kg	<0.50	<0.50	2.4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver	mg/kg	<0.20	<0.20	20	<0.20	<0.20	<0.20	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Sodium	ug/g	120	120	-- ⁽¹⁴⁾	120	130	130	100	93	<50	280	280	280	280	120	120
Strontium	ug/g	9.9	9.8	--	9.8	9.1	9.1	62	9.5	5.9	11	11	11	11	9.0	9.0
Thallium	mg/kg	0.24	0.19	1	0.19	0.19	0.19	0.080	0.15	0.15	0.19	0.19	0.19	0.16	0.16	0.16
Tin	mg/kg	<1.0	<1.0	--	<1.0	<1.0	<1.0	4.3	<1.0	3.6	1.1	1.1	1.1	<1.0	<1.0	<1.0
Uranium	mg/kg	1.0	0.97	23	1.0	1.0	1.0	2.3	0.66	0.67	0.90	0.90	0.90	0.86	0.86	0.86
Vanadium	mg/kg	41	38	86	41	41	41	39	45	43	50	50	50	37	37	37
Zinc	mg/kg	130	110	340	130	85	85	320	99	65	63	63	63	51	51	51

Table 4C: Soil Analytical Results PAHs

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/P/I SOIL COARSE ⁽²⁾	DEBRIS BY RIVER		J-1	J-1	J-10	J-11
				31-May-2017	07-Jun-2017 ⁽³⁾				
Sample Depth	m			DEBRIS BY RIVER	J-1-B	J-1	J-10	J-11	
				0 - 0.15	0.15 - 0.3	0 - 0.15	0 - 0.15	0 - 0.15	
Semi-VOCs									
1- & 2-Methylnaphthalene	ug/g	--	--	<0.014	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071
1-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
2-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthene	ug/g	0.28	7.9	0.011	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	ug/g	320	0.15	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	ug/g	2.5	0.67	0.043	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo [b,j] fluoranthene	ug/g	--	--	0.49	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾	0.5	0.33	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾	0.3	0.23	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[g,h,i]perylene	ug/g	--	6.6	0.13	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾	0.78	0.17	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chrysene	ug/g	6.2	7	0.27	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾	0.1	0.039	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	ug/g	15.4	0.69	0.58	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluorene	ug/g	0.25	62	0.011	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾	0.38	0.16	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Naphthalene	ug/g	0.013 ⁽¹²⁾	0.6	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phenanthrene	ug/g	0.046 ⁽⁸⁾	6.2	0.091	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Pyrene	ug/g	10 ⁽⁸⁾	78	0.46	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 4C: Soil Analytical Results PAHs

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾		REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	J-12		J-13		J-2		J-3		J-4	
		07-Jun-2017			07-Jun-2017 ⁽⁴⁾		07-Jun-2017 ⁽⁵⁾		07-Jun-2017		07-Jun-2017		07-Jun-2017	
Sample Depth	m	0 - 0.15		0 - 0.15		0 - 0.15		0 - 0.15		0.15 - 0.3		0 - 0.15		
Semi-VOCs														
1- & 2-Methylnaphthalene	ug/g	--		--		<0.0071		<0.0071		<0.071		<0.0071		
1-Methylnaphthalene	ug/g	--		0.99 ⁽²⁴⁾		<0.0050		<0.0050		<0.05		<0.0050		
2-Methylnaphthalene	ug/g	--		0.99 ⁽²⁴⁾		<0.0050		<0.0050		<0.05		<0.0050		
Acenaphthene	ug/g	0.28		7.9		<0.0050		<0.0050		<0.05		<0.0050		
Acenaphthylene	ug/g	320		0.15		<0.0050		<0.0050		<0.05		<0.0050		
Anthracene	ug/g	2.5		0.67		<0.0050		<0.0050		<0.05		<0.0050		
Benzo [b,j] fluoranthene	ug/g	--		--		<0.0050		<0.0050		<0.05		<0.0050		
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾		0.5		<0.0050		<0.0050		<0.05		<0.0050		
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾		0.3		<0.0050		<0.0050		<0.05		<0.0050		
Benzo[g,h,i]perylene	ug/g	--		6.6		<0.0050		<0.0050		<0.05		<0.0050		
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾		0.78		<0.0050		<0.0050		<0.05		<0.0050		
Chrysene	ug/g	6.2		7		<0.0050		<0.0050		<0.05		<0.0050		
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾		0.1		<0.0050		<0.0050		<0.05		<0.0050		
Fluoranthene	ug/g	15.4		0.69		<0.0050		<0.0050		<0.05		<0.0050		
Fluorene	ug/g	0.25		62		<0.0050		<0.0050		<0.05		<0.0050		
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾		0.38		<0.0050		<0.0050		<0.05		<0.0050		
Naphthalene	ug/g	0.013 ⁽¹²⁾		0.6		<0.0050		<0.0050		<0.05		<0.0050		
Phenanthrene	ug/g	0.046 ⁽⁸⁾		6.2		<0.0050		<0.0050		<0.05		<0.0050		
Pyrene	ug/g	10 ⁽⁸⁾		78		<0.0050		<0.0050		<0.05		<0.0050		

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	J-4		J-5		J-6		J-6		J-7		J-8	
				07-Jun-2017	07-Jun-2017 (Field Duplicate JP-J4)	07-Jun-2017	J-5	07-Jun-2017 ⁽⁶⁾	J-6	07-Jun-2017 ⁽⁷⁾	J-6-B	07-Jun-2017	J-7	07-Jun-2017	J-8
Sample Depth	m			0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0.15 - 0.3	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15
Semi-VOCs															
1- & 2-Methylnaphthalene	ug/g	--	--	<0.0071	<0.0071	<0.0071	<0.0071	<4.2	<4.2	<0.071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071
1-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
2-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthene	ug/g	0.28	7.9	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	ug/g	320	0.15	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	ug/g	2.5	0.67	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo [b,j] fluoranthene	ug/g	--	--	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾	0.5	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾	0.3	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[g,h,i]perylene	ug/g	--	6.6	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾	0.78	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chrysene	ug/g	6.2	7	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾	0.1	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	ug/g	15.4	0.69	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluorene	ug/g	0.25	62	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾	0.38	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Naphthalene	ug/g	0.013 ⁽¹²⁾	0.6	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phenanthrene	ug/g	0.046 ⁽⁸⁾	6.2	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Pyrene	ug/g	10 ⁽⁸⁾	78	<0.0050	<0.0050	<0.0050	<0.0050	<3	<3	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Table 4C: Soil Analytical Results PAHs

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	J-9		SA-154		SA-192 (LF-1)		SA-202		SA-215		SA-281	
				07-Jun-2017	06-Jun-2017 ⁽⁷⁾	07-Jun-2017	06-Jun-2017	06-Jun-2017	06-Jun-2017	06-Jun-2017	06-Jun-2017				
Sample Depth	m			0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15	0 - 0.15
Semi-VOCs															
1- & 2-Methylnaphthalene	ug/g	--	--	<0.0071	<0.071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071
1-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
2-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthene	ug/g	0.28	7.9	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	ug/g	320	0.15	<0.0050	0.065	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	ug/g	2.5	0.67	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	0.0055	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo [b,j] fluoranthene	ug/g	--	--	<0.0050	<0.050	<0.0050	<0.050	0.015	0.14	0.14	<0.0050	<0.0050	<0.0050	0.013	0.076
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾	0.5	<0.0050	<0.050	<0.0050	<0.050	0.012	0.073	0.073	<0.0050	<0.0050	<0.0050	0.083	0.083
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾	0.3	<0.0050	<0.050	<0.0050	<0.050	0.011	0.094	0.094	<0.0050	<0.0050	<0.0050	0.076	0.076
Benzo[g,h,i]perylene	ug/g	--	6.6	<0.0050	<0.050	<0.0050	<0.050	0.084	0.078	0.078	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾	0.78	<0.0050	<0.050	<0.0050	<0.050	0.053	0.046	0.046	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Chrysene	ug/g	6.2	7	<0.0050	<0.050	<0.0050	<0.050	0.010	0.077	0.077	<0.0050	<0.0050	<0.0050	0.011	0.011
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾	0.1	<0.0050	<0.050	<0.0050	<0.050	<0.0050	0.018	0.018	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	ug/g	15.4	0.69	<0.0050	<0.050	<0.0050	<0.050	0.021	0.15	0.15	0.0071	0.0071	0.0071	0.021	0.021
Fluorene	ug/g	0.25	62	<0.0050	<0.050	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾	0.38	<0.0050	<0.050	<0.0050	<0.050	0.082	0.081	0.081	<0.0050	<0.0050	<0.0050	0.0058	0.0058
Naphthalene	ug/g	0.013 ⁽¹²⁾	0.6	<0.0050	<0.050	<0.0050	<0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phenanthrene	ug/g	0.046 ⁽⁸⁾	6.2	<0.0050	<0.050	<0.0050	<0.050	0.0098	0.037	0.037	<0.0050	<0.0050	<0.0050	0.015	0.015
Pyrene	ug/g	10 ⁽⁸⁾	78	<0.0050	<0.050	<0.0050	<0.050	0.018	0.13	0.13	0.0058	0.0058	0.0058	0.017	0.017

Table 4C: Soil Analytical Results PAHs

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	SA-312	SA-312	SA-313	SA-379-B	SA-382-B	SA-405-B
				06-Jun-2017 SA-312 0 - 0.15	06-Jun-2017 P-312 (Field Duplicate) 0 - 0.15	06-Jun-2017 SA-313 0 - 0.15	31-May-2017 SA 379-B 0.15 - 0.3	31-May-2017 SA 382-B 0.15 - 0.3	30-May-2017 ⁽¹⁷⁾ SA 405-B 0.15 - 0.3
Semi-VOCs									
1- & 2-Methylnaphthalene	ug/g	--	--	<0.0071	<0.0071	0.020	<0.014	0.047	<0.014
1-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	0.0085	<0.0050	0.021	<0.0050
2-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	0.011	<0.0050	0.026	<0.0050
Acenaphthene	ug/g	0.28	7.9	0.023	0.024	<0.0050	0.038	0.0059	<0.0050
Acenaphthylene	ug/g	320	0.15	<0.0050	<0.0050	0.025	<0.0050	<0.0050	<0.0050
Anthracene	ug/g	2.5	0.67	0.051	0.059	0.0064	0.052	<0.0050	<0.0050
Benzo [b,j] fluoranthene	ug/g	--	--	0.15	0.18	0.0093	0.38	<0.0050	0.012
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾	0.5	0.15	0.19	0.0077	0.28	<0.0050	0.0096
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾	0.3	0.12	0.15	0.0069	0.25	<0.0050	0.0080
Benzo[g,h,i]perylene	ug/g	--	6.6	0.063	0.077	<0.0050	0.18	0.0063	0.0080
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾	0.78	0.059	0.063	<0.0050	0.14	<0.0050	<0.0050
Chrysene	ug/g	6.2	7	0.13	0.15	0.0077	0.25	<0.0050	0.0080
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾	0.1	0.019	0.022	<0.0050	0.053	<0.0050	<0.0050
Fluoranthene	ug/g	15.4	0.69	0.30	0.38	0.016	0.65	<0.0050	0.017
Fluorene	ug/g	0.25	62	0.017	0.018	<0.0050	0.034	<0.0050	<0.0050
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾	0.38	0.074	0.090	0.0050	0.21	<0.0050	0.0085
Naphthalene	ug/g	0.013 ⁽¹²⁾	0.6	<0.0050	<0.0050	0.0082	<0.0050	<0.0050	<0.0050
Phenanthrene	ug/g	0.046 ⁽⁸⁾	6.2	0.17	0.19	0.014	0.34	0.0077	0.0075
Pyrene	ug/g	10 ⁽⁸⁾	78	0.23	0.30	0.015	0.46	<0.0050	0.013

Table 4C: Soil Analytical Results PAHs

Parameter	Unit	CCME Soil R/P - Coarse Surface 10-5 ⁽¹⁾	REG153 (11) T2-R/P/ SOIL COARSE ⁽²⁾	SA-406-B			SA-407-B			SA-411-B			SA-417-B		
				30-May-2017	SA 406-B	0.15 - 0.3	30-May-2017 ⁽¹⁸⁾	SA 407-B	0.15 - 0.3	30-May-2017	SA 411-B	0.15 - 0.3	01-Jun-2017	SA 417-B	0.15 - 0.3
Semi-VOCs															
1- & 2-Methylnaphthalene	ug/g	--	--	<0.014	<0.014	<0.014	<0.014	<0.014	0.041	<0.014	<0.014	<0.014	<0.014	<0.014	<0.014
1-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.020	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
2-Methylnaphthalene	ug/g	--	0.99 ⁽²⁴⁾	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.021	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthene	ug/g	0.28	7.9	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.064	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Acenaphthylene	ug/g	320	0.15	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	ug/g	2.5	0.67	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.26	<0.0050	0.0069	0.0079	0.0079	0.0079	0.0079
Benzo [b,j] fluoranthene	ug/g	--	--	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.96	<0.0050	0.059	0.059	0.059	0.059	0.059
Benzo[a]anthracene	ug/g	1 ⁽⁸⁾	0.5	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.85	<0.0050	0.043	0.045	0.045	0.045	0.045
Benzo[a]pyrene	ug/g	0.6 ⁽¹⁶⁾	0.3	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.67	<0.0050	0.041	0.040	0.040	0.040	0.040
Benzo[g,h,i]perylene	ug/g	--	6.6	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.42	<0.0050	0.032	0.031	0.031	0.031	0.031
Benzo[k]fluoranthene	ug/g	1 ⁽⁸⁾	0.78	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.37	<0.0050	0.022	0.022	0.022	0.022	0.022
Chrysene	ug/g	6.2	7	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.70	<0.0050	0.037	0.040	0.040	0.040	0.040
Dibenzo[a,h]anthracene	ug/g	1 ⁽⁸⁾	0.1	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.12	<0.0050	0.0084	0.0084	0.0084	0.0084	0.0084
Fluoranthene	ug/g	15.4	0.69	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	2.1	<0.0050	0.088	0.097	0.097	0.097	0.097
Fluorene	ug/g	0.25	62	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.15	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno[1,2,3-cd]pyrene	ug/g	1 ⁽⁸⁾	0.38	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.49	<0.0050	0.032	0.034	0.034	0.034	0.034
Naphthalene	ug/g	0.013 ⁽¹²⁾	0.6	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.068	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Phenanthrene	ug/g	0.046 ⁽⁸⁾	6.2	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	1.3	<0.0050	0.039	0.044	0.044	0.044	0.044
Pyrene	ug/g	10 ⁽⁸⁾	78	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	1.5	<0.0050	0.067	0.072	0.072	0.072	0.072

Footnotes:

- Tables should be read in conjunction with the accompanying document.
- < Indicates parameter not detected above laboratory method detection limit.
- > Indicates parameter detected above equipment analytical range.
- Chemical not analyzed or criteria not defined.

Value Parameter is greater than CCME Soil R/P - Coarse Surface 10-5

Value Parameter is greater than REG153 (11) T2-R/P/I SOIL COARSE

(1) CCME Soil R/P - Coarse Surface 10-5

(2) O.Reg 153 (2011) Table 2 Standards for residential/parkland/institutional property use for coarse textured soil in full depth generic site condition in a potable groundwater condition

(3) VOCF1 Analysis: Due to high concentration of terpene compounds, the sample required dilution. The detection limits were adjusted accordingly. In order to meet required regulatory criteria, results for selected compounds (obtained by a separate analysis using an appropriate low dilution) are included in the report.

(4) VOCF1 Analysis: Detection limits were raised due to low weight of soil provided. PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

(5) PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

(6) VOCF1 Analysis: Detection limits were raised due to high moisture content of soil provided. PAH analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly. PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

(7) PAH analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly.

(8) Interim remediation criteria.

(9) Data are sufficient and adequate to calculate an SQGHH and an SQGE. 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.

(10) Data are insufficient/inadequate to calculate an SQGHH, a provisional SQGHH, an SQGE, or a provisional SQGE. Therefore the interim soil quality criterion (CCME 1991) is retained as the soil quality guideline for this land use.

(11) 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.

(12) Data are sufficient and adequate to calculate only a provisional SQGE, 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.

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

(14) Not Applicable.

(15) Data are sufficient and adequate to calculate a provisional SQGHH and an SQGE. The provisional SQGHH is less than the SQGE and thus becomes the soil quality guideline for this land use.

(16) Data are sufficient and adequate to calculate an SQGHH and a provisional SQGE. 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.

(17) PAH Analysis: Duplicate results exceeded RPD acceptance criteria for flagged analytes. This is likely due to sample heterogeneity.

- (18) F24 Analysis: Duplicate results exceeded RPD acceptance criteria for flagged analytes. This is likely due to sample heterogeneity.
- (19) This guideline value may be less than the common limit of detection in some jurisdictions. Contact jurisdictions for guidance. Data are sufficient and adequate to calculate an SQGHH and SQGE. 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 retained as the soil quality guideline for this land use.
- (20) Assumes contamination near residence
- (21) F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.
- (22) Data are sufficient and adequate to calculate an SQGHH and SQGE. Therefore the soil quality guideline is the lower of the two and represents a fully integrated de novo guideline for this land use.
- (23) Positive result was mainly contributed by single peak.
- (24) The methyl naphthalene standards are applicable to both 1-methyl naphthalene and 2-methyl naphthalene, with the provision that if both are detected the sum of the two must not exceed the standard.

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	2" PVC		BH-06-01	BH-07-01	BH-09-01	BH-10-01	BH-10-01
				05-Jun-2017	05-Jun-2017	06-Jun-2017	06-Jun-2017 ⁽³⁾	06-Jun-2017	06-Jun-2017	
General Chemistry										
Conductivity (Field)	ms/cm	--	-- ⁽⁵⁾	0.095	0.119	0.119	0.193	0.082	0.140	0.140
Dissolved Oxygen (Field)	mg/l	--	--	4.54	4.12	4.12	6.61	8.05	4.86	4.86
Oxidation-Reduction Potential (Field)	millivolts	--	--	125	196	196	221	223	238	238
pH (Field)	-	--	--	5.71	6.37	6.37	6.09	7.36	6.13	6.13
Temperature (Field)	deg c	--	--	9.56	11.11	11.11	10.26	10.81	10.09	10.09
Turbidity (Field)	NTU	--	--	442	31.5	31.5	28.1	6.0	22.8	22.8
Petroleum Hydrocarbons										
Benzene	mg/l	0.005	0.005	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Ethylbenzene	mg/l	0.14	0.0024	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
m,p-Xylenes	ug/l	--	--	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
o-Xylene	ug/l	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	BH-12-01		BH-13-01		BH-14-01		BH-16-01		MT-5		MT-8	
				02-Jun-2017	BH12-01	02-Jun-2017	BH13-01	02-Jun-2017 ⁽⁴⁾	BH14-01	02-Jun-2017	BH16-01	02-Jun-2017	MT-5	06-Jun-2017	MT-8
General Chemistry															
Conductivity (Field)	ms/cm	--	-- ⁽⁵⁾	0.081	0.265	0.89	0.023	0.070	0.147						
Dissolved Oxygen (Field)	mg/l	--	--	8.05	5.32	10.07	8.59	8.67	1.67						
Oxidation-Reduction Potential (Field)	millivolts	--	--	235	250	215	257	276	139						
pH (Field)	-	--	--	6.13	7.25	6.68	6.57	5.76	5.60						
Temperature (Field)	deg c	--	--	7.54	8.36	7.45	6.44	8.34	10.79						
Turbidity (Field)	NTU	--	--	0.9	7.6	718	82.3	10.4	59.4						
Petroleum Hydrocarbons															
Benzene	mg/l	0.005	0.005	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020						
Ethylbenzene	mg/l	0.14	0.0024	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020						
m,p-Xylenes	ug/l	--	--	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40						
o-Xylene	ug/l	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20						

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	MT-9	NPD-1	NPD-10	NPD-11	NPD-12	NPD-13
				06-Jun-2017 MT-9	30-May-2017 NPD-1	05-Jun-2017 NPD-10	05-Jun-2017 NPD-11	05-Jun-2017 NPD-12	05-Jun-2017 NPD-13
General Chemistry									
Conductivity (Field)	ms/cm	--	-- ⁽⁵⁾	0.057	0.216	0.054	0.040	0.050	0.053
Dissolved Oxygen (Field)	mg/l	--	--	1.87	30.32	6.05	8.36	8.48	0.60
Oxidation-Reduction Potential (Field)	millivolts	--	--	250	69	211	244	192	116
pH (Field)	-	--	--	5.98	7.85	5.76	5.72	6.27	6.03
Temperature (Field)	deg c	--	--	10.95	11.05	9.42	8.27	7.51	12.30
Turbidity (Field)	NTU	--	--	9.2	153	71	35.0	2.6	16.8
Petroleum Hydrocarbons									
Benzene	mg/l	0.005	0.005	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Ethylbenzene	mg/l	0.14	0.0024	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
m,p-Xylenes	ug/l	--	--	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
o-Xylene	ug/l	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	NPD-14		NPD-2		NPD-4		NPD-5		NPD-7	
				05-Jun-2017 NPD-14	30-May-2017 NPD-2	30-May-2017 NPD-4	06-Jun-2017 NPD-5	30-May-2017 NPD-7	30-May-2017 NPD-7				
General Chemistry													
Conductivity (Field)	ms/cm	--	-- ⁽⁵⁾	0.039	-	0.237	-	0.237	0.160	0.165			
Dissolved Oxygen (Field)	mg/l	--	--	9.24	-	23.07	-	23.07	1.43	7.60			
Oxidation-Reduction Potential (Field)	millivolts	--	--	215	-	86	-	86	239	228			
pH (Field)	-	--	--	5.90	-	7.47	-	7.47	7.31	6.23			
Temperature (Field)	deg c	--	--	6.79	-	16.68	-	16.68	11.12	10.20			
Turbidity (Field)	NTU	--	--	23.8	-	110	-	110	15.4	65.8			
Petroleum Hydrocarbons													
Benzene	mg/l	0.005	0.005	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020			
Ethylbenzene	mg/l	0.14	0.0024	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020			
m,p-Xylenes	ug/l	--	--	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40			
o-Xylene	ug/l	--	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	NPD-7		NPD-8		NPD-9	
				30-May-2017 UP-1 (Field Duplicate)	30-May-2017	30-May-2017	05-Jun-2017		
General Chemistry									
Conductivity (Field)	ms/cm	--	-- ⁽⁵⁾	0.165	0.069	0.057			
Dissolved Oxygen (Field)	mg/l	--	--	7.60	46.83	7.85			
Oxidation-Reduction Potential (Field)	millivolts	--	--	228	-24	183			
pH (Field)	-	--	--	6.23	8.58	6.08			
Temperature (Field)	deg c	--	--	10.20	10.74	7.55			
Turbidity (Field)	NTU	--	--	65.8	1000	39.2			
Petroleum Hydrocarbons									
Benzene	mg/l	0.005	0.005	<0.00020	<0.00020	<0.00020			
Ethylbenzene	mg/l	0.14	0.0024	<0.00020	<0.00020	<0.00020			
m,p-Xylenes	ug/l	--	--	<0.40	<0.40	<0.40			
o-Xylene	ug/l	--	--	<0.20	<0.20	<0.20			

Table 5B: Groundwater Analytical Results General Chemistry and PAHs

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	2" PVC		BH-06-01		BH-07-01		BH-09-01		BH-10-01	
				05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	06-Jun-2017 ⁽³⁾	06-Jun-2017	06-Jun-2017	06-Jun-2017		
Semi-VOCs													
1-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/l	--	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo [b,j] fluoranthene	ug/l	--	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]anthracene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]pyrene	mg/l	0.00004	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo[g,h,i]perylene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[k]fluoranthene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo[a,h]anthracene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	ug/l	--	0.41	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/l	--	120	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno[1,2,3-cd]pyrene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	ug/l	--	11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Table 5B: Groundwater Analytical Results General Chemistry and PAHs

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	BH-12-01		BH-13-01		BH-14-01		BH-16-01		MT-5		MT-8	
				02-Jun-2017	02-Jun-2017	02-Jun-2017 ⁽⁴⁾	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017	02-Jun-2017
Semi-VOCs															
1-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/l	--	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo [b,j] fluoranthene	ug/l	--	--	<0.010	<0.010	<0.010	<0.010	0.10	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]anthracene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	0.10	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]pyrene	mg/l	0.00004	0.00001	<0.000010	<0.000010	<0.000010	0.000080	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo[g,h,i]perylene	ug/l	--	0.2	<0.010	<0.010	<0.010	0.035	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[k]fluoranthene	ug/l	--	0.1	<0.010	<0.010	<0.010	0.040	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/l	--	0.1	<0.010	<0.010	<0.010	0.075	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo[a,h]anthracene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	ug/l	--	0.41	<0.010	<0.010	<0.010	0.18	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/l	--	120	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno[1,2,3-cd]pyrene	ug/l	--	0.2	<0.010	<0.010	<0.010	0.025	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	ug/l	--	11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	ug/l	--	1	<0.010	<0.010	<0.010	0.050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	ug/l	--	4.1	<0.010	<0.010	<0.010	0.14	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Table 5B: Groundwater Analytical Results General Chemistry and PAHs

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	MT-9		NPD-1		NPD-10		NPD-11		NPD-12		NPD-13	
				06-Jun-2017	30-May-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017	05-Jun-2017		
Semi-VOCs															
1-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/l	--	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo [b,j] fluoranthene	ug/l	--	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]anthracene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]pyrene	mg/l	0.00004	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo[g,h,i]perylene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[k]fluoranthene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo[a,h]anthracene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	ug/l	--	0.41	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/l	--	120	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno[1,2,3-cd]pyrene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	ug/l	--	11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Table 5B: Groundwater Analytical Results General Chemistry and PAHs

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	NPD-14		NPD-2		NPD-4		NPD-5		NPD-7	
				05-Jun-2017	30-May-2017	30-May-2017	30-May-2017	30-May-2017	06-Jun-2017	30-May-2017	30-May-2017		
Semi-VOCs													
1-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/l	--	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo [b,j] fluoranthene	ug/l	--	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]anthracene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]pyrene	mg/l	0.00004	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo[g,h,i]perylene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[k]fluoranthene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo[a,h]anthracene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	ug/l	--	0.41	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/l	--	120	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno[1,2,3-cd]pyrene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	ug/l	--	11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Parameter	Unit	CDWQG - Health Based ⁽¹⁾	REG153 (11) T2-GW COARSE ⁽²⁾	NPD-7		NPD-8		NPD-9	
				30-May-2017 JP-1 (Field Duplicate)	30-May-2017	30-May-2017	05-Jun-2017		
Semi-VOCs									
1-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/l	--	3.2 ⁽⁷⁾	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/l	--	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo [b,j] fluoranthene	ug/l	--	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]anthracene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[a]pyrene	mg/l	0.00004	0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Benzo[g,h,i]perylene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[k]fluoranthene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/l	--	0.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenzo[a,h]anthracene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	ug/l	--	0.41	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/l	--	120	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno[1,2,3-cd]pyrene	ug/l	--	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	ug/l	--	11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	ug/l	--	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Pyrene	ug/l	--	4.1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Footnotes:

- Tables should be read in conjunction with the accompanying document.
- < Indicates parameter not detected above laboratory method detection limit.
 - > Indicates parameter detected above equipment analytical range.
 - Chemical not analyzed or criteria not defined.

Value Parameter is greater than Canadian Drinking Water Quality Guidelines (CDWQG) - Health Based

Value Parameter is greater than REG153 (11) T2-GW COARSE

(1) CDWQG - HEALTH BASED

(2) O.Reg 153 (2011) Table 2 Standards for all types of property use for groundwater in coarse textured soil in full depth generic site condition in a potable ground water condition

(3) Removal of one half well volume. Pumped to the midpoint of the screen, allowed to recover, then sampled.

(4) Removed >4 well volumes. Low yield well went dry while sampling, left it for 1hr at a time to obtain more samples.

(5) Not Applicable.

(6) F1 fraction does not include BTEX; however, the proponent has the choice as to whether or not to subtract BTEX from the analytical result.

(7) The methyl naphthalene standards are applicable to both 1-methyl naphthalene and 2-methyl naphthalene, with the provision that if both are detected the sum of the two must not exceed the standard.

Table 6: Comparison to CCME Soil Quality Guidelines - Industrial

Parameter	Unit	CCME Soil Ind - Coarse Surface 10-5 ⁽¹⁾	J-1 07-Jun-2017 ⁽²⁾ J-1-B 0.15 - 0.3	J-6 07-Jun-2017 ⁽⁵⁾ J-6 0 - 0.15	DEBRI BY RIVER 31-May-2017 DEBRI BY RIVER 0 - 0.15	SA-312 06-Jun-2017 SA-312 0 - 0.15	SA-379-B 31-May-2017 SA 379-B 0.15 - 0.3	SA-411-B 30-May-2017 SA 411-B 0.15 - 0.3
Petroleum Hydrocarbons								
Benzene	mg/kg	0.03 ⁽¹⁶⁾	<0.0060	<0.012	-	<0.0060	<0.02	<0.02
Ethylbenzene	mg/kg	0.082 ⁽¹⁶⁾	<0.010	<0.020	-	<0.010	<0.02	<0.02
m,p-Xylenes	ug/g	-	<0.020	0.047	-	<0.020	<0.04	<0.04
o-Xylene	ug/g	-	<0.020	0.044	-	<0.020	<0.02	<0.02
Petroleum Hydrocarbons - F1 (C6-C10)	mg/kg	240 ⁽¹⁷⁾	660 ⁽¹⁸⁾	<20	-	<10	<10	<10
Petroleum Hydrocarbons - F1 (C6-C10)-BTX	ug/g	-	660	<20	-	<10	<10	<10
Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	260	<10	640	-	<10	<10	<10
Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	1700	<50	47000	-	<50	<50	56
Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	3300	<50	47000	-	<50	<50	<50
Toluene	mg/kg	0.37 ⁽¹⁸⁾	<0.020	<0.040	-	<0.020	<0.02	<0.02
Xylenes, Total	mg/kg	11 ⁽¹⁸⁾	<0.020	0.090	-	<0.020	<0.04	<0.04
Semi-VOCs								
1- & 2-Methylnaphthalene	ug/g	-	<0.0071	<4.2	<0.014	<0.0071	<0.014	0.041
1-Methylnaphthalene	ug/g	-	<0.0050	<3	<0.0050	<0.0050	<0.0050	0.020
2-Methylnaphthalene	ug/g	-	<0.0050	<3	<0.0050	<0.0050	<0.0050	0.021
Acenaphthene	ug/g	0.28	<0.0050	<3	0.011	0.023	0.038	0.064
Acenaphthylene	ug/g	320	<0.0050	<3	<0.0050	<0.0050	<0.0050	0.050
Anthracene	ug/g	32	<0.0050	<3	0.043	0.051	0.052	0.26
Benzo [b,j] fluoranthene	ug/g	-	<0.0050	<3	0.49	0.15	0.38	0.96
Benzo[a]anthracene	ug/g	10 ⁽⁷⁾	<0.0050	<3	0.33	0.15	0.28	0.85
Benzo[a]pyrene	ug/g	1.4 ⁽²⁰⁾	<0.0050	<3	0.23	0.12	0.25	0.67
Benzo[g,h,i]perylene	ug/g	-	<0.0050	<3	0.13	0.063	0.18	0.42
Benzo[k]fluoranthene	ug/g	10 ⁽⁷⁾	<0.0050	<3	0.17	0.059	0.14	0.37
Chrysene	ug/g	-	<0.0050	<3	0.27	0.13	0.25	0.70
Dibenzo[a,h]anthracene	ug/g	10 ⁽⁷⁾	<0.0050	<3	0.039	0.019	0.053	0.12
Fluoranthene	ug/g	180	<0.0050	<3	0.58	0.30	0.65	2.1
Fluorene	ug/g	0.25	<0.0050	<3	0.011	0.017	0.034	0.15
Indeno[1,2,3-cd]pyrene	ug/g	10 ⁽⁷⁾	<0.0050	<3	0.16	0.074	0.21	0.49
Naphthalene	ug/g	0.013 ⁽¹⁰⁾	<0.0050	<3	<0.0050	<0.0050	<0.0050	0.068
Phenanthrene	ug/g	0.046 ⁽⁷⁾	<0.0050	<3	0.091	0.17	0.34	1.3
Pyrene	ug/g	100 ⁽⁷⁾	<0.0050	<3	0.46	0.23	0.46	1.5

Parameter	Unit	SWIPE #1 08-Jun-2017 10:30 AM Manhole #2 South	SWIPE #2 08-Jun-2017 11:30 AM Manhole #2 North	SWIPE #3 09-Jun-2017 11:00 AM 6-9 Intake Pipe
Metals				
Mercury	ug	<0.01	<0.01	0.01

Footnotes:

Tables should be read in conjunction with the accompanying document.

- < Indicates parameter not detected above laboratory method detection limit.
- > Indicates parameter detected above equipment analytical range.
- Chemical not analyzed or criteria not defined.

Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
Sediment Samples, sample depths meters below water surface (mbws)							
SA-001	295000	5118328	CU25	5.9	6.0	-	Brown silty sand
SA-002	295385	5117970	CU25	4.1	4.2	-	Brown silty sand
SA-003	295192	5118184	CU25	4.1	4.2	-	Brown silty sand
SA-004	295530	5117859	CU25	0.6	0.7	-	Brown sand
SA-005	294928	5118359	CU25	0.9	1.0	-	Brown sand
SA-006	295313	5118002	CU25	6.5	6.6	-	Brown silty sand
SA-007	295120	5118216	CU25	4.7	4.8	-	Brown silty sand
SA-008	295409	5118097	CU25	15.9	16.0	-	Brown silty sand
SA-009	294679	5118730	CU24	5.4	5.5	-	Brown silty sand
SA-010	294939	5118465	CU24	11.1	11.2	-	Brown silty sand
SA-011	294711	5118588	CU24	2.9	3.0	-	Brown silty sand
SA-012	294736	5118641	CU24	6.2	6.3	-	Brown silty sand with trace cobbles
SA-013	294605	5118800	CU24	5.1	5.2	-	Dark brown silty sand
SA-014	294866	5118535	CU24	10.8	10.9	-	Brown silty sand
SA-015	294557	5118773	CU24	4.6	4.7	-	Brown silty sand
SA-016	294817	5118508	CU24	4.0	4.1	-	Brown silty sand with organics
Soil Samples, sample depths in meters below ground surface (mbgs)							
SA-017	295182	5117886	CU 5 / Class 3	0	0.15	0.4	Black silty topsoil overlying light brown sand with trace gravel
SA-018	295593	5117762	CU 5 / Class 3	0	0.15	2.3	Organic rich sand with cobbles and trace gravel
SA-019	294874	5117836	CU 5 / Class 3	0	0.15	0.3	Organic rich brown sand
SA-020	295285	5117787	CU 5 / Class 3	0	0.15	0.6	Brown sand with some organics
SA-021	295764	5117712	CU 5 / Class 3	0	0.15	0.3	Organic with some grey sand
SA-022	295079	5117936	CU 5 / Class 3	0	0.15	0.2	Brown sand and gravel with some cobbles
SA-023	295086	5117820	CU 5 / Class 3	0	0.15	0.6	Organic rich brown sand with trace gravel
SA-024	295702	5117845	CU 5 / Class 3	0	0.15	0.2	Light grey sand with large cobbles
SA-025	295565	5117696	CU 5 / Class 3	0	0.15	0.3	Organic with some grey sand
SA-026	295291	5117919	CU 5 / Class 3	0	0.15	0.8	Grey sand and organics
SA-027	295394	5117795	CU 5 / Class 3	0	0.15	2.3	Organic rich sand with cobbles and trace gravel
SA-028	295120	5118018	CU 5 / Class 3	0	0.15	0.3	Organic rich grey sand with trace gravel
SA-029	295668	5117646	CU 5 / Class 3	0	0.15	1.1	Organic rich dark brown sand with trace gravel
SA-030	294983	5117869	CU 5 / Class 3	0	0.15	0.2	Dark brown organic rich sand with trace gravel
SA-031	295600	5117799	CU 5 / Class 3	0	0.15	0.3	Grey/brown organic rich sand
SA-032	295651	5117749	CU 5 / Class 3	0	0.15	0.4	Organic rich brown sand, dry
SA-033	294558	5117609	CU 4 / Class 3	0	0.15	0.1	Dark brown sand some organics and cobbles
SA-034	294891	5117460	CU 4 / Class 3	0	0.15	0.1	Light brown well sorted fine sand with trace organics
SA-035	295137	5117510	CU 4 / Class 3	0	0.15	0.9	Brown sand with organics and trace of gravel
SA-036	294808	5117759	CU 4 / Class 3	0	0.15	0.2	Brown silty sand with some organics
SA-037	295307	5117634	CU 4 / Class 3	0	0.15	0.4	Light brown silty sand with some roots, dry
SA-038	295639	5117485	CU 4 / Class 3	0	0.15	0.8	Coarse brown sand with gravel, dry
SA-039	295099	5117335	CU 4 / Class 3	0	0.15	0.3	Fine brown sand trace gravel with some roots, dry
SA-040	294766	5117559	CU 4 / Class 3	0	0.15	0.2	Orange/brown well graded sand with some gravel and trace organics
SA-041	295265	5117369	CU 4 / Class 3	0	0.15	1.1	Dark brown silty clayey sand with organics and gravel
SA-042	294933	5117593	CU 4 / Class 3	0	0.15	0.2	Light brown sand and organics with trace gravel
SA-043	294517	5117443	CU 4 / Class 3	0	0.15	0.3	Dark brown silty sand, some organic with trace gravel
SA-044	295182	5117667	CU 4 / Class 3	0	0.15	0.5	Light brown silty sand, some roots, dry
SA-045	295515	5117518	CU 4 / Class 3	0	0.15	0.4	Light brown silty sand, some roots, dry
SA-046	295016	5117393	CU 4 / Class 3	0	0.15	0.5	Yellow/brown sand and organics with some boulders
SA-047	295047	5117468	CU 4 / Class 3	0	0.15	0.7	Cobbley dark sand with organics
SA-048	294714	5117692	CU 4 / Class 3	0	0.15	0.3	Brown fine sand fill with trace organics
SA-049	294588	5117792	CU 3 / Class 3	0	0.15	1.5	Light brown sand
SA-050	294236	5117572	CU 3 / Class 3	0	0.15	0.1	Light brown silty sand with organics underlain by rich brown sand
SA-051	294706	5117968	CU 3 / Class 3	0	0.15	1.9	Dark brown sand with organics
SA-052	294410	5117698	CU 3 / Class 3	0	0.15	0.3	Cobbley light grey sand with organics
SA-053	294647	5118496	CU 3 / Class 3	0	0.15	0.4	Brown sand and gravel with some organics
SA-054	294529	5118232	CU 3 / Class 3	0	0.15	0.3	Brown sand with some organics at surface
SA-055	294383	5118291	CU 3 / Class 3	0	0.15	0.4	Red brown sand with trace organics and gravel
SA-056	294148	5117630	CU 3 / Class 3	0	0.15	0.3	Light brown fine silty sand, wet sediment
SA-057	294618	5118027	CU 3 / Class 3	0	0.15	0.4	Brown sand and gravel with trace organics (fill)
SA-058	294500	5117762	CU 3 / Class 3	0	0.15	0.4	Light brown sand with organics
SA-059	294265	5118159	CU 3 / Class 3	0	0.15	0.4	Rich brown sand with organics and gravel
SA-060	293972	5117542	CU 3 / Class 3	0	0.15	0.3	Organic topsoil with roots
SA-061	294441	5117939	CU 3 / Class 3	0	0.15	1.6	Brown silty sand with trace gravel and organics
SA-062	294559	5118467	CU 3 / Class 3	0	0.15	0.2	Organic rich clayey silty and topsoil
SA-063	294329	5117835	CU 3 / Class 3	0	0.15	0.4	Organic material (topsoil) and cobbles
SA-064	294368	5117586	CU 3 / Class 3	0	0.15	0.3	Dark brown coarse sand and organics
SA-065	294112	5118519	CU 2 / Class 3	0	0.15	0.9	Organic rich black silty sand, grey sand at bottom
SA-066	293941	5117851	CU 2 / Class 3	0	0.15	0.4	Fine light brown sand with organics
SA-067	293597	5118212	CU 2 / Class 3	0	0.15	0.1	Brown/orange sand
SA-068	294284	5118572	CU 2 / Class 3	0	0.15	0.5	Brown/orange sand
SA-069	293855	5118332	CU 2 / Class 3	0	0.15	0.4	Light brown silty sand and organics
SA-070	293511	5118693	CU 2 / Class 3	0	0.15	0.0	Organic rich grey sand
SA-071	294198	5118092	CU 2 / Class 3	0	0.15	0.3	Organics and rich brown sand, some cobbles and gravel
SA-072	293340	5118452	CU 2 / Class 3	0	0.15	1.6	Rich brown sand with some cobbles
SA-073	293140	5118620	CU 2 / Class 3	0	0.15	1.1	Brown sand and gravel fill, refusal at 8cm - boulders
SA-074	293469	5118372	CU 2 / Class 3	0	0.15	0.3	Silty organics, some fine sand, black becoming orange brown
SA-075	293984	5118492	CU 2 / Class 3	0	0.15	1.4	Organic dominant silty sand
SA-076	293186	5118345	CU 2 / Class 3	0	0.15	0.7	Organic topsoil with brown grey sand in bottom 2cm
SA-077	294241	5118412	CU 2 / Class 3	0	0.15	2.1	Brown silty sand, some organics and cobbles
SA-078	294069	5118172	CU 2 / Class 3	0	0.15	0.4	Light brown silty sand and gravel overlying rich brown sand, trace organics
SA-079	293726	5118532	CU 2 / Class 3	0	0.15	0.2	Silty organics, trace rootlets, black
SA-080	293803	5118208	CU 2 / Class 3	0	0.15	0.6	Organics (topsoil) with light brown sand
SA-081	293521	5118845	CU 1 / Class 3	0	0.15	1.9	Organic dominant sand and cobbles
SA-082	294086	5118933	CU 1 / Class 3	0	0.15	1.4	Brown sand, some organics
SA-083	293710	5119197	CU 1 / Class 3	0	0.15	0.1	Red/brown silt with cobbles
SA-084	294463	5118756	CU 1 / Class 3	0	0.15	0.3	Organic rich brown sand
SA-085	293239	5119021	CU 1 / Class 3	0	0.15	0.5	Fine to med brown sand with some organics
SA-086	294369	5118769	CU 1 / Class 3	0	0.15	0.5	Brown sand with some organics
SA-087	293427	5119034	CU 1 / Class 3	0	0.15	0.2	Silty organics, trace sand, black
SA-088	293804	5118858	CU 1 / Class 3	0	0.15	0.1	Fine to med sand, some organics, trace gravel, black brown
SA-089	293945	5118946	CU 1 / Class 3	0	0.15	0.5	Organic rich brown sand and gravel
SA-090	293568	5119210	CU 1 / Class 3	0	0.15	0.1	Dark grey sand and cobbles, some organics
SA-091	293380	5118799	CU 1 / Class 3	0	0.15	0.4	Organic rich silt and cobbles
SA-092	293757	5118622	CU 1 / Class 3	0	0.15	0.1	Silty sandy organics with trace gravel and cobbles, black
SA-093	294039	5118711	CU 1 / Class 3	0	0.15	0.3	Silty brown sand with some gravel
SA-094	293662	5118975	CU 1 / Class 3	0	0.15	0.7	Fine to med sand, some organics, black brown
SA-095	294228	5118828	CU 1 / Class 3	0	0.15	0.3	Organic rich brown sand
SA-096	293851	5119093	CU 1 / Class 3	0	0.15	0.1	Black organic rich silt overlying red/brown silt
SA-097	293207	5117734	BRA	0	0.15	0.9	Silty sandy organics, dark brown becoming grey, fine to med sand, trace gravel
SA-098	292860	5117360	BRA	0	0.15	0.5	Silty organics, dark brown, fine to med sand, trace gravel
SA-099	294082	5116681	BRA	0	0.15	0.2	Silty sand, organics, trace roots, black
SA-100	293733	5117977	BRA	0	0.15	0.7	Silty organics, fine to med sand, trace gravel and cobbles, grey brown

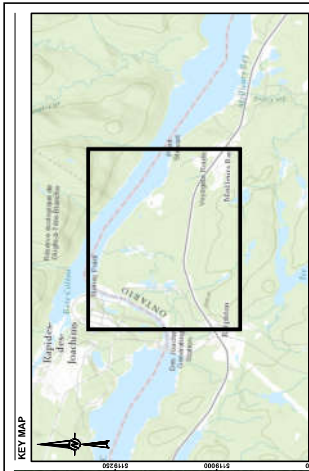
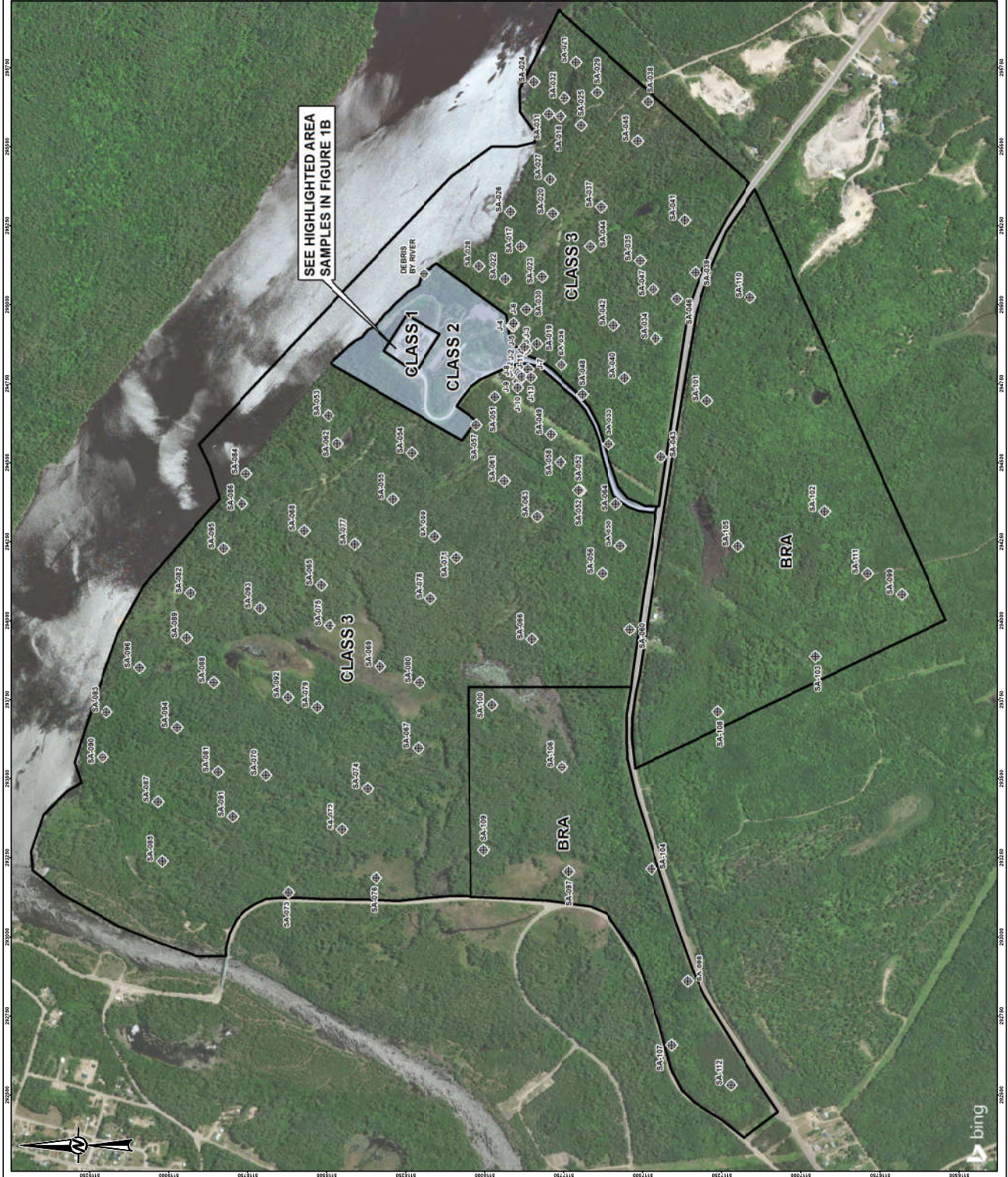
Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
SA-101	294694	5117298	BRA	0	0.15	0.2	Silty dark brown sand with organics and some roots
SA-102	294344	5116927	BRA	0	0.15	0.2	Dark brown silty sand, organics, trace roots
SA-103	293886	5116955	BRA	0	0.15	0.3	Silty black brown sand with organics and trace roots
SA-104	293214	5117474	BRA	0	0.15	0.6	Silty sandy organics, trace gravel, orange brown
SA-105	294235	5117202	BRA	0	0.15	0.2	Silty brown sand, organics, trace roots
SA-106	293537	5117757	BRA	0	0.15	0.2	Silty organics, fine to med sand, trace gravel and cobbles, red/brown/grey
SA-107	292658	5117409	BRA	0	0.15	0.2	Silty sand, organics, trace gravel and cobbles, dark brown
SA-108	293711	5117264	BRA	0	0.15	0.1	Silty sand, organics, fine to med sand, trace gravel
SA-109	293275	5118004	BRA	0	0.15	0.2	Silty sand organics, black/red brown, trace gravel and cobbles
SA-110	295021	5117161	BRA	0	0.15	0.1	Silty brown sand with organics
SA-111	294148	5116790	BRA	0	0.15	0.1	Sandy organics, trace gravel, dark brown
SA-112	292532	5117222	BRA	0	0.15	0.1	Silty sandy organics, fine to med sand, trace gravel and cobbles
SA-113	294990	5118050	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-114	295019	5118050	CU 6 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-115	295005	5118076	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-116	295034	5118076	CU 6 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-117	295019	5118101	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-118	294946	5118126	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-119	294975	5118126	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-120	295005	5118126	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-121	295034	5118126	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-122	295048	5118152	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-123	295078	5118152	CU 6 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-124	295063	5118177	CU 6 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-125	295092	5118177	CU 6 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-126	295048	5118202	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-127	295078	5118202	CU 6 / Class 2	0	0.15	1.0	Dark brown silty sand
SA-128	295034	5118228	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-129	295019	5118253	CU 6 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	0.0	Asphalt
SA-130	294962	5117959	CU 7 / Class 2	0.05	0.2	2.0	Fill sand with gravel
SA-131	294906	5117991	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-132	294943	5117991	CU 7 / Class 2	0	0.15	0.0	Gravel with some coarse brown sand
SA-133	294980	5117991	CU 7 / Class 2	0	0.05	0.0	Asphalt
SA-134	294925	5118023	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	0.0	Asphalt
SA-135	294962	5118023	CU 7 / Class 2	0.05	0.2	0.0	Fill sand with gravel
				0	0.05	0.0	Asphalt
SA-136	294999	5118023	CU 7 / Class 2	0.05	0.2	0.0	Fill sand with gravel
SA-137	294869	5118055	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-138	294906	5118055	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-139	294943	5118055	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-140	294980	5118055	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-141	294887	5118088	CU 7 / Class 2	0	0.05	N/A	Concrete
				0	0.05	0.0	Asphalt
SA-142	294925	5118088	CU 7 / Class 2	0.05	0.2	0.0	Fill sand with gravel and trace of steel
				0	0.05	0.0	Asphalt
SA-143	294962	5118088	CU 7 / Class 2	0.05	0.2	1.0	Fill sand with gravel
SA-144	294999	5118088	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	0.0	Asphalt
SA-145	294906	5118120	CU 7 / Class 2	0.05	0.2	0.0	Fill sand with gravel
SA-146	294943	5118120	CU 7 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	0.0	Asphalt
SA-147	294839	5117884	CU 8 / Class 2	0.05	0.2	0.0	Fill sand with gravel
SA-148	294853	5117907	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-149	294839	5117931	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-150	294866	5117931	CU 8 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-151	294894	5117931	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-151
SA-152	294825	5117955	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-153	294853	5117955	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.15	6.0	Coarse brown sand with gravel
SA-154	294880	5117955	CU 8 / Class 2	0.15	0.3	0.40	Brown sand and gravel some black and orange sand seams
SA-155	294908	5117955	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-156	294839	5117979	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-157	294866	5117979	CU 8 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-158	294894	5117979	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-159	294853	5118003	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-160	294880	5118003	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-161	294908	5118003	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-162	294866	5118027	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-163	294853	5118051	CU 8 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-163
SA-164	294349	5117511	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-165	294372	5117550	CU 9 ROADS / Class 2	0	0.15	N/A	Asphalt
SA-166	294394	5117589	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-166
SA-167	294440	5117589	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	0.0	Asphalt
SA-168	294553	5117629	CU 9 ROADS / Class 2	0.05	0.2	0.0	Soil
SA-169	294667	5117668	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-169
				0	0.1	0.0	Asphalt
SA-170	294781	5117786	CU 9 ROADS / Class 2	0.1	0.2	0.0	Soil
SA-171	294803	5117825	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.1	0.0	Fill sand with gravel
SA-172	294826	5117865	CU 9 ROADS / Class 2	0.1	0.2	0.0	Fill sand with gravel
SA-173	294803	5117983	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-174	294826	5118022	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-175	294803	5118062	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-176	294826	5118101	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-176
SA-177	294894	5118140	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-178	294644	5118180	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-179	294690	5118180	CU 9 ROADS / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-180	294735	5118180	CU 9 ROADS / Class 2	0	0.15	1.5	Sand with gravel (fill)
SA-181	294634	5118035	CU 10 (LF1) / Class 2	0	0.15	1.55	Sand with gravel (fill)
SA-182	294609	5118055	CU 10 (LF1) / Class 2	0	0.15	1.60	Sand with gravel
SA-183	294627	5118051	CU 10 (LF1) / Class 2	0	0.15	1.85	Gravel and sand with cobbles
SA-184	294644	5118052	CU 10 (LF1) / Class 2	0	0.15	1.70	Sand and gravel with some organics
SA-185	294597	5118068	CU 10 (LF1) / Class 2	0	0.15	1.60	Sand and gravel
SA-186	294611	5118072	CU 10 (LF1) / Class 2	0	0.15	0.65	Sand with gravel
				0	0.15	4.35	Sand with gravel some organics
				0.5	1	0.70	Sand with brick
SA-187	294635.3442	5118070.971	CU 10 (LF1) / Class 2	1	1.5	1.70	Silty clay with brick, wire, metal, and concrete
SA-188	294653	5118068	CU 10 (LF1) / Class 2	0	0.15	0.80	Sand with gravel some organics
				0	0.15	0.80	Sand and gravel with some organics and cobbles

Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
SA-189	294594.4346	5118082.428	CU 10 (LF1) / Class 2	2	2.5	0.75	Sand and gravel with trace textile material
SA-190	294608	5118081	CU 10 (LF1) / Class 2	2.5	3	0.80	Sand and gravel with some scrap metal and textile
SA-191	294625	5118084	CU 10 (LF1) / Class 2	0	0.15	1.55	Sand with gravel some cobbles
				0	0.15	0.70	Sand and gravel with organics
				0	0.15	32.60	Sand with gravel (fill)
				1	1.5	0.65	Sand with trace brick and scrap metal
SA-192	294644	5118084	CU 10 (LF1) / Class 2	1.5	2	0.80	Sand with gravel some brick trace asphalt
SA-193	294663	5118084	CU 10 (LF1) / Class 2	0	0.15	0.75	Sand with gravel and some cobbles (fill)
SA-194	294609	5118095	CU 10 (LF1) / Class 2	0	0.15	0.50	Sand with gravel and trace organics
SA-195	294615	5118100	CU 10 (LF1) / Class 2	0	0.15	0.55	Sand and silt with gravel and organics
SA-196	294627	5118090	CU 10 (LF1) / Class 2	0	0.15	0.50	Sand with gravel and trace organics
SA-197	294637	5118122	CU 10 (LF1) / Class 2	0	0.15	0.65	Sand with gravel (fill)
SA-198	294780	5118037	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-199	294746	5118057	CU 11 / Class 2	0	0.15	1.5	Coarse brown sand with gravel
SA-200	294768	5118057	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-201	294791	5118057	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-201
				0	0.15	8.5	Coarse brown sand with gravel, DUP-201
SA-202	294734	5118076	CU 11 / Class 2	0.15	0.3	0.70	Brown sand and gravel;
SA-203	294757	5118076	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-204	294780	5118076	CU 11 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-205	294802	5118076	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-206	294746	5118096	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-207	294768	5118096	CU 11 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-208	294791	5118096	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-209	294814	5118096	CU 11 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-210	294757	5118116	CU 11 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-211	294780	5118116	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-212	294802	5118116	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-213	294768	5118136	CU 11 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-214	294791	5118136	CU 11 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-214
				0	0.15	21.5	Coarse brown sand with gravel, DUP-214
SA-215	294711	5118086	CU 12 / Class 2	0.15	0.3	0.40	Brown sand and gravel;
SA-216	294675	5118106	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-216
SA-217	294699	5118106	CU 12 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-218	294723	5118106	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-219	294663	5118127	CU 12 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-220	294687	5118127	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-221	294711	5118127	CU 12 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-222	294735	5118127	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-223	294651	5118148	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-224	294675	5118148	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-225	294699	5118148	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-226	294723	5118148	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-227	294747	5118148	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-228	294663	5118169	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-229	294687	5118169	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-230	294711	5118169	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-231	294735	5118169	CU 12 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-232	294809	5118133	CU 13 / Class 2	0	0.15	0.0	Asphalt
SA-233	294829	5118133	CU 13 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-234	294849	5118133	CU 13 / Class 2	0	0.15	0.0	Asphalt
SA-235	294779	5118151	CU 13 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-236	294799	5118151	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.05	N/A	Asphalt
SA-237	294823	5118150	CU 13 / Class 2	0.05	0.2	N/A	Soil
SA-238	294838	5118149	CU 13 / Class 2	0	0.15	0.0	Asphalt
SA-239	294859	5118151	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-240	294749	5118168	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-241	294769	5118168	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-242	294789	5118168	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-243	294802	5118174	CU 13 / Class 2	0	0.15	0.0	Asphalt
SA-244	294829	5118168	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-245	294849	5118168	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-246	294779	5118185	CU 13 / Class 2	0	0.15	0.0	Coarse brown sand with gravel, DUP-264
SA-247	294799	5118185	CU 13 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-248	294819	5118185	CU 13 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-249	294737	5118190	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-250	294689	5118207	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-251	294709	5118207	CU 14 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-252	294728	5118207	CU 14 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-253	294747	5118207	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-254	294766	5118207	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-255	294699	5118223	CU 14 / Class 2	0	0.15	0.0	Black peat
SA-256	294718	5118223	CU 14 / Class 2	0	0.15	10/1	Coarse brown sand with gravel
SA-257	294737	5118223	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-258	294757	5118223	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-259	294776	5118223	CU 14 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-260	294709	5118240	CU 14 / Class 2	0	0.15	1.0	Black peat
SA-261	294728	5118240	CU 14 / Class 2	0	0.15	1.0	Black peat
SA-262	294747	5118240	CU 14 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-263	294699	5118257	CU 14 / Class 2	0	0.15	1.0	Black peat
SA-264	294718	5118257	CU 14 / Class 2	0	0.15	1.0	Black peat
SA-265	294709	5118273	CU 14 / Class 2	0	0.15	1.0	Black peat
SA-266	294768	5118233	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-267	294754	5118258	CU 15 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-268	294783	5118258	CU 15 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-269	294740	5118283	CU 15 / Class 2	0	0.15	1.0	Black peat
SA-270	294768	5118283	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-271	294797	5118283	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-272	294725	5118307	CU 15 / Class 2	0	0.15	1.0	Black peat
SA-273	294754	5118307	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-274	294783	5118307	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-275	294811	5118307	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-276	294840	5118307	CU 15 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-277	294740	5118332	CU 15 / Class 2	0	0.15	2.0	Black peat
SA-278	294768	5118332	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-279	294797	5118332	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-280	294826	5118332	CU 15 / Class 2	0	0.15	0.0	Brown peaty sand with gravel
				0	0.15	6.0	Coarse brown sand with gravel
SA-281	294754	5118357	CU 15 / Class 2	0.15	0.3	0.50	Brown sand and peat, some gravel
SA-282	294783	5118357	CU 15 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-283	294832	5118350	CU 16 / Class 2	0	0.15	0.0	Brown peaty sand with gravel

Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
SA-284	294792	5118372	CU 16 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-285	294818	5118372	CU 16 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-286	294845	5118372	CU 16 / Class 2	0	0.15	1.0	Brown peaty sand with gravel
SA-287	294871	5118372	CU 16 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-288	294779	5118395	CU 16 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-289	294805	5118395	CU 16 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-290	294832	5118395	CU 16 / Class 2	0	0.15	1.0	Brown peaty sand with gravel
SA-291	294858	5118395	CU 16 / Class 2	0	0.15	0.0	Brown peaty sand with gravel
SA-292	294884	5118395	CU 16 / Class 2	0	0.15	0.0	Brown peat with gravel
SA-293	294792	5118418	CU 16 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-294	294818	5118418	CU 16 / Class 2	0	0.15	2.0	Black peat with gravel
SA-295	294845	5118418	CU 16 / Class 2	0	0.15	1.0	Brown peaty sand with gravel
SA-296	294871	5118418	CU 16 / Class 2	0	0.15	1.0	Brown peaty sand with gravel
SA-297	294805	5118440	CU 16 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-298	294832	5118440	CU 16 / Class 2	0	0.15	1.0	Black peat
SA-299	294818	5118463	CU 16 / Class 2	0	0.15	1.0	Black peat
SA-300	294897	5118296	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-301	294918	5118296	CU 17 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-302	294887	5118314	CU 17 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-303	294907	5118314	CU 17 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-304	294928	5118314	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-305	294856	5118332	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-306	294877	5118332	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-307	294897	5118332	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-308	294918	5118332	CU 17 / Class 2	0	0.15	2.0	Coarse brown sand with gravel
SA-309	294938	5118332	CU 17 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-310	294867	5118349	CU 17 / Class 2	0	0.15	0.0	Brown peaty sand with organics and gravel
SA-311	294887	5118349	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.15	14.0	Coarse brown sand with gravel
SA-312	294907	5118349	CU 17 / Class 2	0.15	0.3	0.35	brown sand and gravel
				0	0.15	6.0	Coarse brown sand with gravel
				0.15	0.3	0.20	brown sand and gravel
SA-313	294925	5118342	CU 17 / Class 2	0	0.15	0.0	Brown peaty sand with organics and gravel
SA-314	294877	5118367	CU 17 / Class 2	0	0.15	4.0	Coarse brown sand with gravel, DUP-315 collected here
SA-315	294897	5118367	CU 17 / Class 2	0	0.15	0.0	Brown peaty sand with organics and gravel
SA-316	294887	5118385	CU 17 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-317	294973	5118241	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-318	294964	5118256	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-319	294982	5118256	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-320	295000	5118256	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-321	294937	5118272	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-322	294955	5118272	CU 18 / Class 2	0	0.15	0.0	Gravel with some coarse brown sand
SA-323	294973	5118272	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-324	294991	5118272	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-325	294928	5118287	CU 18 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-326	294946	5118287	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-327	294964	5118287	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-328	294982	5118287	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-329	294937	5118303	CU 18 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-330	294955	5118303	CU 18 / Class 2	0	0.15	0.0	Gravel with some coarse brown sand
SA-331	294973	5118303	CU 18 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-332	294946	5118318	CU 18 / Class 2	0	0.15	2.5	Coarse brown sand with gravel
				0	0.15	4.0	Coarse brown sand with gravel
SA-333	294956	5118314	CU 18 / Class 2	0.15	0.3	0.55	brown sand and gravel with boulders
				0	0.15	0.0	Asphalt
SA-334	294986	5118139	CU 19 / Class 2	0.05	0.2	0.0	Sand with gravel (fill)
SA-335	294924	5118160	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-336	294949	5118160	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-337	294974	5118160	CU 19 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-338	294998	5118160	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.15	0.0	Asphalt
SA-339	295023	5118160	CU 19 / Class 2	0.05	0.2	0.0	Sand with gravel (fill)
SA-340	294937	5118182	CU 19 / Class 2	0	0.15	1.0	Coarse brown sand with gravel
SA-341	294961	5118182	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-342	294986	5118182	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-343	295011	5118182	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-344	294949	5118203	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-345	294974	5118203	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-346	294998	5118203	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-347	295023	5118203	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-348	294961	5118224	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-349	294986	5118224	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
SA-350	295011	5118224	CU 19 / Class 2	0	0.15	0.0	Coarse brown sand with gravel
				0	0.15	0.0	Soil
SA-351	294933	5118200	CU 20 / Class 1	0.15	0.3	0.0	Soil
				0	0.15	0.0	Sand and gravel with organics (fill)
SA-352	294909	5118214	CU 20 / Class 1	0.15	0.3	0.0	Silty sand with gravel (fill)
				0	0.15	0.0	Silty sand with gravel (fill)
SA-353	294925	5118214	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Silty sand with some gravel and organics (fill)
SA-354	294940	5118214	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Topsoil sandy silt with organics
SA-355	294917	5118227	CU 20 / Class 1	0.15	0.3	1.0	Sand with gravel (fill)
				0	0.15	0.0	Silty sand with organics and trace of gravel (fill)
SA-356	294933	5118227	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Silty sand (fill)
SA-357	294948	5118227	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel and trace of cobbles (fill)
				0	0.15	0.0	Concrete
SA-358	294909	5118241	CU 20 / Class 1	0.15	0.3	2.0	Silty sand (fill)
				0	0.15	0.0	Asphalt
SA-359	294925	5118241	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Asphalt
SA-360	294940	5118241	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Asphalt
SA-361	294951	5118238	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	2.0	Silty sand with some organics (fill)
SA-362	294901	5118254	CU 20 / Class 1	0.15	0.3	1.0	Sand with gravel (fill)
				0	0.15	0.0	Asphalt
SA-363	294916	5118252	CU 20 / Class 1	0.15	0.3	1.0	Sand with gravel (fill)
				0	0.15	0.0	Gravel and sand with trace of organics (fill)
SA-364	294933	5118254	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)
				0	0.15	0.0	Sand and gravel with trace of organics (fill)
SA-365	294948	5118254	CU 20 / Class 1	0.15	0.3	0.0	Sand with gravel (fill)

Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
SA-366	294909	5118268	CU 20 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-367	294925	5118268	CU 20 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-368	294892	5118154	CU 21 / Class 1	0	0.15	0.0	Sand with gravel and some organics (fill)
				0.15	0.3	0.0	Silty sand with gravel (fill)
SA-369	294869	5118167	CU 21 / Class 1	0	0.15	0.0	Silty sand with organics (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-370	294884	5118167	CU 21 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-371	294900	5118167	CU 21 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-372	294915	5118167	CU 21 / Class 1	0	0.15	0.0	Fine sand with trace brick (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-373	294847	5118180	CU 21 / Class 1	0	0.15	0.0	Topsoil silty clay with sand
				0.15	0.3	0.0	Sand with gravel (fill)
SA-374	294862	5118180	CU 21 / Class 1	0	0.15	0.0	Silty clay and sand (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-375	294877	5118180	CU 21 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-376	294892	5118180	CU 21 / Class 1	0	0.15	0.0	Silty sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-377	294907	5118180	CU 21 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-378	294922	5118180	CU 21 / Class 1	0	0.15	0.0	Silty sand (fill)
				0.15	0.3	0.0	Silty sand (fill)
SA-379	294854	5118193	CU 21 / Class 1	0	0.15	0.0	Concrete
				0.15	0.3	0.0	Sand with gravel (fill)
SA-380	294870	5118191	CU 21 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-381	294900	5118193	CU 21 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Soil
SA-382	294915	5118193	CU 21 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Soil
SA-383	294930	5118193	CU 21 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-384	294907	5118206	CU 21 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with some gravel and wood (fill)
SA-385	294843	5118191	CU 22 / Class 1	0	0.15	0.0	Silty sand with some organics (fill)
				0.15	0.3	0.0	Sand with some gravel (fill)
SA-386	294815	5118202	CU 22 / Class 1	0	0.15	0.0	Sand and organics (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-387	294832	5118202	CU 22 / Class 1	0	0.05	0.0	Asphalt
				0.05	0.2	0.0	Sand with gravel (fill)
SA-388	294791	5118216	CU 22 / Class 1	0	0.15	1.0	Asphalt
				0.15	0.3	1.0	Fill sand with clay
SA-389	294807	5118216	CU 22 / Class 1	0	0.15	0.0	Concrete
				0.15	0.3	0.0	Fill sand
SA-390	294823	5118214	CU 22 / Class 1	0	0.15	N/A	Asphalt
				0.15	0.3	N/A	N/A
SA-391	294840	5118216	CU 22 / Class 1	0	0.15	0.0	Soil
				0.15	0.3	0.0	Soil
SA-392	294799	5118230	CU 22 / Class 1	0	0.15	1.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-393	294815	5118230	CU 22 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with some gravel (fill)
SA-394	294832	5118230	CU 22 / Class 1	0	0.15	0.0	Sand with gravel and some organics (fill)
				0.15	0.3	0.0	Sand with gravel and some brick (fill)
SA-395	294848	5118230	CU 22 / Class 1	0	0.15	0.0	Sand with gravel and trace brick (fill)
				0.15	0.3	0.0	Sand with gravel and trace brick (fill)
SA-396	294807	5118244	CU 22 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-397	294824	5118244	CU 22 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-398	294840	5118244	CU 22 / Class 1	0	0.15	0.0	Sand with gravel and some organics (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-399	294856	5118244	CU 22 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-400	294815	5118258	CU 22 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-401	294832	5118258	CU 22 / Class 1	0	0.15	1.0	Sand with gravel and some organics (fill)
				0.15	0.3	1.0	Sand with gravel and some organics (fill)
SA-402	294845	5118254	CU 23 / Class 1	0	0.15	0.0	Asphalt and topsoil
				0.15	0.3	0.0	Sand with gravel and trace brick (fill)
SA-403	294862	5118254	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-404	294837	5118268	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	1.0	Sand with gravel (fill)
SA-405	294853	5118268	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-406	294870	5118268	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-407	294886	5118268	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-408	294832	5118280	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-409	294845	5118282	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-410	294862	5118282	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-411	294878	5118282	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)
SA-412	294892	5118282	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-413	294909	5118279	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill) and trace organics
				0.15	0.3	0.0	Brown sand (fill)
SA-414	294841	5118295	CU 23 / Class 1	0	0.15	0.0	Asphalt
				0.15	0.3	0.0	Sand with gravel (fill)
SA-415	294853	5118296	CU 23 / Class 1	0	0.15	0.0	Soil
				0.15	0.3	0.0	Soil
SA-416	294870	5118296	CU 23 / Class 1	0	0.15	0.0	Sand with gravel (fill)
				0.15	0.3	0.0	Sand with gravel (fill)

Location	X Coordinate	Y Coordinate	Characterization Unit and Class	Sample A Start Depth	Sample A End Depth	PID Reading, PPM (Organic Gas, Combustible Gas)	Sample A Description
SA-417	294886	5118296	CU 23 / Class 1	0.15	0.3	0.0	Soil
				0	0.15	0.0	Soil
SA-418	294862	5118310	CU 23 / Class 1	0.15	0.3	0.0	Sand with gravel and trace of organics (fill)
						0.0	Sand with gravel (fill)
DEBRIS BY RIVER	295095	5118193	Judgemental Sampling	0	0.15	N/A	
				0	0.15	1,105	Brown sand and gravel
J-1	294854	5117869	Additional Sampling	0.15	0.3	68,75	Brown sand and gravel
				0	0.15	0,185	Gravel and brown sand, debris nearby
J-2	294856	5117880	Additional Sampling	0.15	0.3	1.80	Brown sand and gravel
J-3	294864	5117874	Additional Sampling	0	0.15	0.40	Gravel and brown sand
J-4	294931	5117915	Additional Sampling	0	0.15	0.50	Brown sand and some gravel
J-5	294930	5117909	Additional Sampling	0	0.15	0.45	Brown sand and gravel
				0	0.15	0.30	Peat, twigs, some sand, some tar paper
J-6	294939	5117909	Additional Sampling	0.15	0.3	0.35	Brown sand and gravel
J-7	294793	5117864	Additional Sampling	0	0.15	2.45	Brown sand
J-8	294782	5117894	Additional Sampling	0	0.15	0.30	Brown sand and gravel
J-9	294755	5117895	Additional Sampling	0	0.15	0.45	Brown sand and gravel
J-10	294736	5117896	Additional Sampling	0	0.15	0.45	Brown sand and gravel
J-11	294775	5117888	Additional Sampling	0	0.15	0.35	Brown sand and gravel
J-12	294770	5117883	Additional Sampling	0	0.15	1.25	Brown sand and gravel
J-13	294768	5117855	Additional Sampling	0	0.15	0.40	Brown sand and gravel



SCALE 1:100,000

LEGEND
 [Symbol] CONTAMINATED CLASS ZONES

NOTES
 1. ALL LOCATIONS ARE APPROXIMATE

REFERENCES
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 3. PROJECTION: UTM, ZONE 18, DATUM: NAD 83.
 4. COORDINATE SYSTEM: UTM, ZONE 18, VERTICAL DATUM: GVD028



CLIENT
 CANADIAN NUCLEAR LABORATORIES

PROJECT
 NPD STATION - CHALK RIVER

TITLE
 SITE PLAN (ALL INVESTIGATION LOCATIONS)

CONSULTANT
 YYYYYY-AM-00 2017-04-25

DESIGNED —

PREPARED JEM

REVIEWED AW

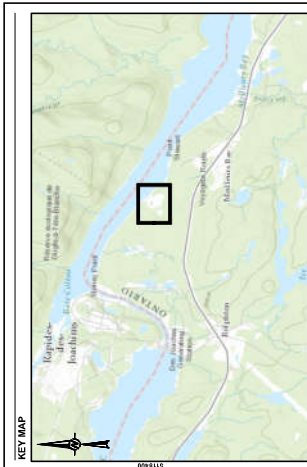
APPROVED PH

REV. 0

PHASE 8002

PROJECT NO. 1668131





LEGEND

- APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
- APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION

NOTES

- ALL LOCATIONS ARE APPROXIMATE

REFERENCES

- LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTERS OF NATURAL RESOURCES, TOLUENES PRINTER 2014
- ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISS TOPO, IGN, KADASTER NL, ORDNANCE SURVEY, CORP., GEBCO, USGS, PAC NPS, ARCAN, GEBCO, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISS TOPO, IGN, KADASTER NL, ORDNANCE SURVEY, © 2017 DIGITALGLOBE (2017) DISTRIBUTION AIRBUS DS © 2017 MICROSOFT CORPORATION TRANSVERSE MERCATOR DATUM, NAD 83 COORDINATE SYSTEM UTM, ZONE 18, VERTICAL DATUM, CGVD28



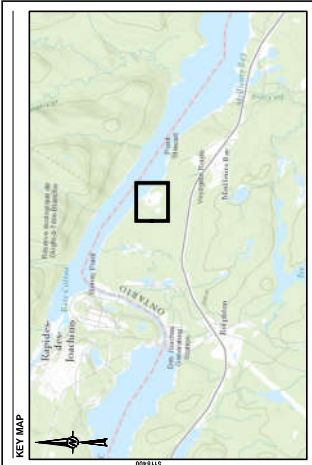
CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
DETAILED SITE PLAN (ALL INVESTIGATION LOCATIONS)

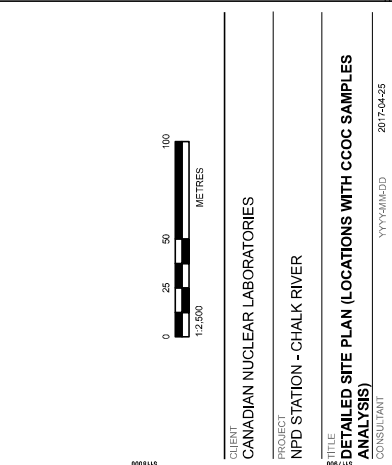
CONSULTANT	YYYYMM-DD	2017-04-25
DESIGNED		
PREPARED	JEM	
REVIEWED	AW	
APPROVED	PH	
PROJECT NO.	PHASE	REV.
1668131	8002	0





- LEGEND**
- ⊕ APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
 - ⊕ APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
- NOTES**
1. ALL LOCATIONS ARE APPROXIMATE
- REFERENCES**
1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTRY OF NATURAL RESOURCES & GOLDER ASSOCIATES LTD.
 2. AIR PHOTO INTERPRETATION REPORT, NPD STATION, CHALK RIVER, ONTARIO, CANADA, 2017, GOLDER ASSOCIATES LTD.
 3. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
 4. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
 5. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
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 12. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
 13. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
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 18. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
 19. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.
 20. CADASTRAL PLAN, CHALK RIVER, ONTARIO, CANADA, 2017, ONTARIO LAND REGISTRY.

COORDINATE SYSTEM: UTM, ZONE 18, VERTICAL DATUM: CGVD28



CLIENT: CANADIAN NUCLEAR LABORATORIES

PROJECT: NPD STATION - CHALK RIVER

TITLE: DETAILED SITE PLAN (LOCATIONS WITH CCOCS SAMPLES ANALYSIS)

CONSULTANT: YYYYYY-AM-00 2017-04-25

DESIGNED: JEM

PREPARED: JEM

REVIEWED: AW

APPROVED: PH

PROJECT NO.: 1668131

PHASE: 8002

REV.: 0

FIGURE: 1C



Class 2 Area
A PAH exceedance was detected at location SA-312 from 0-0.15 m. No exceedances in the surrounding samples.

Class 2 Area
A PAH exceedance was detected from a sample taken near a pile of debris found along the Ottawa River during soil sampling.

Licensed Area
Exceedances of PAHs were detected in location SA-411 from 0.15-0.30 m.

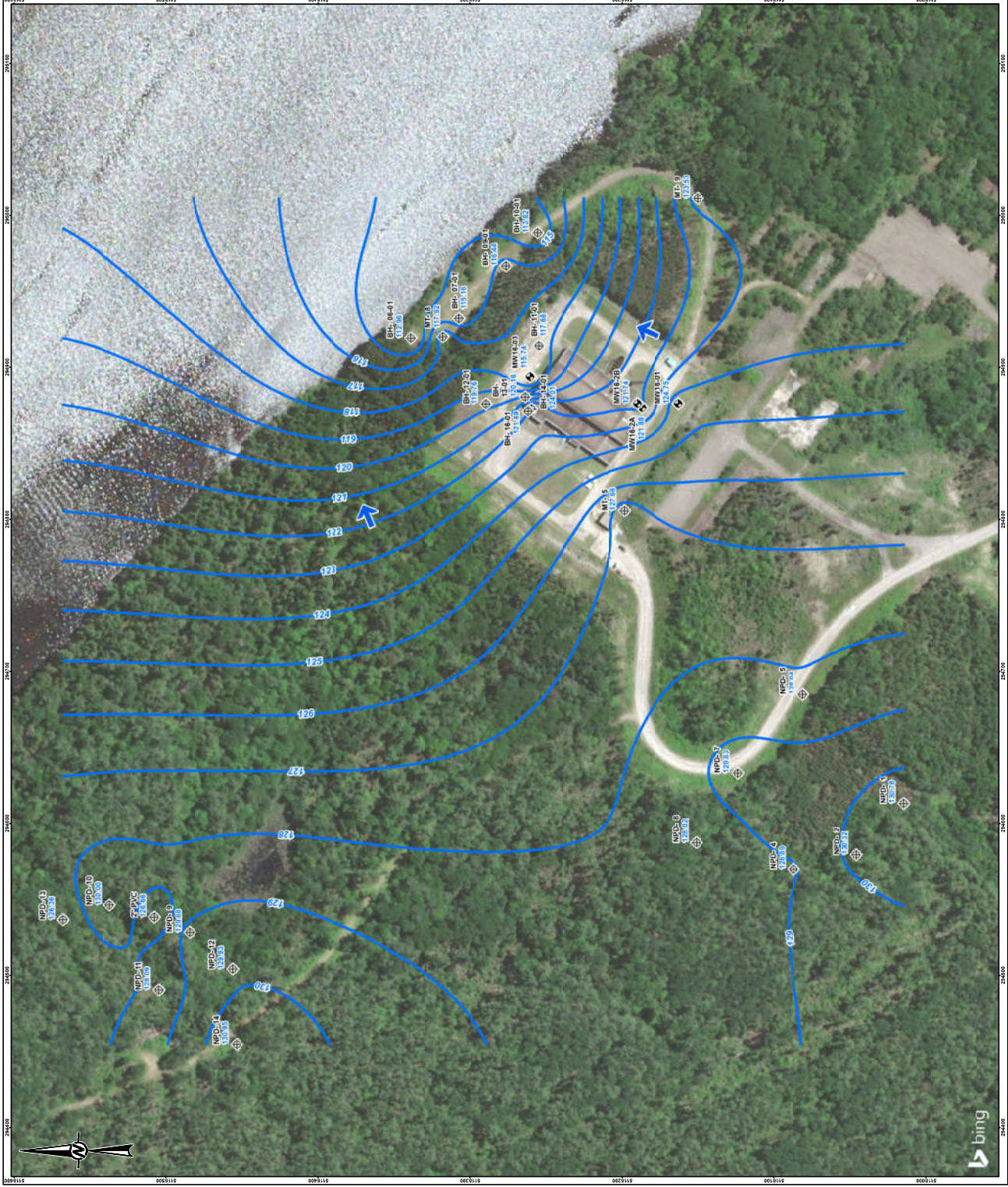
Licensed Area
A PAH exceedance was detected at location SA-379 from 0.15-0.30 m. No exceedances in the surrounding samples.

Historic Unauthorized Dumping Site
Exceedances of metals and PHCs were detected in location J-1 from 0-0.3 m. No exceedances at J-2 or J-3.

Historic Unauthorized Dumping Site
Exceedances of metals, and PHCs were detected in location J-6 from 0 -0.15 m. No exceedances at J-4 or J-5.



KEY MAP



LEGEND

- ⊕ APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
- ⊕ APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
- 958.9 GROUNDWATER ELEVATION, MASL
- ↙ INTERPRETED GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR, MASL

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. SERVICE LAYER CREDITS: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, LIGSS, IACI, NPS, ANCAN, GEBCO, ION, KADASTER NL, ORDINANCE SURVEY, AND THE GIS USER COMMUNITY
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM, ZONE: 18, VERTICAL DATUM: CGVD28

REFERENCES

1. CANADIAN NUCLEAR LABORATORIES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES
2. SERVICE LAYER CREDITS: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, LIGSS, IACI, NPS, ANCAN, GEBCO, ION, KADASTER NL, ORDINANCE SURVEY, AND THE GIS USER COMMUNITY
3. 2017 DIGITAL GLOBE (2017) DISTRIBUTION AIRBUS DS © 2017 MICROSOFT



CLIENT: CANADIAN NUCLEAR LABORATORIES

PROJECT: NPD STATION - CHALK RIVER

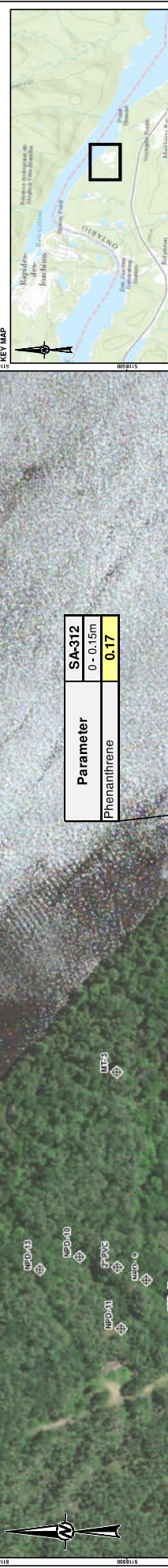
TITLE: GROUNDWATER ELEVATIONS AND INTERPRETED SHALLOW GROUNDWATER FLOW DIRECTION

CONSULTANT: YYY-AAA-000 2017-04-25

DESIGNED	JEM
PREPARED	JEM
REVIEWED	AW
APPROVED	PH



PROJECT NO.: 1666131 PHASE: 0002 REV.: 0



SCALE 1:100,000

LEGEND
 ♦ APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
 ♦ APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION

NOTES
 1. BOLD VALUES INDICATES PARAMETER IS GREATER THAN CCME SOIL RIP - COARSE SURFACE TOPS
 2. BOLD VALUES INDICATES PARAMETER IS GREATER THAN REG 159 (11) T-RP4 SOIL COARSE
 3. ALL LOCATIONS ARE APPROXIMATE

REFERENCES
 1. BOLD VALUES INDICATES PARAMETER IS GREATER THAN CCME SOIL RIP - COARSE SURFACE TOPS
 2. BOLD VALUES INDICATES PARAMETER IS GREATER THAN REG 159 (11) T-RP4 SOIL COARSE
 3. ALL LOCATIONS ARE APPROXIMATE

CLIENT: CANADIAN NUCLEAR LABORATORIES
PROJECT: NPD STATION - CHALK RIVER

TITLE: SUMMARY OF SOIL ANALYSIS AND EXCEEDANCES

CONSULTANT: YYY-AAA-DDD 2017-04-25
 DESIGNED: JEM
 PREPARED: JEM
 REVIEWED: AW
 APPROVED: PH

PROJECT NO.: 16681931
PHASE: 8002
REV.: 0
FIGURE: 3

Parameter		SA-312	
Phenanthrene		0.17	

DEBRIS BY RIVER		0.081	
Phenanthrene		0.17	

Parameter		SA-411-B	
Phenanthrene		1.3	

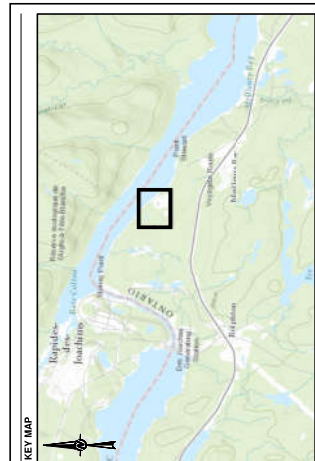
Parameter		SA-411-B	
Benzolanthracene		0.95	
Benzopyrene		0.67	
Dibenzoflanthracene		0.12	
Fluoranthene		2.1	
Indeno[1,2,3-cd]pyrene		0.49	
Naphthalene		0.068	
Phenanthrene		1.3	

Parameter		SA-379-B	
Phenanthrene		0.34	

Parameter		J-6	
Vanadium		97	
Parameter		J-1-B	
PHCs - F1 (C8-C10)		660	
PHCs - F1 - BTEX		660	

Parameter		J-6	
Arsenic		15	
Zinc		320	
PHCs - F2 (C10-C16)		640	
PHCs - F3 (C16-C34)		11000	
PHCs - F2 (C34-C50)		47000	

Logo for **Golden Associates**. Text: PROJECT NO. 16681931, PHASE 8002, REV. 0, FIGURE 3.



SCALE 1:100,000

LEGEND

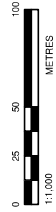
- ◆ APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
- ◆ APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
- MONITORING WELL WITH SAMPLE COLLECTED

NOTES

1. BOLD VALUES INDICATES PARAMETER IS GREATER THAN CDWOG - HEALTH BASED
2. ITALIC VALUES INDICATES PARAMETERS GREATER THAN REG153 (11) T-50W
3. ALL LOCATIONS ARE APPROXIMATE

REFERENCES

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER
2. SERVICE USER CREDITS SOURCES: ESTRI, HERE, DELORME, INTERMAP, INCREMENT P
3. CONTRIBUTORS AND THE GIS USER COMMUNITY
4. © 2017 DIGITALGLOBE (CNCS 2017) DISTRIBUTION AIRBUS DS © 2017 MICROSOFT
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
6. COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: COVID28



CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
SUMMARY OF GROUNDWATER ANALYSIS AND EXCEEDANCES

CONSULTANT	YYYY-MM-DD	2017-04-25
DESIGNED		
PREPARED	JEM	
REVIEWED	AW	
APPROVED	PH	
PROJECT NO.	PHASE	REV.
1666131	8002	0



FIGURE
4

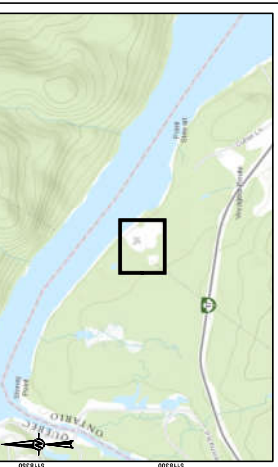


Parameter **BH-14-01**
Benzolalpyrene **0.000080**





KEY MAP



SCALE 1:50,000

LEGEND

- ⊕ APPROXIMATE MONITORING WELL LOCATION, CURRENT INVESTIGATION
- ⊕ APPROXIMATE BOREHOLE/MONITORING WELL LOCATION, PREVIOUS INVESTIGATION

CROSS-SECTION LOCATION

A A'

B B'

NOTES

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCES

1. CANADIAN NUCLEAR LABORATORIES
2. SERVICE LAYER CREDITS: SOURCES: ESRI HERE DELORME, INTERMAP, INCREMENT P, ESRI JAPAN, METI, ESRI CHINA, HONG KONG, SWISSTORO, MAPYNDIA, © OPENSTREETMAP CONTRIBUTORS AND THE GIS USER COMMUNITY
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM, ZONE 18, VERTICAL DATUM: CGVD09

CROSS-SECTION SUMMARY

CLIENT	CANADIAN NUCLEAR LABORATORIES
PROJECT	NPD STATION - CHALK RIVER
CONSULTANT	YYYY-MM-DD 2017-04-25
DESIGNED	JEM
PREPARED	JEM
REVIEWED	AW
APPROVED	PH
PROJECT NO.	1668131
PHASE	8002
REV.	0
FIGURE	5

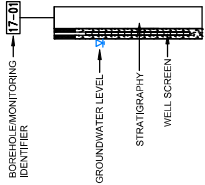
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00 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000 3100 3200 3300 3400 3500 3600 3700 3800 3900 4000 4100 4200 4300 4400 4500 4600 4700 4800 4900 5000 5100 5200 5300 5400 5500 5600 5700 5800 5900 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100 7200 7300 7400 7500 7600 7700 7800 7900 8000 8100 8200 8300 8400 8500 8600 8700 8800 8900 9000 9100 9200 9300 9400 9500 9600 9700 9800 9900 10000

00 0100 0200 0300 0400 0500 0600 0700 0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500 2600 2700 2800 2900 3000 3100 3200 3300 3400 3500 3600 3700 3800 3900 4000 4100 4200 4300 4400 4500 4600 4700 4800 4900 5000 5100 5200 5300 5400 5500 5600 5700 5800 5900 6000 6100 6200 6300 6400 6500 6600 6700 6800 6900 7000 7100 7200 7300 7400 7500 7600 7700 7800 7900 8000 8100 8200 8300 8400 8500 8600 8700 8800 8900 9000 9100 9200 9300 9400 9500 9600 9700 9800 9900 10000

bing

LEGEND



STRATIGRAPHY LEGEND

- FILL
- GRANITE
- ASPHALTIC CONCRETE
- COBBLES and BOULDERS
- SAND and GRAVEL
- TOPSOIL/ORGANICS
- SAND

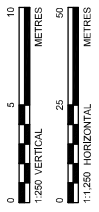
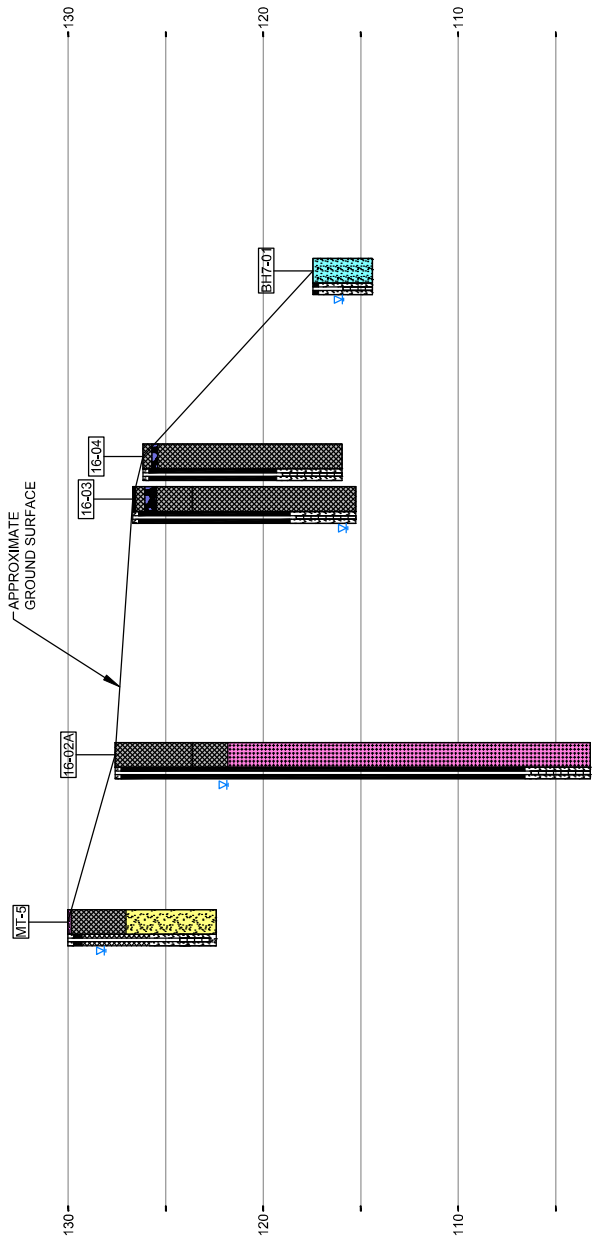
NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE
2. FOR THE LOCATION OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1

A1

A1'

ELEVATION, metres



CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
GEOLOGICAL CROSS-SECTION A1-A1'

CONSULTANT	YYYY-MM-DD	2017-07-21
DESIGNED	JEM	
PREPARED	JEM	
REVIEWED	AW	
APPROVED	PH	

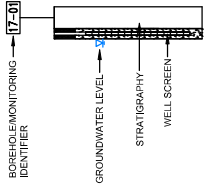


PROJECT NO.
1666131

PHASE
6002

REV.
0

LEGEND

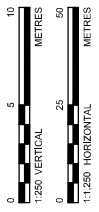


STRATIGRAPHY LEGEND

- ASPHALTIC CONCRETE
- FILL
- COBBLES and BOULDERS
- SAND and GRAVEL
- GRANITE
- TOPSOIL/ORGANICS
- GLACIAL TILL

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE
2. FOR APPROXIMATE ELEVATIONS OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1



B1'

140

130

120

110

100

APPROXIMATE GROUND SURFACE

MT-3

BHT1-01

T6-03

BHT13-01

BHT15-01

BHT12-01

ELEVATION, metres

ELEVATION, metres

DISTANCE ALONG BASELINE (metres)

300

250

200

150

100

50

0

CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
GEOLOGICAL CROSS-SECTION B1-B1'

CONSULTANT	YYYY-MM-DD	2017/07/21
DESIGNED	JEM	---
PREPARED	JEM	---
REVIEWED	AW	---
APPROVED	PH	---



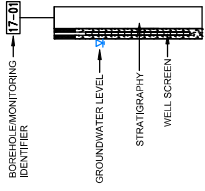
PROJECT NO.
1666131

PHASE
6002

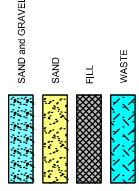
REV.
0

FIGURE
6B

LEGEND

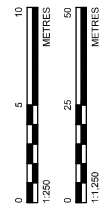
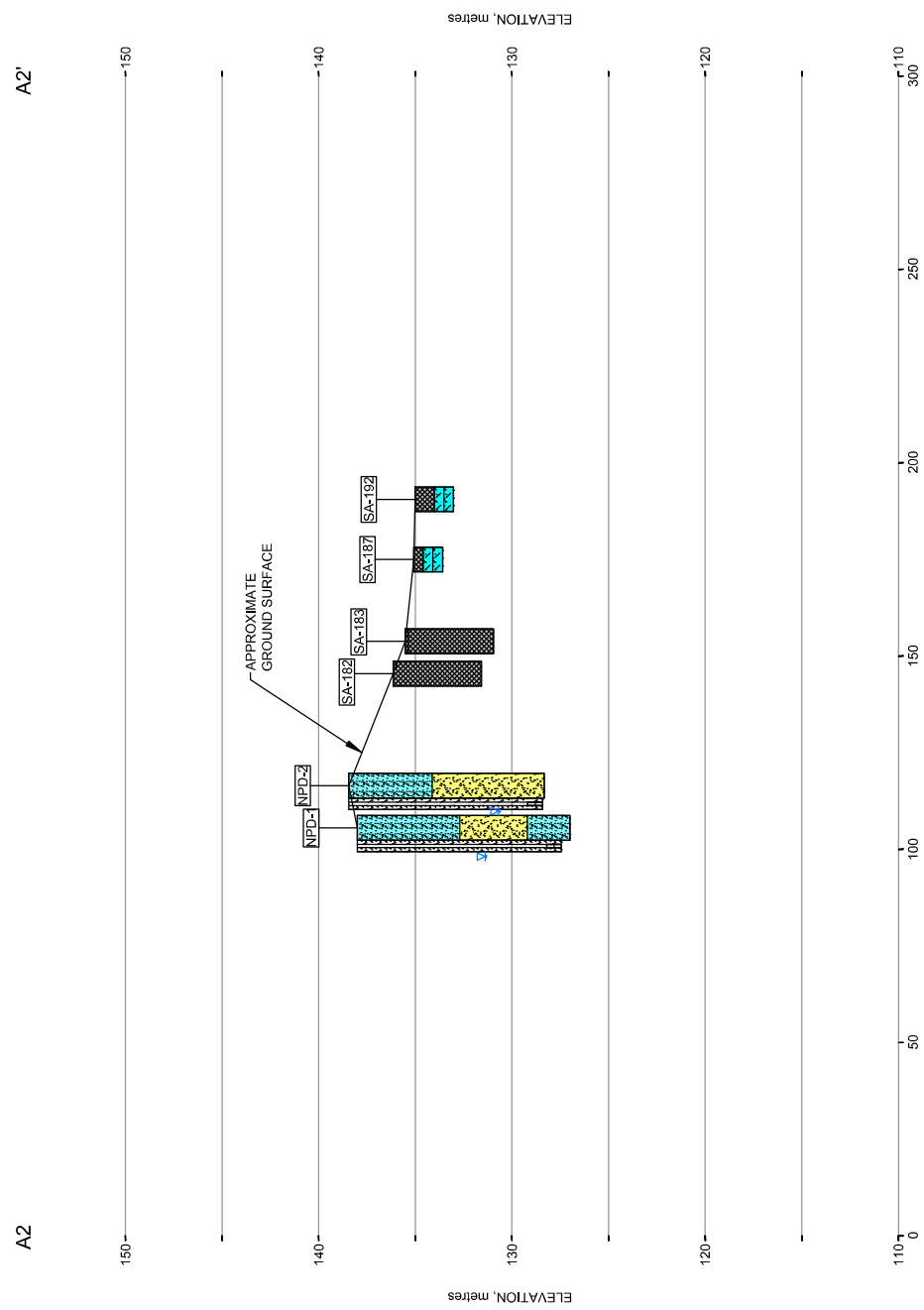


STRATIGRAPHY LEGEND



NOTES

- 1. ALL LOCATIONS ARE APPROXIMATE
- 2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
- 3. FOR CROSS-SECTION LOCATION SEE FIGURE 1



CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
GEOLOGICAL CROSS-SECTION A2-A2'

CONSULTANT	YYYY-MM-DD	2017-07-21
DESIGNED	JEM	
PREPARED	JEM	
REVIEWED	AW	
APPROVED	PH	

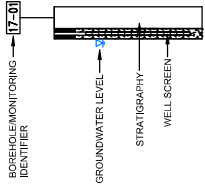


PROJECT NO.
1666131

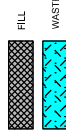
PHASE
6002

REV.
0

LEGEND



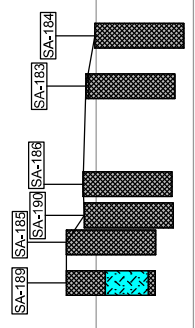
STRATIGRAPHY LEGEND



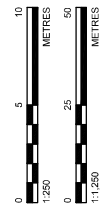
NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1

B2'



ELEVATION, metres



CLIENT
CANADIAN NUCLEAR LABORATORIES

PROJECT
NPD STATION - CHALK RIVER

TITLE
GEOLOGICAL CROSS-SECTION B2-B2'

CONSULTANT	YYYY-MM-DD	2017-07-21
DESIGNED	JEM	---
PREPARED	JEM	---
REVIEWED	AW	---
APPROVED	PH	---



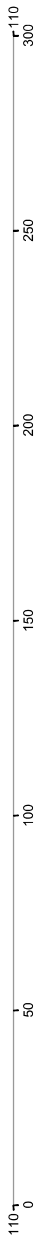
PROJECT NO. 1666131

PHASE 6002

REV. 0

FIGURE 7B

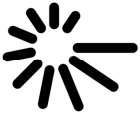
DISTANCE ALONG BASELINE (metres)





APPENDIX A

Environmental Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories (November 21, 2016)



**ENVIRONMENTAL SITE
ASSESSMENT REV 3 SAMPLING
PLAN FOR THE NPD SITE
CANADIAN NUCLEAR
LABORATORIES**

NPD DECOMMISSIONING

64-509410-PLA-002

Revision 0

<input type="checkbox"/>			CNL			LNC		
<input type="checkbox"/> ACCEPTED AS NOTED			<input checked="" type="checkbox"/> ACCEPTED			<input type="checkbox"/> NOT ACCEPTED		
Signature			Representing			Date		
<i>Meggen Vukob</i>			gen			2016/11/21		
<p>"The use and meaning of "ACCEPTED" is governed by the terms and conditions of the P.O. CNL Ref. No 488645 and in any event its use does not relieve the manufacturer of any of its obligations to CNL and/or to its Client"</p> <p>OFFICIAL USE ONLY À USAGE EXCLUSIF</p>								



November 21, 2016

Environmental Site Assessment REV 3 Sampling Plan for the NPD Site Canadian Nuclear Laboratories

Submitted to:
Canadian Nuclear Laboratories

REPORT



Document Number: 1666131-1

Distribution:

- 1 e-copy – Canadian Nuclear Laboratories
- 1 e-copy – Golder Associates Ltd.





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Summary of Investigation Locations and Scope



1.0 OVERALL SCOPE

Golder Associates Ltd. (Golder), under Purchase Order (PO) 488645 is conducting an Environmental Site Assessment of the Canadian Nuclear Laboratories (CNL) Nuclear Property Demonstration (NPD) Site, located at 36510 Highway 17, Rolphton, ON K0J 2H0.

As part of this project, Golder has sub-contracted the following services:

Name of Subconsultant	Brief Description of Work Performed
International Safety Research Inc. (ISR)	<p>ISR will provide nuclear and radiological characterization planning and execution expertise, including Senior and Intermediate Characterization SMEs, Field supervisors and RP technicians for characterization process. ISR will also provide a Sr. Health Physicist to assist in the execution of the already developed characterization plan</p> <p>Health physics and engineering staff at ISR will support operations in radiological environments through the development of plans for radiation protection and radiological surveys that are compliant with regulatory requirements and consistent with industry best practices. ISR maintains a staff of technicians who are trained to work in radiological environments to perform radiation protection and survey/sampling duties. Such duties include performing measurements of radiation fields and/or contamination, performing waste management, collecting samples, taking swipes and managing a decontamination line and general labour.</p> <p>ISR will also support the conduct of the characterization field work.</p>
USL-1 Ltd.	USL-1 will provide utility service locates
Kinetrics Inc.	Kinetrics will provide laboratory analysis of Radiological Contaminants of Concern (ROCs)
Maxxam Analytics Ltd.	Maxxam will provide laboratory analysis of Conventional Contaminants of Concern (CCOCs)

Applicable Guidance and Standards

The investigation will be conducted in accordance with both the Canadian Council Ministers of the Environment (CCME) Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk assessment (CCME Guidance Manual) and the Ontario Ministry of Environment and Climate Change (MOECC) Guidance on Sampling and Analytical Methods for use at Contaminated Sites in Ontario (MOECC Sampling Guidance). For Radiological aspects, CSA 292.5-11 as well as MARSSIM are applicable to address radiological final status survey.



Overview of Investigation

Based on both the Statement of Work and the Characterization Plan the following investigation is required.

Table 1: Overview of Field Investigation Requirements

PDU	Sample Class	Overview of Investigation Requirement
Exclusion Zone	All Class 3 locations and a number of Class 2 locations within the Station Area of the Exclusion Zone	Gamma radiation surface scans Surface soils sampling (0 to 0.15 mbgs) Landfill #1 sampling (soil samples from 0 to 0.5 and 0.5 to 1.0 metre intervals within waste layer) Groundwater sampling Judgemental sediment sampling Additional radiological surface scans (Gamma, Alpha, Beta) of miscellaneous items and equipment
Ottawa River	Class 3 locations	Sampling of upper 0.15 m of sediment at 16 locations, varying from a few metres off-shore to approximately 90 metres off-shore. One sample at CU25 is approximately 150 metres off-shore. Based on hydrograph mapping and inferred depth of surface water, sampling depth is expected to be a maximum of approximately 20 metres [60 feet]
Licensed Area	Class 1 locations	Gamma radiation surface scans Surface soils sampling (0 to 0.15 mbgs) Subsurface soil sampling (0.15 to 0.30 mbgs) Groundwater sampling Judgemental sediment sampling Characterization of Effluent Process Lines Miscellaneous Station/Licensed Land Area Items and Equipment Scanning (Gamma, Alpha, Beta)

2.0 WORK DEFINITION

The following sections provide the work definition by task. Each task assessment defines the scope of the task and identifies potential hazards associated with completing the scope and associated hazard mitigations which are applicable. This sampling plan identifies specific hazards for each task, however the Health and Safety plan should be reviewed and understood in its entirety prior to proceeding with the investigation.

The following Appendices form part of this Sampling Plan

- Appendix A – Standard Operation Procedures (SOPs) developed by ISR
- Appendix B – SOPs developed by Golder
- Appendix C – Health and Safety Plan
- Appendix D – Radiation Protection Plan
- Appendix E – Field Maps
- Appendix F – Summary of Investigation Locations and Scope



Hazard mitigations are provided in the site specific health and safety plan provided in Hazards that are common to all tasks include:

Hazards	Hazard Mitigation Reference
Radiation Exposure	9
Uneven, unstable, and slippery ground surfaces (slips trips and falls)	10
Cold Weather	13

Site Specific Requirements

In addition to the Health and Safety Plan (Appendix C) and Radiation Protection Plan (Appendix D), the following requirements exist for the job:

- Following direction from CNL for any necessary radiological requirements
- Adhering to CNL direction by CNL compliance groups such as Fire, Occupational Safety and Health, Environmental Protection, Radiation Protection and Radioactive Material Transport
- Attending any pre and post job briefings with CN
- The requirement for spill kits (see Health and Safety Plan – Hazard Mitigation #14)
- Only conducting field work (including river sampling), once a Work Permit has been provided and signed by all staff

Site Specific Training

As part of this project, ISR will certify Golder technicians to use the radiological scanning equipment. No scanning is to proceed without this training.

2.1 Task 1 – Radiological Surface Survey Scans - Gamma

ISR will perform gamma radiation surface scans on Class 1, Class 2, and Class 3 characterization units (CUs) as well as the background radiation area (BRA) by using a graded approach to ensure the appropriate degree of survey effort is expended based on the likelihood of radiological contamination in each class of zone. At each sampling point, a 1 minute gamma surface reading will also be collected. Gamma scans will be conducted in accordance with Section 5.2.1 of the Characterization Plan, and in accordance with the following Standard Operating Procedures:

- Appendix A – **SOP ISR 01 - DAILY QA / BACKGROUND CHECK**
- Appendix A – **SOP ISR 02 - CLASS 3 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**
- Appendix A – **SOP ISR 03 - CLASS 2 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**
- Appendix A – **SOP ISR 04 - CLASS 1 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**



2.1.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 1:

Task	Hazards	Hazard Mitigation Reference
Task 1 - Gamma Radiation Surface Scans	Hunters in area	8
	Lack of established travel routes	9
	Wildlife – biting insects, bears, moose	1, 3
	Noxious plants	2
	Traffic	6
	Soil contamination	5
	Compressed gases	4

2.1.2 Constraints and Limitations

The following constraints apply to Task 1:

- That no snow cover exceeding 5cm will be present during radiological gamma surface scanning activities (snow cover attenuates the radiation count rates measurable by the scanning equipment).
- That the temperature will be greater than zero degrees Celsius during radiological scanning activities (the scanning equipment is rated to minus 10 degrees Celsius, however in our experience operating at this temperate is not reliable).
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season).
- Due to proximity of Des Joachims Dam a portion of the NPD property (very northwest corner) is within the floodway of the dam. Please consult with the NPD point of contact (Kristan Schruder) in order to make appropriate notifications and arrangements with OPG for work in this region for locations SA-083, SA-085, SA-087, SA-090.

2.2 Task 2 – Soil Sampling (0 to 0.15 mbgs)

Shallow soil samples will be collected by hand at all exclusion area CUs, SUs and the BRAs with the exception of the Licensed Area (CU20, CU21, CU22 and CU23) as described in Section 5.2.2 of the Characterization Plan.

For Class 3 Areas and the Background Reference Area (BRA), this task will be conducted in conjunction with (i.e., at the same time) as Task 1. Two teams, each comprising of one Golder and one ISR technician will complete the work as follows:

- ISR will collect a 1 minute surface gamma scan reading;
- Golder will collect a surface soil sample; and,
- ISR will collect a second 1 minute gamma scan reading at 0.15 metres below ground surface (mbgs).



For Class 2 Areas the work will be completed as follows:

- ISR will collect a 1 minute surface gamma scan reading during their implementation of Task 1;
- Golder will confirm that ISR has collected gamma readings and will collect a surface soil sample; and,
- Golder will collect a second 1 minute gamma scan reading at 0.15 mbgs.

For Class 1 Areas, soil sampling (0 to 0.15 mbgs) will be completed during Task 4 (see Section 2.4 below).

Shallow soil samples (0 to 0.15 mbgs) will be collected using a small spade. The soil will be screened using a photoionization detector (PID) for organic vapours and placed into laboratory supplied or pre-approved containers for analysis of Radiological Contaminants of Concern (ROCs) in accordance with Tables 6.2 and 6.31 of the Characterization Plan. Field screening and observations will be used to assess if additional laboratory jars are required to allow for analysis of Conventional Contaminants of Concern (CCOCs). When field temperatures are 10C or greater, samples will be screened using the photoionization detector (PID) at the sample location; when temperatures are below 10C, samples will be taken to a warmed space (indoors or heated car) and allowed to warm for 10 minutes prior to vapour measurement.

Indications of increasing gamma radiation levels with depth or the presence of organic vapours may indicate the presence of impacts at a location. Such occurrences will be documented and communicated to CNL for consideration of additional subsurface investigation in Task 4.

Soil sampling will be conducted in accordance with the following Standard Operating Procedures:

- Appendix B – **SOP 4 – Headspace Screening**
- Appendix B – **SOP 6 – Soil Logging**
- Appendix B – **SOP 11 – Equipment Decontamination**
- Appendix B – **SOP 13 – Test Pitting**
- Appendix B – **SOP 14 – Soil Classification**

2.2.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 2, Soil Sampling (0 to 0.15 mbgs):

Task	Hazards	Hazard Mitigation
Task 2 – Surface Soil Sampling	Hunters in area	8
	Lack of established travel routes	9
	Wildlife – biting insects, bears, moose	1, 3
	Noxious plants	2
	Traffic	6
	Soil contamination	5
	Sample collection	7, 11, 12, 15



2.2.2 Constraints and Limitations

The following constraints apply to Task 2:

- That the ground is not frozen for the hand soil sampling activities
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season)
- Due to proximity of Des Joachims Dam a portion of the NPD property (very northwest corner) is within the floodway of the dam. Please consult with the NPD point of contact (Kristan Schruder) in order to make appropriate notifications and arrangements with OPG for work in this region for locations SA-083, SA-085, SA-087, SA-090.

2.3 Task 3 – Landfill #1 (Soil and Subsurface Sampling)

At Landfill #1, continuous soil coring through the overburden and into the waste layer will be conducted using a track mounted 9580-VTR PowerProbe. At each location, a 0 – 0.5 metre and 0.5 to 1.0 metre thick sample within the waste material will be collected.

Soil and waste layer samples will be screened using a PID for organic vapours and scanned for gamma and beta radiation. The soil will be placed into laboratory supplied or pre-approved containers for analysis of ROCs in accordance with Tables 6.2 and 6.3 of the Characterization Plan. If distinct regions of potential impact are identified, they will be containerized separately for analysis. When field temperatures are 10C or greater, samples will be screened using the PID in the field; when temperatures are below 10C, samples will be taken to a warmed space (indoors or heated car) and allowed to warm for 10 minutes prior to vapour measurement. Field observations will be used to assess if additional laboratory jars are required to be filled for CCOC analysis.

ISR will record surface gamma radiation measurements in advance (during Task 1) and Golder will record gamma radiation measurements of the samples and at the base of each hole. Similarly, soil samples (0 to 0.15mbgs) will already have been collected during Task 2.

Subsurface sampling at the landfill will be conducted in accordance with Section 5.2.4 of the Characterization Plan, including a NaI scan of the sample core. Soil and subsurface sampling will also be conducted in accordance with the following Standard Operating Procedures:

- Appendix B – **SOP 3 – Borehole Drilling and Sampling**
- Appendix B – **SOP 4 – Headspace Screening**
- Appendix B – **SOP 6 – Soil Logging**
- Appendix B – **SOP 11 – Equipment Decontamination**
- Appendix B – **SOP 13 – Test Pitting**
- Appendix B – **SOP 14 – Soil Classification**



2.3.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 3, Landfill #1 (Soil and Subsurface Sampling):

Task	Hazards	Hazard Mitigation
Task 3 – Landfill #1 (Soil and Subsurface Sampling)	Wildlife – biting insects, bears, moose	1, 3
	Noxious plants	2
	Soil contamination	5
	Sample collection	7, 11, 12, 15
	Drilling	14
	Compressed gases	4

2.3.2 Constraints and Limitations

The following constraints apply to Task 3:

- CNL Group 4 training is required for samples deeper than 0.15 mbgs;
- That the ground is not frozen for the hand soil sampling activities
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season)

2.4 Task 4 – Subsurface Soil Sampling (Licensed Area and Surface Anomalies)

Subsurface sampling at the Licensed Area will be conducted in accordance with Section 5.2.4 of the Characterization Plan using continuous soil coring to a minimum depth of 1.2 metres into the soil will be conducted using a track mounted 9580-VTR PowerProbe. At each location, the following investigation will be conducted:

- Set up traffic cones and/or barricades to ensure a safe work area
- Collection of a surface soil sample (0 to 0.15 metres) and field scanning of gamma and beta radiation
- Collection of a subsurface soil sample (0.15 to 0.30 metres) and field scanning of gamma and beta radiation
- If deemed necessary based on continued field monitoring, advancing the borehole deeper in 0.5 metre increments until the base of the anomaly is reached. Each deeper core will be scanned, for gamma and beta radiation, screened for organic vapours and containerized

Due to minimum volumes required by Kinetrics (see Section 3.0), soil sample collection will be supplemented where necessary and possible by also using a hand shovel to obtain a sufficient volume or by advancing a second soil core beside the original core location.

Task 4 also includes subsurface sampling at anomalies and locations of potential impact which may be identified during Task 2, and agreed to by CNL for completion of additional sampling. Judgemental locations within forested zones will either be completed using hand methods or a pionjar.



When field temperatures are 10C or greater, samples will be screened using the PID in the field; when temperatures are below 10C, samples will be taken to a warmed space (indoors or heated car) and allowed to warm for 10 minutes prior to vapour measurement.

In the Licensed Area, Golder will conduct all radiological scanning using equipment supplied by ISR. In accordance with Section 5.2.4 of the Characterization Plan, a NaI scan of the sample core.

If distinct layers of potential impact are identified at a sample location, soil from the layer(s) will be containerized separately for analysis. Field observations will be used to assess if additional laboratory jars are required to be filled for CCOC analysis.

Subsurface sampling will be conducted in accordance with the following Standard Operating Procedures:

- Appendix B – **SOP 3 – Borehole Drilling and Sampling**
- Appendix B – **SOP 4 – Headspace Screening**
- Appendix B – **SOP 6 – Soil Logging**
- Appendix B – **SOP 11 – Equipment Decontamination**
- Appendix B – **SOP 13 – Test Pitting**
- Appendix B – **SOP 14 – Soil Classification**
- Appendix A – **SOP ISR 01 – DAILY QA / BACKGROUND CHECK**
- Appendix A – **SOP ISR 02 – CLASS 3 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**
- Appendix A – **SOP ISR 03 – CLASS 2 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**
- Appendix A – **SOP ISR 04 – CLASS 1 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT**

2.4.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 4, Subsurface Soil Sampling (Licensed Area and Surface Anomalies):

Task	Hazards	Hazard Mitigation
Task 4 – Subsurface Soil Sampling (Licensed Area and Surface Anomalies)	Hunters in area	8
	Lack of established travel routes	9
	Wildlife – biting insects, bears, moose	1, 3
	Noxious plants	2
	Traffic	6
	Soil contamination	5
	Sample collection	7, 11, 12, 15
	Drilling	14



Task	Hazards	Hazard Mitigation
	Compressed gases	4

2.4.2 Constraints and Limitations

The following constraints apply to Task 4:

- That the ground is not frozen for the hand soil sampling activities
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season), however Golder will make reasonable scheduling efforts to avoid the necessity to work in the Licenced Area on Fridays

2.5 Task 5 – Station and Licensed Land Area Groundwater Sampling Program

Groundwater sampling is to be completed at monitoring wells within the Exclusion Zone and Licensed Area as described in Section 5.5 of the Characterization Plan. Prior to collecting samples, the details of construction of the monitoring wells will be reviewed and the monitoring wells will be inspected to assess if they are functioning. Any monitoring wells not labelled will be labelled.

At each well, water levels will be recorded, the well will be purged using low-flow methods and a sample collected.

Wells will be purged using a peristaltic pump with dedicated tubing. Golder will containerize all purge water in ULC approved liquid drums for disposal by CNL. Drums shall be labeled with contents and the NPD contact (Kristan Schruder) person while stored in the field awaiting analysis results for dispositioning. Samples will be collected using low flow sampling techniques using a peristaltic pump. In the event that some monitoring wells cannot be sampled, Golder will discuss with CNL the absence of the groundwater data and how/if it would affect the project Data Quality Objectives.

Groundwater sampling will be conducted in accordance with the following Standard Operating Procedures:

- Appendix B – **SOP 2 – Water Level Measurements**
- Appendix B – **SOP 10 – Low-Flow Groundwater Sample Collection**
- Appendix B – **SOP 11 – Equipment Decontamination**

2.5.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 5, Station and Licensed Land Area Groundwater Sampling Program:

Task	Hazards	Hazard Mitigation
Task 5 – Station and Licensed Land Area Groundwater Sampling Program	Hunters in area	8
	Wildlife – biting insects, bears, moose	1, 3
	Noxious Plants	2



Task	Hazards	Hazard Mitigation
	Contaminated Groundwater	5, 12, 16
	Exposure to groundwater sampling preservative	16

2.5.2 Constraints and Limitations

The following constraints apply to Task 5:

- Up to 34 monitoring wells are accessible and can be sampled
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season)

2.6 Task 6 – Miscellaneous Station and Licensed Land Area Items and Equipment

Radiological Surface Survey Scans – Alpha plus Beta

A concrete pad in the licensed area and a portion of the land area in Class 2 CUs contains building pads from previously demolished warehouses and support buildings. Surface scanning for alpha plus beta contamination would be performed on these pads at 100% coverage using a large area gas proportional detector floor monitor. The scanning grid will be matched to the detector window area of approximately 30cm x 50cm to ensure total coverage, and maintained using a direct measurement system similar to the high density gamma scans. The floor monitor will be advanced at a maximum rate of 0.3 m/s to allow for accurate readings, with readings recorded every second.

Any areas where these scans identify elevated radiation levels will be subject to further direct alpha and beta measurements where residues or samples may be collected for further analysis.

Some of the land area in these CUs also contain miscellaneous items and equipment, including laydown areas on site where materials have been staged. These materials included soil or debris removed from the historic uncontrolled surface dumping sites as well as other miscellaneous materials such as fencing, shielding blocks, and drainage piping. Radiological gamma surface scans will be performed on these items using NaI hand-held detectors. Items with elevated gamma readings will be subject to further direct alpha and beta measurements.

Radiological surface scanning will be conducted in accordance with Section 5.6 of the Characterization Plan and with the following Standard Operating Procedures:

- Appendix A – **SOP ISR 01 – DAILY QA / BACKGROUND CHECK**
- Appendix A – **SOP ISR – 06 – ALPHA/BETA SCANS OF DEMOLISHED BUILDING PADS**

2.6.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 6 – Miscellaneous Station and Licensed Land Area Items and Equipment:



Task	Hazards	Hazard Mitigation
Task 6 – Miscellaneous Station/Licensed Land Area Items and Equipment	Wildlife – biting insects, bears, moose	1, 3
	Noxious Plants	2
	Compressed gases	4
	Abandoned equipment and waste	10

2.6.2 Constraints and Limitations

The following constraints apply to Task 6:

- That no snow cover exceeding 5cm will be present during radiological gamma surface scanning activities (snow cover attenuates the radiation count rates measurable by the scanning equipment)
- That zero snow cover will be present during radiological alpha plus beta surface scanning activities (snow cover entirely shields these forms of radiation, and poses an electronic hazard for detectors used at the ground surface)
- That the temperature will be greater than zero degrees Celsius during radiological scanning activities (the scanning equipment is rated to minus 10 degrees Celsius, however in our experience operating at this temperate is not reliable)

2.7 Task 7 – Judgemental Exclusion Zone Sediment Sampling

Grab samples would be collected from the top 0.15 metres of sediment using a sediment sampler or by hand, whichever is appropriate, at judgemental locations associated with road side ditches, streams and ponds/wetlands as described in Section 5.2.3 of the Characterization Plan. Sediment samples would be collected into laboratory supplied jars or pre-approved containers and submitted for analysis of ROCs, and mercury.

Judgemental sediment sampling will be conducted in accordance with the following Standard Operating Procedures:

- Appendix B – **SOP 4 – Headspace Screening**
- Appendix B – **SOP 6 – Soil Logging**
- Appendix B – **SOP 11 – Equipment Decontamination**
- Appendix B – **Sediment Sampling SOP TBD**

2.7.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 7 – Judgemental Exclusion Zone Sediment Sampling:

Task	Hazards	Hazard Mitigation
Task 7 –	Wildlife – biting insects, bears, moose	1, 3



Task	Hazards	Hazard Mitigation
Judgemental Exclusion Zone Sediment Sampling	Noxious Plants	2
	Working near water bodies	17
	Traffic	6
	Sample collection	7, 11, 12, 15
	Soil contamination	5

2.7.2 Constraints and Limitations

The following constraints apply to Task 7:

- That the ground is not frozen for the hand soil sampling activities
- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season)

2.8 Task 8 – Ottawa River Sediment Sampling

Grab samples using a Ponar would be collected from the top 0.15 metres of sediment in the Ottawa River, specifically at CU24 (upstream) and CU25 (downstream). Sample locations will be accessed via a non-inflatable rigid hull boat, which would be launched from the public boat launch in Village Des Joachims.

Sediment samples will be collected into laboratory supplied jars and submitted for analysis of ROCs, and select CCOCs including PCB and mercury.

Ottawa River sediment sampling will be conducted in accordance with Section 5.3 of the Characterization Plan the following Standard Operating Procedures:

- Appendix B – **SOP 4 – Headspace Screening**
- Appendix B – **SOP 6 – Soil Logging**
- Appendix B – **SOP 11 – Equipment Decontamination**
- Appendix B – **Sediment Quality Technical Procedure – Attachment 2**

2.8.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 8 – Ottawa River Sediment Sampling:

Task	Hazards	Hazard Mitigation
Task 8 – Ottawa River Sediment Sampling	Working on a water body	17
	Sample Collection	7, 11



2.8.2 Constraints and Limitations

The following constraints apply to Task 8:

- That work can be conducted Monday to Friday (i.e., that approval can be granted given the closeness to the winter season)
- That the river conditions and weather are safe for conducting sediment sampling

2.9 Task 9 - Licensed Land Area Subsurface Effluent Process Lines Investigation

Two effluent process lines identified in the historical site assessment and clarifications will be assessed for gamma and beta contamination.

This assessment will be performed by mounting a geiger muller handheld detector onto a remotely-controlled vehicle, which will drive inside the pipes with its position measurable by marked length of coaxial cable. The device is also equipped with a video camera, and will produce a visual inspection of the pipes while also visualizing the data displayed on the detector.

Additionally, two tile drain systems will be visually inspected using the same vehicle device, inserted into the drain from manhole locations within the licensed area. There will not be radiological inspection of these pipes. One of these pipes is understood to have an active flow rate of approximately 7 L/s.

A large-area swab sample will be used on accessible, defined surface areas near pipe inlets and manhole locations to perform analyses for alpha contamination and other radionuclides of concern.

The Effluent Process Line Investigation will be conducted according the following procedures:

- Appendix A – **SOP ISR – 07 - EFFLUENT PROCESS LINES**

2.9.1 Job Hazard Assessment and Mitigation

The following hazards apply to Task 9 – Licensed Land Area Subsurface Effluent Process Lines Investigation:

Task	Hazards	Hazard Mitigation
Task 9 – Licensed Land Area Subsurface Effluent Process Lines Investigation	Wildlife – biting insects, bears, moose	1, 3
	Noxious plants	2
	Equipment operation	11
	Working at heights	18
	Confined spaces (access to manholes)	19

2.9.2 Constraints and Limitations

The following constraints apply to Task 8:

- The a 0.13 metre diameter access hole is available for the sewer



- That no confined space entry is required

3.0 SAMPLE PROCEDURES, MANAGEMENT, DOCUMENTATION AND QA/QC

All field activities will be conducted in accordance with the following:

- Section 6.0 of the Characterization Plan;
- Section 7.0 of the Project Quality Plan
- MOECC Sampling Guidance (which is generally more stringent than the CCME Guidance Manual)
- The Environmental Site Assessment Sampling Plan (this document) and Golder's internal Standard Operating Procedures, as required by O. Reg. 153/04
- Daily bump checks (and documentation) of the photoionization detector (PID) are required. The PID shall be calibrated in accordance with the Project Quality Plan, Section 7.6
- As part of this project, ISR will certify Golder technicians to use the radiological scanning equipment. No scanning is to proceed without this training
- Hard copies (log book and/or field forms) will be used to store all field results, in accordance with Section 6.3 of the Characterization Plan. iPad tablet will be used as a checklist for completion of scope during the project, however the hard copies will be the official record

For ROC Samples, the following sampling protocol will be followed:

- Sampling equipment will be decontaminated between sampling locations following Appendix B - SOP 11
- Clean new disposable nitrile glove between each sample will be used
- Collection and submission of one blind soil duplicate for ROCs at a ratio of one duplicate per 20 samples
- GPS coordinates at each sample location will be collected
- Chain of Custody (COCs) Forms will be accurately and neatly filled out with all required information including sample number, matrix, date, time, sampler initials, project number, relinquishment date/time, receiving party name, and sample condition upon receipt at the laboratory. All COCs will be reviewed by a second staff member for accuracy prior to laboratory drop off or shipment. COC seals will be used on all coolers. The sample naming convention defined in the summary tables provided in Appendix F shall be followed
 - Core Samples:
 - Require 500 mL min of core sample (Based on core size of approximately 0.05 m, in diameter and 0.15 m in length (300 mL), 2 cores will meet the requirement)
 - 2 cores per sample placed in ziploc bags (both cores will be placed in the same bag if they fit; if not two bags per sample will be used)
 - Affix lab with required information (Sample ID, Location, Date, Analysis, Initials of sampler)



- Soil (0 to 0.15 mbgs) from Class 2 / 3 areas and BRA area
 - Fill 1 L HDPE jar with sample
 - Affix lab with required information (Sample ID, Location, Date, Analysis, Initials of sampler)
- Soil samples for ROC analysis will be immediately placed in a cooler, however do not require cooling

For CCOC Samples, the following sampling protocol will be followed:

- Sampling equipment will be decontaminated between sampling locations following Appendix B - SOP 11
- Clean new disposable nitrile glove between each sample will be used
- Collection and submission of one blind soil duplicate for CCOCs at a ratio of one duplicate per 10 samples
- Soil sample containers shall be filled in accordance with Table 2 (below) and Appendix F summary tables
- Groundwater sample containers shall be filled in accordance with Table 3 (below) and Appendix F summary tables
- GPS coordinates at each sample location will be collected
- Clean new disposable nitrile glove between each sample will be used
- Where PHC F1 samples will be submitted, samples will be collected using laboratory supplied pre-cut syringes or Terra-Core samples and field preserved in laboratory supplied pre-charged methanol vials, which is required by O.Reg 153/04
- Submission of one PHC F1 trip blank water sample, per cooler submitted for quality assurance and QA/QC purposes, which is required by O.Reg 153/04
- Soil and Groundwater samples for CCOC analysis will be immediately placed in a cooler with ice or ice packs. Sample for volatile analysis will have all jars/bottles filled with zero headspace to minimize loss of volatiles
- GPS coordinates at each sample location will be collected
- Chain of Custody (COCs) Forms will be accurately and neatly filled out with all required information including sample number, matrix, date, time, sampler initials, project number, relinquishment date/time, receiving party name, and sample condition upon receipt at the laboratory. All COCs will be reviewed by a second staff member for accuracy prior to laboratory drop off or shipment. COC seals will be used on all coolers. The sample naming convention defined in the summary tables provided in Appendix F shall be followed

Table 2: Ideal Soil Analysis Requirements

Analysis	Analysis Requirements (all containers supplied by Maxxam)
Core samples (Class 1 areas) and landfill waste samples	0.5 L minimum, minimum of 2, 50mm diameter cores
Soil (0 to 0.15 mbgs) from Class 2 / 3 areas and BRA area	Fill 1 L HDPE jar provided by Kinetrics
PHC F1/BTEX,	2 x methanol preserved vials



CNL NPD SAMPLING PLAN - REV 3

Analysis	Analysis Requirements (all containers supplied by Maxxam)
PHC F2-F4 & Moisture	1 x syringe or Terra Core 1 x 60mL soil jar (for Moisture and/or PHC F2-F4)
PAHs	120 mL clear glass, Teflon lined
PCBs	120 mL clear glass, Teflon lined
Mercury	250 ml clear glass, Teflon lined (Sediment Only)



Table 3: Ideal Groundwater Analysis Requirements

Analysis	Analysis Requirements	Laboratory supplying container(s)
Gamma, tritium, Cl-36	1L unpreserved	Kinetrics
Strontium-90 (Sr-90), Ni-63, Isotopic Pu, Tc-99)	1L preserved with HNO ₃	Kinetrics (pre-charged container)
Carbon 14 (C-14)	1 L preserved with NaOH	Kinetrics (pre-charged container)
PHC F1/BTEX,	3 x 40 ml clear glass vials preserved with sodium bisulphate	Maxxam
PHC F2-F4 & Moisture	2 x 250 ml amber glass bottles, unpreserved	Maxxam
PAHs	2 x 250 ml amber glass, preserved with sodium bisulphate	Maxxam
PCBs	2 x 500 ml amber glass unpreserved	Maxxam
Mercury	100 ml clear glass, hydrochloric acid	Maxxam

4.0 SAFETY PROGRAM

Golder's Health and Safety Plan, and Radiation Protection Plan is provided in Appendix C.

5.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Name	Role	Company
Paul Hurst	Project Manager	Golder
David Smyth	Project Director	Golder
Mathew Riopelle	Field Lead	Golder
Alex Wood	Field technician	Golder
Bret Timmis	Field technician	Golder
Chuck Albert	Field technician	Golder
James Doyle	Field technician	Golder
Alex Wolf	Project Manager	I.S.R.
Francois Lemay	Decommissioning Health Physicist	I.S.R.
Dustin Kelly	Field Technician	I.S.R.
Ahmad Abdulkarim	Field Technician	I.S.R.
Guanle Shi	Field Technician	I.S.R.
Ryan O'Sullivan	Field Technician	I.S.R.
Matthew Barnes	Field Technician	I.S.R.
Lee Williams	Field Technician	I.S.R.



6.0 SAMPLING EQUIPMENT

The following table summarizes equipment and replacement values for the field program, as well as standby rates if applicable. Rates below do not include Golder or ISR field staff or office time:

Equipment	Quantity	Replacement Cost (per item)
Ludlum Model 2221	6	\$ 4150 USD
Ludlum Model 44-10	6	\$ 1300 USD
Trimble Pro XH	7	\$ 2000 USD
Trimble Data Logger	7	\$ 1500 USD
Drain-All Sewer Crawler	1	\$ 70,000 CAD
Berthold LB166	1	\$35,000 CAD
ThermoFisher RadEye B20	1	\$1,500 CAD
ISR Equipment Standby Rate, includes 6 gamma probes coupled to GPS units and 3 alpha/beta/gamma units	Per week	\$9,712 per week
ISR Non-Staff Standby Rate, while alpha/beta floor monitor is on site (additional to ISR Equipment Standby Rate)	Per day	\$3,325 per day
ISR Non-Staff Standby Rate, while pipe analysis team is on site (additional to ISR Non Equipment Standby Rate), includes Drain-All time and Drain-All Equipment	Per day	\$3,795 per day
Trimble R1 GPS Unit	3	\$ 3,600 CAD
iPad Tablets & accessories	3	\$ 1,200 CAD
Field Shovel (spade)	3	\$ 35 CAD
Field Backpack	3	\$ 75 CAD
Coolers (Laboratory supplied)	10	\$ 50 CAD
Power motor boat (for sediment sampling)	1	\$22,000 CAD
Ponar	1	\$1,500 CAD Weekly standby rate: \$60



Equipment	Quantity	Replacement Cost (per item)
YSI 556 multi metre & flow through cell	2	\$4,100 CAD Weekly standby rate: \$187.50 Daily standby rate: \$57.50
Peristatic pump	1	\$1,900 CAD (unit only) Weekly standby rate: \$67.50 Daily standby rate: \$22.50
Water level tape	1	\$615 CAD (unit only) Weekly standby rate: \$56.25 Daily standby rate: \$18.75
Track mounted 9580-VTR PowerProbe	1	\$290,000 CAD Weekly Rate: \$4,200.00 per week Monthly Rate: \$17,000 per month
Remobilization cost to return and pick up the Track mounted 9580-VTR PowerProbe once CNL had it certified clean		\$4,060
MiniRAE 3000 Photoionization Detector (PID)	2	\$5,900 CAD Weekly standby rate: \$225 Daily standby rate: \$56.25

7.0 UPDATED SCHEDULE

The updated schedule is provided in Appendix D.

8.0 SUPPLEMENTAL INSTRUCTIONS

This section is intended to track supplemental instructions which may be issued to field staff from time to time.

Supplemental Instruction #1 – Photo Instructions

Photo collection within the Licensed Area or photos showing any part of the fence line shall be collected according to the following procedure:

- Photos (if required to document field work, samples, unique situations, etc), shall be collected using a digital camera and the memory card must be left with CNL nightly. At no time shall photos be collected using phones or tablets
- The photo number, location and caption should be recorded in a field log book

Photo collection outside of the licensed area which do not show the fence line shall be collected according to the following procedure:

- The ESRI collector app shall be used for each photo.
- The photo number, location and caption shall be stored in a field log book



9.0 TASK READINESS TABLE

This section provides a record of which task have been approved by CNL. Tasks which have not been approved shall not be completed until such time formal approval is given:

Table 4: Task Readiness Table

Task	Approved by CNL to Begin	Date	Comments
Task 1 – Radiological Surface Survey Scans - Gamma			
Task 2 – Soil Sampling (0 to 0.15mbgs)			
Task 3 – Landfill #1 (Soil and Subsurface Sampling)			
Task 4 – Subsurface Soil Sampling (Licensed Area and Surface Anomalies)			
Task 5 – Station and Licensed Area Groundwater Sampling Program			
Task 6 – Miscellaneous Station and Licensed Area Items and Equipment			
Task 7 – Judgemental Exclusion Zone Sediment Sampling			
Task 8 – Ottawa River Sediment Sampling			



CNL NPD SAMPLING PLAN - REV 3

Task	Approved by CNL to Begin	Date	Comments
Task 9 – Licensed Area Subsurface Effluent Process Lines Investigation			

Report Signature Page

GOLDER ASSOCIATES LTD.

Paul Hurst, P.Eng.
Project Manager

David Smyth, P.Geo.
Project Director

BT/PH/hw/md

https://golderassociates-my.sharepoint.com/personal/phurst_golder_com/documents/cnl/01 - sampling plan/1666131 cnl npd_environmental sampling plan_nov 2016_rev3.docx

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APPENDIX A

I.S.R Standard Operating Procedures

SOP ISR – 01 - DAILY QA / BACKGROUND CHECK

- Equipment: Ludlum 2221 Ratemeter/Scaler with Ludlum 44-10 NaI probe coupled to Trimble Pro GPS Unit and datalogger.
- Each morning, ISR technicians will enter designated area in BRA and collect a 5-minute scaler count at 1m height. This scaler count will be recorded in technician log books and used post-hoc to calculate background dose rate in the same units as walking dose rate data. Data sets will be referenced to specific devices such that variations in background counts across devices can be accounted for.
- At this point each day, a Cesium-137 check source will also be used to verify detector response. All radiological equipment used on site has been calibrated to be compliant with relevant regulations with documentation provided.

SOP ISR – 02 - CLASS 3 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT:

- Equipment: Ludlum 2221 Ratemeter/Scaler with open electronic window and Ludlum 44-10 NaI probe coupled to Trimble Pro GPS Unit and data logger as per the requirements stated in section 5.2.1 of the statement of work.
- ISR technicians will walk from one sampling point to the next at approximately 0.5m/s with NaI gamma detector held at approximately 1m height. Data will be collected every second by data logger coupled to GPS.
- At each sampling predetermined point, ISR technicians will conduct a 1 minute scaler count with lowest probe surface between 2-3cm from location as identified by GPS and record reading in Golder tablet device.
- Golder technician will then collect soil sample and dig to 15cm depth.
- ISR technician will then repeat 1-minute scaler count with lowest probe surface between 2-3cm from bottom of 15cm hole and record reading in Golder tablet device.
- **Note:** Where sampling points are found to be located at an inaccessible location such as wetlands or on a tree, technicians will select the nearest suitable location instead. These new coordinates will be recorded and used to update the parameters in data files prior to analysis.

This process will be used for all sampling points in Class 3 and BRA areas.

- Objects such as fences, fence posts, shielding blocks, draining piping, laydown areas staged with materials removed from historic uncontrolled dumping sites, and miscellaneous other materials may be encountered during this Phase 1 process. These objects will be surveyed for count rate averaged over 10 seconds at a distance of 1m. The GPS coordinates for all such objects and their description will be recorded in technician log books along with average dose rate at 1m if it exceeds background levels. Large items such as fences will be scanned and documented in judgmental increments (i.e. one measurement per fence section). Areas with elevated readings will be subject to follow-up alpha plus beta scanning using a Thermo-Fisher Scientific RadEye B20.

SOP ISR – 03 - CLASS 2 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT:

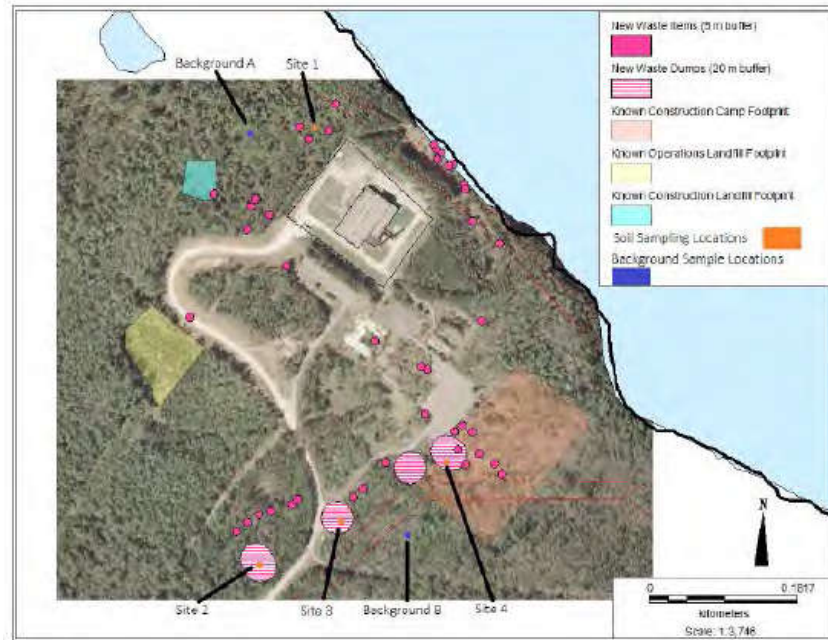
- Equipment: Ludlum 2221 Ratemeter/Scaler with open electronic window and Ludlum 44-10 NaI probe coupled to Trimble Pro GPS Unit and data logger as per the requirements stated in section 5.2.1 of the statement of work.
- At each predetermined sampling point, conduct a 1 minute scaler count with lowest probe surface between 2-3cm from location as identified by GPS. Reading will be recorded in data logger. Sampling points on asphalt will be reviewed collaboratively by CNL and Golder during a site visit prior to surface counts to assess whether they will be moved.
- After sampling point counts have been completed, technicians will walk the complete class 2 unit land areas by following GPS waypoints established in an approximate grid formation such that a path is generated with 4m between rows. This allows for an overall 25% coverage of the land in these areas.
- Areas within these sections which are both a) unlikely to be impacted; and b) difficult to access (such as wetlands or steep grades) will be replaced with further coverage of more suitable areas. Data will be collected every second by data logger coupled to GPS.
- Areas within these sections which include surfaces with a high probability of being impacted, such as roads, building pads, and laydown areas will not be scanned this manner as they will receive a higher density coverage as described in PHASE 4.
- Objects such as fences and fence posts and miscellaneous other materials may be encountered during this Phase 1 process. These objects will be surveyed for dose rate averaged over 10 seconds at a distance of 1m. The GPS coordinates for all such objects and their description will be recorded in technician log books along with average dose rate at 1m if it exceeds background levels. Large items such as fences will be scanned and documented in judgmental increments (i.e. one measurement per fence section). Areas with elevated readings will be subject to follow-up alpha plus beta scanning using a Thermo-Fisher Scientific RadEye B20.

SOP ISR – 04 – CLASS 1 UNITS SURFACE GAMMA SCAN AND SAMPLING POINT COUNT:

- Equipment: Ludlum 2221 Ratemeter/Scaler with open electronic window and Ludlum 44-10 NaI probe coupled to Trimble Pro GPS Unit and data logger as per the requirements stated in section 5.2.1 of the statement of work.
- ISR technicians will walk the complete class 1 unit land areas by following GPS waypoints established in a grid formation such that a path is generated with 1m between rows. This allows for an overall 100% coverage of the land in these areas. Areas which are obstructed by objects such as shipping containers and building structures will not be scanned in this manner.

SOP ISR – 05 - ADDITIONAL ITEMS/LOCATIONS SUBJECT TO 100% COVERAGE SCANNING:

- Equipment: Ludlum 2221 Ratemeter/Scaler open electronic window and Ludlum 44-10 NaI probe coupled to Trimble Pro GPS Unit and data logger as per the requirements stated in section 5.2.1 of the statement of work. In addition to class 1 units, ISR technicians will also perform 100% high-density gamma scanning on the following objects and locations:
 - o Paved roads
 - o Natural or engineered drainage pathways
 - o Historical uncontrolled dumping sites
 - o Building footprints
 - o Laydown areas



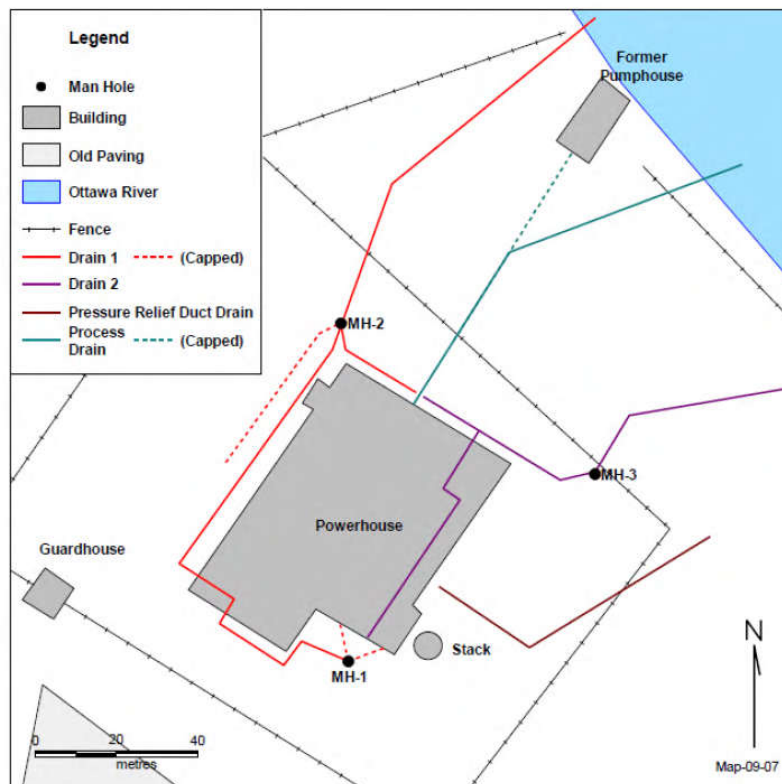
SOP ISR – 06 - ALPHA/BETA SCANS OF DEMOLISHED BUILDING PADS:

- Equipment: Berthold LB166 large-area gas proportional detector coupled to Trimble Pro GPS Unit and data logger as per the requirements stated in section 5.2.1 of the statement of work
- ISR technicians will perform a 100% coverage scan of all suitable surfaces of the identified demolished building pads located on site. These include the former training centre, north and south warehouse, and construction camp area to the South-East of the licensed area, and the emergency vehicle garage and large unspecified building within the licensed area.
- Alpha/beta readings observed above background will be recorded and mapped against the corresponding GPS coordinate.



SOP ISR – 07 - EFFLUENT PROCESS LINES

- Equipment: Thermo-Scientific RadEye B20 multi-purpose survey meter, mounted in front of camera on custom sewage inspection unit. This device records its location by knowledge of the cable length used to reach its location, and this value is reported live on-screen in the video recording. This position information will be used to map radiological readings within the pipes to their accurate location. The device does not require an external power source.
- ISR Technicians will insert the inspection unit first into the two process drains by accessing the powerhouse. The inspection unit will be slowly driven down the process drain with video recording location in pipe and combined gamma plus beta doserate display on survey meter.
- ISR Technicians will next insert the inspection unit into Tile Drain 2 by accessing the MH-3 manhole. The device will be lowered 23ft into the tile drain and driven to inspect accessible sections of Tile Drain 2 North of the powerhouse only. Only video will be captured in this tile drain.
- ISR technicians will next insert the inspection unit into Tile Drain 1 by accessing the MH-1 manhole. The device will be lowered 16ft into the tile drain and driven to inspect accessible sections of the tile train in this location. Only video will be captured in this tile drain.
- Finally, ISR technicians will insert the inspection unit into Tile Drain 1 by accessing the MH-2 manhole. The device will be lowered 22ft into the tile drain and driven to inspect accessible sections of the tile drain in this location. Only video will be capture in this tile drain. This tile drain has an estimated flow rate of 7L/min.





APPENDIX B

Golder Standard Operating Procedures



PURPOSE

Water levels are measured to determine the depth of the water table below ground surface or the pressure head in a confined aquifer. This information can be used to estimate hydraulic gradients, groundwater flow direction, and changes in flow conditions over time. Free product levels are measured to aid in estimating free product quantities present at the site and because they influence groundwater levels.

LIMITATIONS

This Standard Operating Procedure (SOP) is applicable to all groundwater monitoring wells, including those installed primarily for groundwater sampling. Water levels must be measured at least 24 hours after monitoring well development (O. Reg. 153/04); however, in low-permeability geologic environments it may take substantially longer than 24 hours to obtain a static water level measurement. In high hydraulic conductivity geologic materials (e.g., sands and gravels) a static water level measurement may be feasible almost immediately following well installation.

In fractured rock, purging and sampling can cause significant drawdown in adjacent or nearby monitoring wells. Therefore, in fractured rock geologic settings, consideration should be given to measuring water levels in all monitoring wells prior to purging or sampling.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Water level measurement requires a water level probe or an oil-water interface probe with a graduated tape marked in millimetres.

FIELD PROCEDURE

To measure groundwater and/or free product levels:

- 1) Open the monitoring well.
- 2) Establish or locate the reference point from which measurements will be taken (e.g., notch cut into the top of the monitoring well standpipe).
- 3) Take measurements using one of the following methods:
 - **Method 1.** Measure depth to water using a clean electric water-level probe:
 - a. Lower the probe into the monitoring well until you hear a steady tone.
 - b. When the expected depth to water is reached, measure the depth to water to the nearest 0.003 m (3 mm).



STANDARD OPERATING PROCEDURE NO. 2: WATER LEVEL MEASUREMENT

- c. Take a second confirmatory reading and check that is within 0.003 m (3 mm) of the first reading. If not, take additional reading(s) until you are satisfied that the static depth to water has been found.

Note: Repeatability of the measurement ensures an accurate water-level record and that the probe is not up against a wet wall, etc.

- d. Record the water levels on the form titled Static Water Level Measurement.
- e. Calculate the groundwater elevation by subtracting the measured depth to water from the elevation of the reference point (e.g., notch cut into the top of the pipe).
- f. Remove the probe from the monitoring well and decontaminate it in accordance with Golder SOP No. 11 (Equipment Decontamination).

■ **Method 2.** Measure water and free product levels using a clean oil-water interface probe:

- a. Lower the probe into the monitoring well.

Note: A steady tone will be emitted when the probe is fully immersed in the free product.

- b. Slowly raise the probe until the sound stops, and then lower the probe until sound is just heard again to define the air-product interface.
- c. Repeat and ensure that both readings are within 0.003 m (3 mm). If not, take additional measurements until two consecutive readings are within 0.003 m (3 mm) of each other.
- d. Read the tape marking and record the depth to free product on the Static Water Level Measurement form.
- e. Slowly lower the probe through the free product.

Note: An intermittent tone will be emitted when the probe reaches the base of the floating free product (oil-water interface).

- f. Repeat and ensure that both readings are within 0.003 m (3 mm). If not, take additional measurements until two consecutive readings are within 0.003 m (3 mm) of each other.
- g. Calculate the free product elevation by subtracting the measured depth to free product from the elevation of the reference point (notch cut into the top of the pipe).
- h. Calculate the free product thickness by subtracting the measured depth to base of product from the measured depth to the air-product interface and record the free-product thickness. At the discretion of the Qualified Person, verify free product thickness using second measurement technique (e.g., bailer).
- i. Remove the probe from the monitoring well and decontaminate the probe and tape in accordance with Golder SOP No. 11 (Equipment Decontamination).



REQUIRED DOCUMENTATION

The static water level measurement and/or free-product level measurement(s) will be recorded on a field form (see form titled Static Water Level Measurement, Appendix C) at the time of the measurements.

REFERENCES

Golder Associates Ltd. Procedure No. 24: Water-Level Monitoring in Wells

Golder Associates Ltd. Procedure No. 23: Installation of Groundwater Monitoring Wells (In Overburden)

ASTM D 4750-87 (Reapproved 2001). Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well).

Ontario Regulation 153/04 (Records of Site Condition) (as amended) under the Environmental Protection Act (Ontario).

DOCUMENT CONTROL

Author: Basil Sullivan

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Edit 2 Editor : Dave Smyth Edit Date: January 9, 2014

SOP2-Water Level Measurements.docx



PURPOSE

Boreholes are generally drilled when information on soil quality is required for depths greater than about 4 or 5 metres (i.e., depths greater than those easily accessible by a backhoe or excavator), and/or where information on bedrock quality is needed. A borehole may also be drilled for the purpose of installing a groundwater monitoring well. Advantages of drilling over test pitting include minimal disruption of the ground surface (e.g., paving or concrete) and subsurface soils and the ability to penetrate and sample (core) bedrock. Disadvantages include potentially greater inaccuracies when interpolating soil conditions between testing locations due to the one-dimensional perspective, potentially poor soil sample recovery (particularly in very coarse soils), and cost.

LIMITATIONS

This Standard Operating Procedure (SOP) is applicable to the drilling and sampling of all boreholes in overburden and/or in bedrock. Portions of this SOP (concerning sample collection) may not be applicable or required in situations where a borehole is being drilled solely to facilitate monitoring well installation in an area where the subsurface geologic conditions are already well known. Portions of this SOP (concerning sample collection methods) may also not be applicable where the borehole is being drilled for purely geotechnical purposes and where the presence of environmental contamination is not suspected.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Boreholes may be drilled using a wide variety of drilling rigs, including sonic, hollow or solid stem auger, direct push (e.g. Geoprobe), air or mud rotary, Becker Hammer, or cable tool. Depending on the drill rig used, soil samples may be collected using a split spoon sampler or a continuous corer, or they may be carried to the surface using air or drilling mud. Each of these techniques has its distinct advantages and disadvantages and ideal situations for application. The selection of the drilling method will depend on project objectives, expected subsurface conditions, project-specific constraints such as access limitations, contractor availability, schedule, and cost.

FIELD PROCEDURE

- 1) Prior to starting field activities, review reasonably available documentation pertinent to the proposed borehole investigation. Such documentation should generally include:
 - Project Health & Safety Plan;
 - The Conceptual Site Model, where one exists;
 - Site plan and plan showing proposed borehole locations;
 - Project-specific sampling and analysis plan;



STANDARD OPERATING PROCEDURE NO. 3: BOREHOLE DRILLING

- Information regarding local subsurface conditions (geology, hydrogeology, and (where applicable) contaminant presence), such as regional mapping or specific project data previously obtained from the work site or from other local projects; and
 - Existing information regarding the presence of subsurface or overhead utilities or other structures.
- 2) Mark out borehole locations at the work site.
 - 3) Identify logistical issues with proposed locations, e.g. access restrictions, overhead clearance issues, workspace control requirements (e.g. traffic control), etc. Modify proposed borehole locations if necessary.
 - 4) Ensure utility clearances are up to date and/or arrange for new clearances if necessary.

Note: Public utility clearances are required. The use of private utility locators is recommended where appropriate.
 - 5) Modify borehole locations if necessary based on utility clearances.
 - 6) Conduct a tailgate meeting with drilling contractor as required by Golder Health & Safety protocols.

Note: This should include review of utility clearances, as well as verification that down-hole drilling equipment is clean (decontaminated).
 - 7) Where information regarding degree and location of subsurface contamination is available, and where doing so is practical subject to other logistical considerations, stage the investigation such that areas of least contamination are drilled first, and areas of heaviest contamination are drilled last.
 - 8) Prepare each drilling location. This may include, as appropriate:
 - Restricting public access to work area and/or providing a safe work area for workers (e.g., providing traffic control);
 - Mitigating potential contamination of ground surface during drilling (e.g., using a plastic and/or plywood sheet to receive drill cuttings);
 - Setting up monitoring equipment for health and safety and/or environmental management purposes;
 - Removing asphalt or concrete surface pavements.
 - 9) Start drilling the borehole. As the borehole is advanced, collect representative soil and/or rock samples using soil sampling equipment appropriate to the type of drilling rig (e.g., split spoon sampler, dual-tube sampler, core barrel, or other).
 - 10) Examine samples in the field for stratigraphic information and evidence of contamination.
 - 11) Collect sub-samples from retrieved soil and/or rock samples for possible further characterization. Conduct all sampling and sub-sampling as determined in the sampling and analysis plan, subject to any practical



STANDARD OPERATING PROCEDURE NO. 3: BOREHOLE DRILLING

limitations encountered (e.g., limited soil recovery in sampling device) or modifications made in the field based on observed conditions:

- As a general guide, collect soil samples at least every 1.5 m in depth. In general, use smaller vertical sampling intervals where conditions are highly variable, where the presence and/or depth of contamination is unknown, or where specific zones of limited thickness are to be targeted.
- In bedrock, collect continuous samples (cores) unless directed otherwise.

Field screening of soil samples should be conducted in accordance with Golder SOP No. 4 (Soil Headspace Vapour Screening) and SOP No. 6 (Soil Logging). If evidence of contamination is observed, it is advisable to notify the Qualified Person.

- 12) Decontaminate non-dedicated sampling equipment between uses in accordance with Golder SOP No. 11 (Equipment Decontamination).
- 13) Upon completion of the borehole, do one or more of the following:
 - Install a monitoring well, if called for in the sampling and analysis plan. Refer to Golder SOP No. 1 (Monitoring Well Installation).
 - If the borehole is not considered a “well” under the provisions of O. Reg. 903, and if no evidence of contamination was identified during drilling, backfill the borehole with the auger or drill cuttings. Replace cuttings generated from the bottom of the borehole in first, followed by soils from subsequently higher zones.
 - If the borehole could be considered a “well” under the provisions of O. Reg. 903 and/or if evidence of contamination was identified during drilling, backfill the borehole with bentonite (e.g., Holeplug) and/or grout.
 - Reinststate surface pavements or other ground treatments where appropriate.

- 14) For each subsequent borehole, ensure that clean down-hole drilling equipment is used.
- 15) Prepare a field sketch documenting actual, final borehole locations, with measurements referenced to fixed local landmarks or through the use of GPS coordinates, as appropriate.

Note: The required level of accuracy for such measurements will depend upon the specific investigation objectives.

- 16) Where required based upon investigation objectives, measure the elevation of ground surface at each borehole location, referenced to a fixed local benchmark or to a geodetic benchmark, as appropriate.

Note: The required level of accuracy for elevations will depend upon the specific investigation objectives.



REQUIRED DOCUMENTATION

Details regarding drilling methodology, subsurface conditions observed during drilling, soil/rock sample intervals, and other pertinent observations as appropriate shall be recorded on a field borehole log or field corehole log, as appropriate (see field forms titled Record of Borehole and Record of Corehole, Appendix C) at the time of drilling.

The field log must include the following:

- file identification;
- site identification;
- date and time;
- a unique (per site) borehole/corehole number;
- information regarding drilling method;
- information regarding subsurface conditions encountered; and
- information regarding samples collected

REFERENCES

Ontario Regulation 903 (Wells Regulation) under the Ontario Water Resources Act.

DOCUMENT CONTROL

Author: Ryan Smith

Edit 1 Editor: Margaret Shaw Edit Date: November 3, 2010

Edit 2 Editor: Dave Smyth Edit Date: January 9, 2014

SOP3- BH Drilling and Sampling.doc



PURPOSE

Soil headspace vapour screening (headspace screening) measures relative concentrations of volatile organic compounds in the headspaces of soil sample containers as an indicator of volatile contaminants in the soil sample. Headspace screening is carried out on any environmental project where soil samples are collected. After the headspace screening is done, the relative concentrations are evaluated for indications of possible impacts and to provide guidance on which soil samples are to be submitted to an analytical laboratory.

LIMITATIONS

It is important to note that the headspace concentrations measured are relative rather than absolute. The actual concentrations of volatile compounds in soil are determined through laboratory testing. Also, the headspace measurement does not identify the compound(s) that may be in the soil but represents an aggregate of all volatile compounds.

Note that some combustible gas detectors can operate in a “methane elimination” mode that substantially excludes methane from the measurement; however in some instances naturally occurring methane can interfere with the headspace reading caused by the presence of volatile contaminants.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Soil headspace vapour can be measured using different instruments depending on the nature of the suspected contamination. If petroleum hydrocarbons are suspected, a combustible gas detector can be used. If volatile organic compounds are suspected, a photoionization detector can be used. Other instruments can also be considered, and the instrument used should be selected taking into account the best available information about site history and uses. Field instruments must be calibrated in accordance with the requirements of the Quality Assurance Program and Golder SOP No. 12 (Measurement of Field Parameters).

FIELD PROCEDURE

To screen soil headspace for volatile compounds:

- 1) Collect the soil sample and place it in a secure container so as to minimize losses of volatile components during headspace screening.
- 2) Immediately place the soil sample in a plastic bag (0.5 L to 1 L), filling the bag about one-quarter full.
- 3) Seal the bag tightly leaving a minimal headspace.
- 4) While the sample is secure in the bag, knead any lumps of soil by hand within the closed bag to break them up.
- 5) Allow the soil sample to equilibrate for a minimum of 15 minutes and until it reaches a minimum temperature of 10°C, but complete all headspace measurements within two hours of sample collection.



STANDARD OPERATING PROCEDURE NO. 4: SOIL HEADSPACE VAPOUR SCREENING

- 6) To measure the headspace vapours, insert the instrument probe(s) into the headspace above the soil sample, taking care to minimize potential vapour loss.
- 7) Agitate/manipulate the sample by hand as the measurement is taken.
- 8) Record on the field form or log the peak reading registered by the instrument during the first 15 seconds of measurement.

REQUIRED DOCUMENTATION

Soil headspace readings should be recorded on the field form or log on which the soil sample is otherwise described, so that each headspace reading is clearly identified with the sample to which the results apply. There must be a notation on the field form or log that identifies the type of instrument used. Units of measurement must also appear with the reading. Include documentation of calibration and calibration checks in the field file.

REFERENCES

MOEE Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario, dated May 1996. Version 1

DOCUMENT CONTROL

Author: Keith Salt

Edit 1 Editor: Margaret Shaw Edit Date: November 5, 2010

Edit 2 Editor: Dave Smyth Edit Date: January 9, 2014

SOP4-Headspace Screening.docx



PURPOSE

Monitoring wells are developed to remove fine particles from the filter pack and to remove any fluids introduced to the monitoring well during drilling. Proper monitoring well development ensures that samples collected are representative of surrounding aquifer conditions and reduces the amount of sediment produced during sample collection.

LIMITATIONS

This Standard Operating Procedure (SOP) generally applies to all groundwater monitoring wells except those installed for the sole purpose of water level measurement. However, if free product is present in the monitoring well, well development should consider the potential for smearing free product in the filter pack and the surrounding formation.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Monitoring well development requires a pump and a water level meter. In addition, the Qualified Person may determine that the measurement of water quality parameters (e.g., turbidity, pH, specific conductivity) is necessary and a water quality meter is required (e.g., turbidity meter, pH meter, specific conductivity meter).

The pump selected will vary depending upon the depth of the monitoring well and the transmissivity of the formation. Inertial pumps equipped with a surge block are widely applicable. However, other pumping methods may be preferred, or may be required for deep and/or high-yield monitoring wells (e.g., air-lift pumping using either compressed air or nitrogen). The selection of the pumping method is the responsibility of the Qualified Person.

FIELD PROCEDURE

To develop a monitoring well:

- 1) Measure the initial depth to water.
- 2) Use the measured depth to water and the monitoring well completion details to determine the monitoring well volume (i.e., the standing volume of groundwater inside the monitoring well screen and pipe).

Note: monitoring well volume = $\pi r^2 h$

Set the pump intake at the top of the monitoring well screen. Direct the pump discharge to a container for volume measurement.

- 3) Start pumping at the maximum rate possible without exceeding the monitoring well yield.
- 4) Progressively lower the pump intake down the monitoring well screen. Complete at least two minutes of pumping for each 0.3 m of monitoring well screen.



STANDARD OPERATING PROCEDURE NO. 5: MONITORING WELL DEVELOPMENT

- 5) Where possible, lower the pump to the bottom of the monitoring well to remove any accumulated fine-grained materials.
- 6) Pump at least three well volumes from the monitoring well and continue pumping until one of the following three conditions is met:
 - a. Ten well volumes have been removed;
 - b. The field water quality of the produced groundwater stabilizes (e.g., the measured turbidity is within ± 10 percent for three successive measurements); or
 - c. For low-yield monitoring wells (i.e., monitoring wells with a maximum yield that is less than 0.5 L/min and that go dry during development), purge at least one monitoring well volume.
- 7) Contain produced groundwater appropriately and characterize it for disposal in accordance with the requirements of the Quality Assurance Program.

REQUIRED DOCUMENTATION

Monitoring well development and the rationale for its conclusion (e.g., ten well volumes purged, field water quality stabilized, or low-yield monitoring well) will be recorded on the field form titled Monitoring Well Development (Appendix C) at the time of well development (O. Reg. 153/04).

REFERENCES

Ontario Regulation 153/04 (Records of Site Condition) (as amended) under the Environmental Protection Act (Ontario).

DOCUMENT CONTROL

Author	Eric Hood	
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SOP5-Monitoring Well Development.docx



PURPOSE

Soil logging is conducted while drilling boreholes or excavating test pits whenever information on subsurface conditions is required or when soil samples are to be collected. Soil logging assists in developing a good understanding of the soil, groundwater, and environmental conditions at a site.

LIMITATIONS

This Standard Operating Procedure (SOP) is applicable to the collection of all soil samples. However, site-specific environmental factors and health and safety protocols may preclude the collection of some information.

EQUIPMENT AND MATERIAL SPECIFICATIONS

The sub-contractor may supply various specific soil sampling equipment (e.g., split spoon sampler, liners, augers, etc.).

Any or all of the following equipment may also be required:

- Field screening instruments to test for specific requirements (e.g., headspace screening, in situ density, etc.);
- Measuring tape;
- Sampling tools (e.g., putty knife, trowel, shovel, dredge samplers, or other specific sampling tools);
- Sampling containers (e.g., plastic bags, glass or plastic jars, or other specific sampling containers);
- Labels, markers, pens, and/or pencils for labelling the sample containers; and
- Camera to document the site and/or soil conditions.

Equipment and materials required for standard decontamination procedures of all sampling tools will also be required at sites with known or potential contamination.

FIELD PROCEDURE

When logging soil and/or collecting soil samples, record the following types of information on the standardized, task-specific log appropriate to the job (e.g., borehole log or test pit log).

Record information needed to identify the job, site, and sample location:

- Project number and site identification (e.g., street address, name of site, etc.);
- Date, time and weather conditions;
- Name of person conducting soil logging/ sampling;



STANDARD OPERATING PROCEDURE NO. 6: SOIL LOGGING

- Name of contractor (if used), including type and size of equipment and methodology (e.g., type of drill rig and type and size of sampling equipment, trowel or shovel);
- Sample identification number;
- Location of sample (i.e., the horizontal distance of the testing location from a fixed feature on the site, or relative to a sampling grid, or a cell number, or GPS coordinates, etc.); and
- Measured depth of the sample below ground surface, including the top and bottom of the sample interval.

Record the characteristics of the geologic material encountered or sampled:

- Describe the consistency or compactness, moisture content, colour, grain size, indicators of contamination, and structure (optional). Refer to Golder SOP No. 14 for guidance;
- Record each stratigraphic unit and each zone of inferred contamination;
- Note the characteristics, depth, thickness, and extent of any staining, odours and/or debris. Note that the odour of soil samples should only be recorded if incidentally noticed during the course of typical soil logging activities. Field personnel shall not deliberately smell field samples.
- Describe any evidence of free phase product/sheen.
- Identify any naturally occurring organic matter (e.g., topsoil, peat).
- Identify fill materials.
- Note the type of bedrock (e.g., shale, limestone, etc.) if bedrock is encountered or inferred.

Record the following information related to field measurements and samples:

- Soil vapour headspace screening results if completed (see Golder SOP No. 4);
- Soil moisture content (e.g., dry, damp, wet);
- Wetness on the sampling device, groundwater seepage or accumulation in a borehole or test pit, or any zone of sloughing/collapse in a trench or test pit;
- Recovery of samples (if using split spoon, coring, etc.) as a proportion of the maximum possible (e.g., 22/24 inches);
- Sampling progress and/or difficulties (e.g., drilling refusal, collapsing test pit, etc.)
- Samples submitted for analysis and chemical parameters to be analyzed; and
- Factors that may affect the sample's chemical integrity.



REQUIRED DOCUMENTATION

Soil logging requires that a field record be documented on a standardized task-specific log (e.g., borehole log, test pit log), that can be incorporated into the field file. Refer to Appendix C for standardized field forms.

DOCUMENT CONTROL

Author: Tim Mullings

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SOP6-Soil Logging.docx



PURPOSE

Groundwater samples are collected to provide information about the chemical composition of the groundwater. Prior to collecting groundwater samples, monitoring wells are purged to remove stagnant water in the monitoring well so that representative groundwater samples may be obtained. Low-flow purging is used to minimize the generation of purge water and to facilitate the continuous field measurement of water quality parameters such as dissolved oxygen and redox potential, in addition to temperature, pH, and specific conductivity.

LIMITATIONS

This Standard Operating Procedure (SOP) applies to most groundwater monitoring wells except those containing free product (i.e., either LNAPL or DNAPL) and low-yield monitoring wells. This SOP applies to collection of groundwater samples for a wide range of analytes. Groundwater sample collection must take place at least 24 hours after monitoring-well development (refer to Golder SOP No. 5). However, in high permeability geologic materials, Qualified Persons should consider using professional judgement in adhering to this specific regulatory requirement.

This SOP does not apply to low-yield monitoring wells that cannot sustain a stable water level during purging and sample collection. Below are some limiting factors that could affect the use of low-flow purging and sampling:

- Low-flow purging and sampling are best suited to monitoring wells completed in permeable formations (hydraulic conductivity greater than 10^{-5} m/s). Low-flow sampling should not be used in low-yield monitoring wells where drawdown cannot be maintained at a constant level (<0.3 m below static water level) at a pumping rate between 0.1 and 1 litres per minute (L/min).
- The depth to water can be a limiting factor when using a peristaltic pump. This type of pump is not capable of lifting water from depths greater than about 9 m, due to gravity effects. Also, the greater the depth to water, the more degassing (including loss of volatile organic compounds (VOCs)) can occur as a result of the greater vacuum required to lift the water. Degassing will result in bubbles being visible in the tubing; minimal bubbles are acceptable. Ideally, a peristaltic pump should not be used to sample for dissolved gases (such as VOCs or methane) where the water table is more than 3 m below ground surface. In this case, a bladder pump or centrifugal pump should be used instead.
- During cold winter conditions, water can freeze in the tubing above ground, making it difficult to purge the monitoring well. A heating mechanism at surface may be required to ensure that water does not freeze in the above-ground section of the tubing.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Low-flow monitoring-well purging and groundwater sampling requires the following equipment:

- Pump (bladder, centrifugal or peristaltic) and tubing;



STANDARD OPERATING PROCEDURE NO. 10: LOW-FLOW GROUNDWATER SAMPLE COLLECTION

Notes: Inertial pumps are not as well suited to low-flow purging and sampling as the other pump types since it is difficult to maintain a constant purging rate and may cause too much disturbance. The pump selected (e.g., bladder, centrifugal, or peristaltic) will vary depending upon the depth of the monitoring well and the transmissivity of the formation. For a peristaltic pump, silicone or Pharmed tubing should only be used in the drive head, while high density polyethylene (HDPE) tubing or similar material should be used for sample collection. Low-flow purging using a grab sampler (e.g., a bailer) is not possible.

- Electric water-level probe;
- Graduated container (e.g., a bucket) for measuring volume of water removed;
- Water quality meter(s) (as a minimum, temperature, pH, and specific conductivity; possibly also dissolved oxygen, redox potential (Eh), and turbidity);

Note: Water quality meters capable of simultaneously measuring multiple water quality parameters, such as Horiba U-22 or YSI 556, and the use of manufactured flow-through cells are recommended;

- 250-mL plastic beaker or a flow-through cell (preferred) for measurement of field indicator parameters; and
- Detailed descriptions of the equipment and material required for most common purging and sampling methods are provided in ASTM 6634-01.

FIELD PROCEDURE

- 1) Measure and record the depth to water. (O. Reg. 153/04).

Note: The monitoring well must be properly developed at least one day prior to groundwater sample collection. Refer to Golder SOP No. 5 (Monitoring Well Development).

- 2) Calculate the volume of the pump tubing and flow-through cell.
- 3) Set up pump apparatus at monitoring well. If a fuel-powered generator is used, set up generator downwind of monitoring well.
- 4) Carefully set the pump intake in the monitoring well screen, at whichever of the following is lower:
 - The midpoint of the monitoring well screen;
 - The midpoint of the water column;

Notes: Avoid stirring up any accumulated sediment at the base of the monitoring well. An intake that is too low could disturb sediment in the monitoring well, biasing results for analytes that preferentially accumulate in the sediment (e.g., petroleum hydrocarbon compounds (PHCs), semi-volatile organics, VOCs or metals). The intake depth should be consistent between sampling events for each monitoring well.

- 5) Secure the pump intake at the required depth.



STANDARD OPERATING PROCEDURE NO. 10: LOW-FLOW GROUNDWATER SAMPLE COLLECTION

- 6) Attach the pump discharge to the flow-through cell and the calibrated field probe(s) to the water quality meter.
- 7) Re-measure and record the depth to water.
- 8) Starting with the pump in a zero-flow control position, slowly increase the flow to a rate that is between about 0.1 and 1 L/min.
- 9) Notes: Measure the flow rate using a graduated container (i.e. graduate cylinder or bucket). Flow rates as high as 1.0 L/min can be used, provided the resulting drawdown is minimal (i.e., less than 0.3 m). To minimize the volume of purge water generated and avoid excessive drawdown, the lowest flow rate achievable is generally desirable. Water quality parameter stabilization will often occur more rapidly if the purging rate is very uniform. Visually assess sample turbidity and reduce flow rate, if necessary, to minimize turbidity,
- 10) Purge at least one volume of water estimated to be contained within the pump tubing and flow-through cell (for ½ inch inner diameter tubing, this equates to ~0.1 L of water per metre of tubing).
- 11) Measure and record water level. The goal is to create a stable drawdown that is less than 0.3 m during purging. Achieving a stable drawdown may be difficult to achieve under some circumstances, and may require adjustment based on site-specific conditions and personal experience. If drawdown is greater than 0.3 m, reduce pumping rate.
- 12) If drawdown constantly increases, standing water is being purged from the monitoring well. Standing water is not representative of aquifer conditions. As an alternative, consider the use of the procedure described in Golder SOP No. 9 (Conventional Groundwater Sample Collection).
- 13) After the first volume of water in the tubing and flow-through cell has been purged, start measuring and recording field parameters every three to five minutes until the water quality parameters have stabilized, as defined below (USEPA, 1996), over three successive measurement intervals.
 - Temperature: ± 0.5 °C;
 - pH: ± 0.1 units;
 - Specific conductivity: ± 3 percent of reading;
 - Dissolved oxygen (if required): ± 1 milligrams per litre (mg/L); and
 - Redox potential (if required): ± 10 mV

Note: Minimize movement of equipment in the monitoring well and fluctuation in purging rate to minimize disturbance of water column. Dissolved oxygen and redox potential commonly take the longest to stabilize. The most reliable indicators of stabilization are conductivity and dissolved oxygen. If stabilization does not occur, the Field Team Leader should contact the Qualified Person. As an alternative to the stabilization of field parameters, the Qualified Person may determine that purging should be terminated after a specified time limit (e.g., 30 minutes).

- 14) Record visual observations during purging.



STANDARD OPERATING PROCEDURE NO. 10: LOW-FLOW GROUNDWATER SAMPLE COLLECTION

- 15) Perform field measurements of water quality parameters (including, at minimum, temperature, pH, and specific conductivity) as specified in Golder SOP No. 12.
- 16) Minimizing any unnecessary agitation of the groundwater, collect the groundwater samples specified in the Sampling and Analysis Plan (not necessarily the entire list shown here) into pre-cleaned, preserved sample containers in the following order:
 - a. Unfiltered analytes, including VOCs, fixed hydrocarbon gases, PHCs, semi-volatiles and other organic contaminants, total organic carbon, and anions; and
 - b. Field-filtered analytes, including dissolved metals, mercury, dissolved organic carbon, and alkalinity.

Note: Samples should be collected in progression beginning with the least contaminated well and ending with the most contaminated well (if known). For wells where multiple analytes are required, volatile and oxygen-sensitive (e.g., ferrous iron, methane, sulphide) analytes are generally collected first. The sequence in which inorganic analytes are collected is not important, unless field filtration is required (unfiltered analytes collected first, then filtered analytes). Where possible, at least 250 mL water should be processed through the filter prior to sample collection. The details of sample collection and handling requirements are summarized in Table 2 of the Quality Assurance Program.

Note: Groundwater samples collected for PHC, semi-volatile, VOC or metals analysis should not include visible particulates. Visible particulates can exert a significant positive bias on the reported sample concentrations of these analytes. If visible particulates are present, modify the sample protocol to obtain a sediment-free sample. If collection is impractical, discuss further modification of the sample protocol with the Qualified Person.

- 17) Carefully pack the samples into a cooler. A trip blank must be placed in each container containing samples for volatile organic compound analysis (O. Reg. 153/04).
- 18) Maintain the sample temperature at less than 10°C using ice or cold packs, even if samples are to be submitted the same day as collected.

REQUIRED DOCUMENTATION

The methods and results of groundwater sample collection will be recorded on a field form at the time of sample collection (see form titled Groundwater Sample Collection, Appendix C).

REFERENCES

ASTM 6634-01. Standard Guide for the Selection of Purging and Sampling Devices for Groundwater Monitoring Wells.

Ontario Regulation 153/04 (Records of Site Condition) (as amended) under the Environmental Protection Act (Ontario).



STANDARD OPERATING PROCEDURE NO. 10: LOW-FLOW GROUNDWATER SAMPLE COLLECTION

USEPA Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, EPA/540/S-95/504, April 1996.

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Author: Sandra Carrelas

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SOP10-Low-flow Groundwater Sample Collection.docx



PURPOSE

Where dedicated field sampling equipment cannot be used, sampling equipment must be decontaminated prior to retrieving samples of soil, water or sediment (O. Reg. 153/04). Decontamination is used to reduce the likelihood of cross-contamination between sampling locations.

LIMITATIONS

This Standard Operating Procedure (SOP) applies to field equipment constructed of metallic and synthetic materials that comes in contact with samples that will be submitted for laboratory analysis. It is not intended for use at sites where PCBs, biohazards, or radioactive substances are present.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Equipment decontamination requires the following materials as appropriate to the task:

- Sample containers for the laboratory analysis of rinse water.
- Mechanical cleaning device(s) (e.g., paper towels, bottle brush, broom, pressure washer) to dislodge and remove gross contamination. The cleaning device should be appropriate to the equipment being decontaminated.
- Detergent Solution - laboratory-grade non-phosphate detergent solution (e.g., AlcoNox or LiquiNox) prepared using analyte-free water as per the detergent instructions (typically 1 part detergent to 100 parts water).
- Solvent Rinse Solution - isopropanol, acetone, or methanol (pesticide grade).
- Analyte-free Rinse Water - typically distilled water. To demonstrate that the rinse water is analyte free, a sample of the source water can be submitted for laboratory analysis.
- Labelled squeeze bottles containing prepared decontamination solutions (note: decontamination solutions will be prepared for each sample event and will not be reused at more than one site to avoid cross-contamination). For the decontamination of larger equipment, larger solution containers may be necessary.
- Waste-water collection containers (barrels or pails with sealable lids).

FIELD PROCEDURE

- 1) Remove gross contamination using brushes or paper towel.
- 2) At a minimum, sample contacting equipment should be washed with a detergent solution and rinsed with analyte-free water.



STANDARD OPERATING PROCEDURE NO. 11: EQUIPMENT DECONTAMINATION

- 3) Wash with detergent solution, using a brush made of inert material to remove any particles or surface film. For equipment that, because of internal mechanism or tubing cannot be adequately cleaned with a brush, the decontamination solutions should be circulated through the equipment.
- 4) Rinse thoroughly with analyte-free water.
- 5) If a non-aqueous phase is present, rinse with a solvent solution (may be deleted if samples will not undergo organic chemical analyses).
- 6) Thoroughly rinse with analyte-free water.
- 7) Allow equipment to air dry as much as practicable prior to next use.
- 8) Contain waste decontamination solutions and dispose of them using the same procedure as for other investigation-derived wastes.
- 9) Collect a rinsate blank for laboratory analysis (O.Reg. 153/04).

The probes of water level meters can be decontaminated using only a detergent wash and a thorough rinse using analyte-free water. If a non-aqueous phase liquid is present, a solvent rinse is required.

REQUIRED DOCUMENTATION

In addition to the documentation requirements of the Golder Quality Assurance Program, the Field Team will document the decontamination procedures, the source and types of solution(s) used for decontamination, and the handling of rinse fluids and accumulated solids, if any.

REFERENCES

ASTM D5088-02 (Reapproved 2008). Standard Practice for Decontamination of Field Equipment Used at Waste Sites.

Ontario Regulation 153/04 (Records of Site Condition) (as amended) under the Environmental Protection Act (Ontario).

DOCUMENT CONTROL

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SOP11-Equipment Decontamination.docx



PURPOSE

Field measurements of water quality parameters provides information about the basic geochemistry of the groundwater and may be used to assess the representativeness of groundwater samples submitted for laboratory analysis.

LIMITATIONS

This Standard Operating Procedure (SOP) applies to the measurement of groundwater quality parameters in the field. This procedure applies to groundwater samples from monitoring wells that have been properly developed and purged (refer to Golder SOP No. 4, Golder SOP No. 9, and Golder SOP No. 10).

EQUIPMENT AND MATERIAL SPECIFICATIONS

Field measurement of water quality parameters requires the following:

- Appropriate water quality field instrument(s), which can include meters, field spectrophotometers, field titration apparatus and other. The use of widely-available multi-parameter water quality meters for the measurement of temperature, pH and specific conductivity is recommended.
- Any necessary calibration materials.

FIELD PROCEDURE

- 1) Set up the water quality instrument(s) in accordance with the manufacturer's instructions.
- 2) Calibrate the instrument(s) in accordance with the manufacturer's instructions and the requirements of the Quality Assurance Program. Document initial instrument calibration and calibration checks in the field file.
- 3) Collect a water sample and measure water quality parameters in accordance with the manufacturer's instructions.

REQUIRED DOCUMENTATION

Record the results at the time of measurement on an appropriate field form (e.g., a monitoring well development field form, a groundwater sample collection field form, or other) in Appendix C.



STANDARD OPERATING PROCEDURE NO. 12: MEASUREMENT OF FIELD PARAMETERS

DOCUMENT CONTROL

Author: Eric Hood

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SOP12-Measurement of Field Parameters.docx



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

PURPOSE

This procedure provides a systematic guide for general use in classifying soils and describing their characteristics. The classification scheme is suitable for both geotechnical and environmental purposes.

LIMITATIONS

This Standard Operating Procedure (SOP) requires the classification of samples of geologic materials encountered during an investigation. The Ontario Ministry of the Environment site condition standards are applicable to soil as it is defined in O. Reg 153/04, that is, as “unconsolidated naturally occurring mineral particles and other naturally occurring material resulting from the natural breakdown of rock or organic matter by physical, chemical or biological processes that are smaller than 2 millimetres in size or that pass the US #10 sieve” (O. Reg. 153/04).

For the purpose of this SOP, all types of unconsolidated geologic materials are subject to the requirements of this procedure even though some of these geologic materials (most gravel, all cobbles, and all boulders) do not meet the O. Reg. 153/04 definition of soil. For the purpose of this SOP, the term “soil” will be understood to apply to all unconsolidated geologic materials.

EQUIPMENT AND MATERIAL SPECIFICATIONS

Practitioners who have not memorized the various classifications presented in this SOP will need the classifications at hand when they classify and describe the soils. Other equipment and material are as follows:

- Hand lens;
- Grain size guide; and
- Plastic bags (optional; use if submitting samples for grain size analysis).

FIELD PROCEDURE

1.0 GENERAL

Where possible, use the following convention for the description and classification of soils encountered (terms are defined in subsequent sections):

Item/Parameter	
1) USCS Group Symbol – BLOCK LETTERS.	Based on particle size and plasticity
2) Soil Group Name; e.g., CLAYEY SILT- with the Group Name in BLOCK LETTERS.	
3) Description of Primary Components; Particle size, grading (for sands	



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

Item/Parameter	
and gravels containing <12% fines) and shape (optional) for coarse-grained soils. Optional for fine-grained soils as plasticity is captured in the USCS Group Symbol.	
4) Description of Secondary components; with an estimate of their percentage (optional), and giving their particle size for coarse-grained secondary constituents or plasticity for fine-grained secondary constituents.	
5) Other minor components.	
6) Colour.	General characteristics
7) Structure (if appropriate); e.g., fissuring & cementation.	
8) Contamination (if applicable), staining and odour.	
9) Additional observations; Presence of cobbles/boulders, origin or geological notes (FILL, Glacial Till, Alluvium, etc.) or mineralogy (i.e., calcareous, micaceous) if appropriate.	
10) Behaviour (non-cohesive or cohesive).	Material bulk behaviour characteristics
11) Field Moisture Condition (non-cohesive soils). Water Content (cohesive soils).	
12) Compactness (non-cohesive soils). Consistency (cohesive soils).	

- The order does not necessarily infer the relative importance of each item/parameter. The order reflects a systematic way of describing materials and an order compatible with reporting formats.
- Record the soil or sample description in the above-noted manner on the appropriate field form.
- When in doubt as to whether observations may be useful, document them.
- Collect additional sample volume, if warranted or as required by the sampling plan, to conduct grain size analysis or other physical tests.

2.0 CLASSIFYING ACCORDING TO GRAIN SIZE AND PLASTICITY

- 1) Observe the soil and, with reference to the following chart, classify the soil according to its predominant grain size:



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

Grain Size	Particle Size (in millimetres)/Identification
BOULDER	Larger than 300
COBBLE	75 to 300
GRAVEL	4.75 to 75
Coarse	19 to 75
Fine	4.75 to 19
SAND	0.075 to 4.75
Coarse	2.00 to 4.75
Medium	0.425 to 2.00
Fine	0.075 to 0.425
SILT and CLAY	< 0.075 Classified on the basis of their plasticity instead of grain size SILT - (Plasticity Index and Liquid Limit plot below A-Line on Plasticity Chart below) CLAY - (Plasticity Index and Liquid Limit plot above A-Line on Plasticity Chart below)

Note: Use a hand lens and grain size guide to assist in determining the grain size fractions present in the sample.

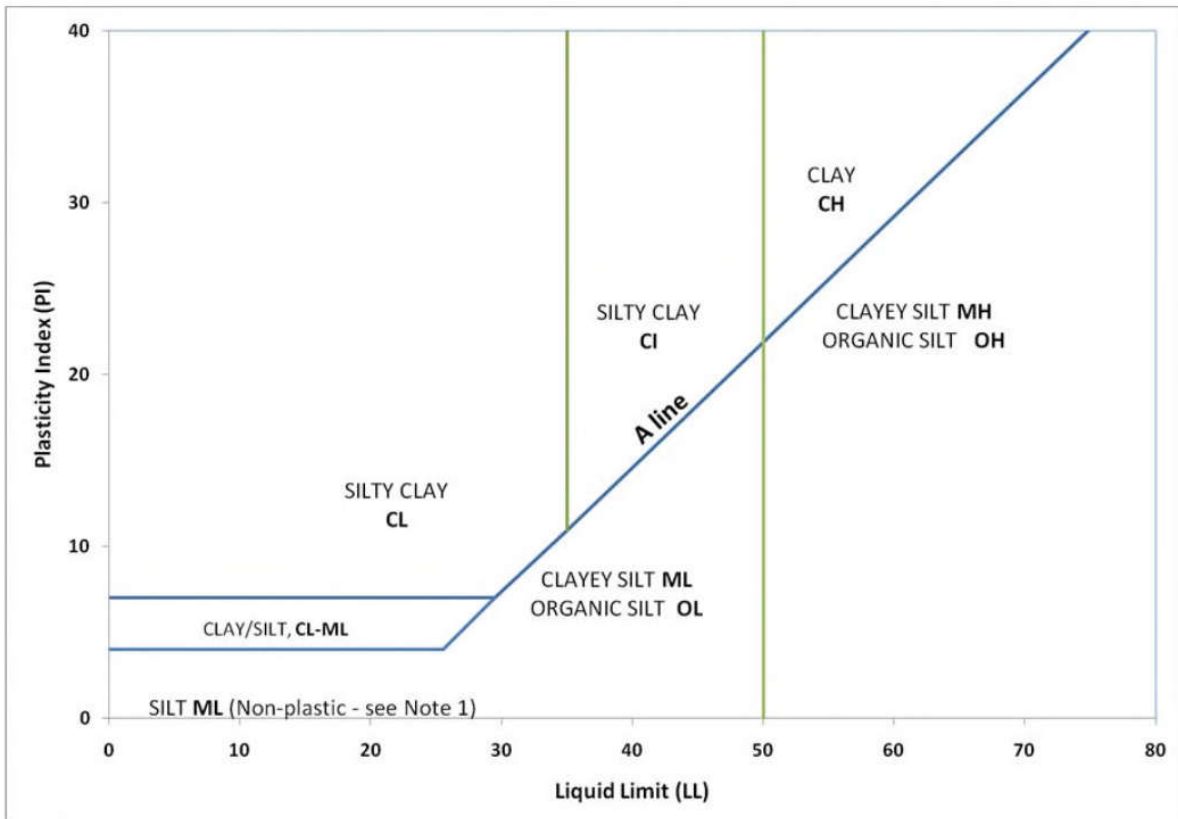


Figure: Plasticity Index vs. Liquid Limit Chart



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

- 2) Estimate the proportions of minor or secondary constituents present, and describe them using the following terms:

Modifiers for Secondary and Minor Constituents

Components	% (by mass)	Modifier
Minor	≤5	Use "trace" or omit.
	5 to 12	Use "some."
Secondary	12 to 35	Prefix primary soil name with "gravelly, sandy, SILTY or CLAYEY" as applicable. Note that the terms SILTY or CLAYEY are prescribed based on behaviour and not particle size.
	>35	Use 'and' to combine major constituents (i.e., SAND and GRAVEL, SAND and SILT, SILTY CLAY and SAND).

Note: When mixtures of grain sizes are present, the predominant particle size determines the soil type, while the relative predominance of other particle sizes modifies the description. The predominant soil type is written in block (upper case) letters (e.g., sandy GRAVEL with some silt; silty CLAY, coarse SAND with some cobbles)

- 3) If appropriate or if prescribed by the sampling and analysis plan, collect approximately 500 mL to 1 L of sample in a plastic bag and submit it for grain size analysis to confirm that descriptions of soil type and relative percentages are accurate.

3.0 DESCRIBING SOIL COLOUR

Colour may be an important indicator of soil properties or subsurface conditions. Organic soils are often indicated both by colour and odour. In temperate climates where chemical weathering and oxidization is not rapid, the change of soils from brown tones to grey is an indicator of the historical groundwater level.

Observe and record the colour of freshly broken sample or fresh exposure as follows:

- In most cases, only the primary colour modified, if appropriate, by a single adjective need be used (e.g., grey, dark grey, oxidized red-brown).
- If individual sample(s) contains layers or zones of varying colour, include this detail in the description of each individual sample, but do not necessarily repeat it in the summary description of the overall deposit.
- Describe soil colour as "mottled" if there are localized spots, streaks, or splotches of one or more different colours or shades within a soil mass of another predominant colour.



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

4.0 DESCRIBING SOIL STRUCTURE (OPTIONAL)

Structure is the term applied to features or discontinuities within the overall soil mass. Structure is often an indication of the method of deposition or geologic history of the soil. Most importantly, the structure may greatly change the characteristics of the soil mass from that indicated by individual samples.

Soil structure must be noted in the field as the structure evident in soil samples is often lost during transportation. Soil structures greater in size than that visible in borehole samples can be more evident in test pit investigations, in construction excavations and in tunnels; where evident, the soil structure, size, orientation and dip direction should be noted. The following terms are used in describing soil structure:

4.1 Zoning

Zoning

Term	Description
Heterogeneous	Soil mass is of non-uniform, variable composition or structure.
Homogeneous	Soil mass is of uniform composition or structure.
Repetitive Structures	
Laminated	Closely spaced, alternating layers of differing soils and/or differing colours or shades of soils of similar gradation, usually arranged in a regular pattern. The following terms may be used: <ul style="list-style-type: none">■ Thinly laminated – mean spacing under 6 mm■ Thickly laminated – 6 mm to 20 mm
Stratified or Layered	Differing soils or visible variations in soil constituents or colour arranged in layers, generally but not necessarily parallel to one another. The following terms may be used: <ul style="list-style-type: none">■ Very thinly bedded – 20 mm to 60 mm■ Thinly bedded – 60 mm to 200 mm■ Medium bedded – 200 mm to 600 mm■ Thickly bedded – 600 mm to 2 m■ Very thickly bedded – over 2 m
Varved	A laminated soil consisting of two distinct soils (usually clay and silt) occurring in a regularly repeating pattern resulting from seasonal variations in sediment load in a lacustrine environment.
Discrete layers or features	
Lens	An inclusion of a different soil type within surrounding soils, which thins out laterally (horizontally) and may not be continuous over any significant distance. Typically identified by test pits or correlation between boreholes.
Parting	Paper thin separation of one soil type by another. Usually applied to fine-grained soils.



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

Term	Description
Pocket	A different soil type of very limited thickness or lateral extent (a small lens).
Seam	A soil layer of considerable extent but with a thickness of less than about 10 mm.

4.2 Fissures

Fissured: Generally applied to dried or overconsolidated fine-grained soils (silts and clays) containing cracks or physical discontinuities which can be vertical, horizontal or inclined. Fissuring is indicated when otherwise strong soil breaks along definite or pre-existing fracture planes. The degree of fissuring may be described as:

- Highly fissured – fissures spaced 10 mm or closer over most of the interval described.
- Moderately fissured – two or more fissures occur per 150 mm length of sample or exposure.
- Slightly fissured – only random, infrequent and narrow fissures (average distance between fissures consistently greater than 75 mm).

Friable, Blocky, Platy: Otherwise cohesive soil breaks into small (friable), larger (blocky) or thin, plate like (platy) fragments with little effort.

Slickensided: Polished or striated surfaces resulting from movement of a material block relative to the adjacent block(s), often an indication of an existing failure or slip surface. If continuous slickensided shear zones are found, an estimate should be made of their angle in relation to the horizontal plane.

4.3 Cementation

Soils or defects within soils may be held together by cementing materials, often chemical precipitates or deposits within the overall soil mass.

If the cementing agent allows fracturing by hand of the particle aggregations when saturated, it is described as weakly cemented.

The nature of the cementing agent should be identified if possible from its appearance, strength, reaction to acid, etc.

4.4 Other Defects

Other defects to be noted may include:

- Roots;
- Root holes or tubes (hollow);
- Tube casts (solid material filling old tube); and



- Surface cracks.

5.0 DESCRIBING INDICATORS OF CONTAMINATION

- 1) If indicators of contamination are present, describe them in as much detail as possible, as these descriptions may assist in the selection of samples for laboratory analysis, in the location of potentially contaminated zones at other testing locations, or during future excavations. Specific indicators of the presence of contamination may include the following:
 - An unusual or distinctive colour (e.g., black, dark brown, red);
 - Staining or residues;
 - Diesel, oil, tar, or other non-aqueous products present in the pore spaces (may present staining or greasiness on gloves or sample containers);
 - A sheen on free water, if free water is present;
 - The results of headspace screening performed with an appropriate field instrument (e.g., combustible gas detector, photoionization detector);
 - Distinctive odour; and
 - Flakes, fragments, or pieces of foreign substances or debris such as metal, paint, brick, or wood waste. A distinction should be made between natural wood debris (e.g., twigs and branches) and man-made wood waste (e.g., wood chips and dimensional lumber);
- 2) Where appropriate, include the following detail:
 - Relative proportion, quantity, and size of foreign substances or debris;
 - Consistency of foreign matter (e.g., viscous, dry, powdery); and
 - Particular characteristics (e.g., quality of an odour; is it similar to something commonly encountered?)

Note: the odour of soil samples should only be recorded if incidentally noticed during the course of typical soil sampling activities. **Field personnel shall not deliberately smell field samples.** As odours are subjective, the description of any incidental odours that are noted should be kept simple.

6.0 DESCRIBING COHESIVENESS

The word cohesive usually describes a soil which has an undrained shear strength measured in an unconfined compression test.

In practical terms, cohesive soils are those which remain intact when rolled between the fingers (i.e., stick together when wet).



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

Non-cohesive (cohesionless or non-plastic) soils may include both coarse-grained and/or fine-grained constituents, and are soils that fall apart when not confined.

The behaviour will be obvious for some materials. For example, coarse-grained soils with less than 12% fines will always be non-cohesive, and high plasticity clay containing less than 12% coarse particles will always be cohesive. The behaviour of materials containing mixtures of constituents is often not implicit in the classification.

For materials where the behaviour is not implicit, the field logs and records of boreholes shall identify whether the soil mass (after removing cobbles and boulders) is cohesive or non-cohesive.

7.0 DESCRIBING FIELD MOISTURE CONTENT / WATER CONTENT

The following terms are used to describe the field moisture condition of non-cohesive soils.

Non-cohesive Soils - Field Moisture Condition

Term	Abbreviation	Description
Dry	D	Soil flows freely through fingers.
Moist	M	Soils are darker than in the dry condition and may feel cool.
Wet	W	As moist, but with free water forming on hands when handled.

The water content (w) of cohesive soils is described relative to the Plastic Limit (PL) using the following terms:

Cohesive Soils – Water Content

Term	Description
$w < PL$	Material is drier than the plastic limit (cannot be rolled to a thread of 4 mm).
$w \sim PL$	Material is close to the plastic limit (can be rolled a thread of between 2 mm and 4 mm).
$w > PL$	Material is wetter than the plastic limit (can be rolled to a thread of less than 2 mm).

8.0 DESCRIBING CONSISTENCY OR COMPACTNESS

There are two ways of determining consistency or compactness:

- From examination of undisturbed samples, for example, those taken from test pit excavations or Shelby tubes; or
- From the blow count obtained in standard penetration tests. A standard penetration test is conducted during drilling using a 5-cm OD split spoon sampler. It consists of repeatedly raising and dropping a 140-lb hammer (around the collar of the sampler rod) 30 cm and counting the number of blows required to advance the rod 15 cm.



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

8.1 Non-cohesive soils – Compactness

Compactness of Non-cohesive Soils

Description	SPT 'N' (blows/0.3m)	Field Identification of Soil Exposures
Very Loose	0 - 4	Easily penetrated with shovel handle.
Loose	4 – 10	Easily penetrated with 12 mm rebar pushed by hand. Easily excavated with hand shovel.
Compact	10 - 30	Easily penetrated with 12 mm rebar driven with 2.5 kg hammer. Difficult to excavate with hand shovel.
Dense	30 – 50	Penetrated 300 mm with driven rebar. Must be loosened with pick to excavate.
Very Dense	>50	Penetrated only a few inches with driven rebar. Very difficult to excavate even with pick.

Notes:

- 1) SPT 'N' in accordance with ASTM D 1586, uncorrected for overburden pressure effects or energy transfer. Different hammer weights, sampler size and sampler fall will result in a different correlation of blow counts to compactness descriptions.
- 2) Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) – can be assumed to correspond to typical average N60 values (i.e., they are representative of tests where the average energy transferred by the hammer to the split spoon sampler is about 60% of the theoretical free-fall energy of the hammer).
- 3) Coarse gravel and cobbles, in particular, can result in high 'N' values that are not representative of the compactness condition and the Corresponding 'N' values should not be used to describe the compactness condition.
- 3) Heaving sands will result in low SPT values not representative of in-situ conditions.

8.2 Cohesive Soils – Consistency

Consistency of Cohesive Soils

Description	Field Identification	Undrained Shear Strength (kPa)	Unconfined Compressive Strength (kPa)	SPT 'N' (blows/0.3m)
Very Soft	Extrudes between fingers when squeezed	<12	<25	0 to 2
Soft	Moulded by light finger pressure	12 to 25	25 to 50	2 to 4
Firm	Moulded by strong finger pressure	25 to 50	50 to 100	4 to 8
Stiff	Indented by thumb	50 to 100	100 to 200	8 to 15
Very Stiff	Indented by thumbnail	100 to 200	200 to 400	15 to 30
Hard	Difficult to indent with thumbnail	>200	>400	>30

Version:



STANDARD OPERATING PROCEDURE NO. 14: SOIL CLASSIFICATION AND DESCRIPTION

Notes:

- 1) SPT 'N' in accordance with ASTM D 1586, uncorrected for overburden pressure effects or energy transfer. Different hammer weights, sampler size and sampler fall will result in a different correlation of blow counts to consistency descriptions.
- 2) Undrained Shear Strength equals one-half the Unconfined Compressive Strength (UCS).
- 3) 'N' values should be considered ONLY an approximate guide to consistency.

REQUIRED DOCUMENTATION

Soil classification and description will be recorded on the appropriate field log (e.g., borehole log, test pit log) (see Appendix C).

REFERENCES

ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Golder Associates Ltd. Technical Procedure – GAL Soil Classification System, Rev 0, September 20, 2011.

Ontario Regulation 153/04 (Records of Site Condition) (as amended) under the Environmental Protection Act (Ontario).

Terzaghi and Peck (1967), Soil mechanics in engineering practice.

DOCUMENT CONTROL

Author: Tim Mullings

Edit 1 Editor: Margaret Shaw Edit Date: November 24, 2010

Edit 2 Editor: Dave Smyth Edit Date: January 9, 2014

SOP14-Soil Classification.docx



ATTACHMENT 2

Grab Sampling Methods



Attachment 2: Grab Sampling Methods

1. Label sample container (can be done prior to field sampling).
2. Measure water depth with a weighted rope or an electronic depth sounder.
3. Grab sampler should be triple rinsed with ambient water prior to sampling to dislodge any residual material. This should be done with the jaws open. Be sure to check that sediments have not dried onto the sampler. If so, remove dry material to prevent contamination and rinse sampler again. Additional cleaning may be required, as specified in the SWI. Rinsing should be done away from the sampling area.
4. Set the grab sampling device with the jaws cocked open.
5. Using a graduated line attached to the top of the sampler, lower it **slowly** until it touches the bottom. If using the Ekman grab, be sure to retain the messenger (small weight used to trigger sampler) at the surface. Be careful not to touch the bottom too abruptly as surface sediments could be disturbed by the mouth of the sampler, which would result in an inaccurate sample. At this point, the slackening on the line activates the mechanism to close the jaws of the Ponar and Petersen grabs.
6. Remember that the speed of deployment of the sampler can affect the operation and success of sample recovery. Too rapid of a deployment generates and increases the shock wave advancing in front of the equipment, which can displace the soft unconsolidated surface sediments. Rapid deployment may also cause equipment malfunction, such as activating the trigger mechanism before the device reaches the sediment. Too slow of a deployment may result in the grab sampler not penetrating to the desired sediment depth.
7. For the Ekman grab, make sure the graduated line is as vertical as possible, and send the messenger down to “trip” the release mechanism. Maintain some tension of the line to ensure that the messenger falls freely; too much tension can cause the messenger to bounce and not fully activate closing of the jaws. Other environmental factors may affect the line tension: for large river programs, we will limit the time of year to sample and for marine programs we sometimes limit the time in the tidal cycle when sampling will occur.
8. Once you feel the messenger trigger the sampler, begin to slowly raise it off the bottom. It is important to raise the grab slowly otherwise fine sediments may be lost.
9. Once the grab reaches the surface, place sampling device in a container to prevent loss of sample. Siphon excess water from the top of the sampler prior to disturbing substrate. Sub-samples can either be scooped directly out of the sampling device and into sample container (bottle or bags) or into a bowl or similar container to homogenize samples so that sub-samples are representative. Another method of sample retrieval once the grab reaches the surface is to pry open the spring loaded jaws and the sample put into a flat bottomed pan or similar container. The entire sample, or the top layer of the sample can then be scooped into containers. Sample containers (jars or bags) should be stored appropriately, as instructed by the analytical laboratory or the Specific Work Instructions.
10. If the sample is to be split, then open the top flaps and carefully divide the sample into the required number of split samples with a clean spatula. Scoop the samples into pre-labelled jars or bags and store in a cooler.
11. Sediment samples for chemical analysis of volatile compounds should be frozen as as soon as possible (ASAP) in a dark place to minimize loss.

Note: If the jaws did not close completely when triggered, any collected sample must be discarded. Discard the sample into a bucket if the second collection attempt is to be made from the same general area. Dump the unwanted sample only after a sample has been successfully collected.



APPENDIX C

Health and Safety Plan



Health Safety And Environment Plan

**A world of
capabilities
delivered locally**

CNL NPD ENVIRONMENTAL SITE ASSESSMENT

Site Address

NPD CANADIAN NUCLEAR LABORATORIES
36510 HIGHWAY 17 ROLPHTON, ON K0J 2H0

Submitted By

Revision

Date: November 18, 2016

Project No.1666131



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

1.0 CONTACTS LIST SUMMARY

1.1 Emergency Contacts

Contact	Number
Ambulance	911
Fire	911
Police	911
Allianz Global Assistance (Manulife policy #17142)	1-800-265-9977
Golder Crisis Hotline (from outside Canada)	xxx-403-775-1041
Golder Crisis Hotline (from within Canada)	1-866-249-0439
Golder Media Relations	647-402-3596
Local Electrical Authority	1-888-664-9376
Local Gas Authority	1-877-362-7434 (Enbridge Eastern Region)
Local Telecom Authority	NA
Local Water Authority	NA
Provincial Poison Control Centre	1-800-268-9017
Spills Reporting	1-800-268-6060

Hospital name	Address	Phone	Level of Care Available
Deep River & District Hospital	117 Banting Dr, Deep River, ON K0J 1P0	(613) 584-3333	Emergency

1.2 Golder Contacts

	Name	Office Name	Office	Cell	Home
Project Manager	Paul Hurst	Ottawa	+1 613 592-9600 x4292	+1 613 880-4598	613 722 9875
Project Director	David Smyth	Ottawa	+1 905 567-6100 x1146	+1 416 662-9350	
Field Lead	Mathew Riopelle	Sudbury	+1 (705) 524-6861 x2521	+1 (705) 561-3586	
Field technician	Alex Wood	Ottawa	+1 (613) 592-9600 x.3306	(613) 328-4804	
Field technician	Bret Timmis	Mississauga	+1 (905) 567-4444 x1155	289 259 8062	
Field technician	Chuck Albert	Ottawa	+1 (613) 592-9600 x3278	+1 (613) 266-9017	
Project Manager	Paul Hurst	Ottawa	+1 613 592-9600 x4292	+1 613 880-4598	
Field technician	James Doyle	Ottawa	+1 (613) 592-9600 x3222	613 298 0765	
Client	Canadian Nuclear Laboratories				



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

1.3 ISR Main Contact

	Name	Office Name	Office	Cell	
	Alex Wolf	Ottawa	(613) 241-4884 x303	(613) 854-7043	

1.4 Missed Check-in Contacts

	Name	Phone	Cell
Project Manager	Paul Hurst	+1 613 592-9600 x4292	+1 613 880-4598
Project Director	David Smyth	+1 905 567-6100 x1146	+1 416 662-9350

1.5 Client and Site Contacts

	Number
Site field cell phone	+1 (705) 561-3586
Nearest Golder office	Canada - Ottawa
Phone	+1 (613) 592 9600
Fax	+1 (613) 592 9601
Email	

Role	Name	Number
Contact person on site	Mathew Riopelle	Office: +1 (705) 524-6861 x2521 Cell: +1 (705) 561-3586
Client safety contact	Mr. Kristan Schruder	613-633-8157
Company Golder reports to	CNL	
Company reporting to Golder	ISR	1-613-241-4884
	USL-1 Ltd.	(613) 226 8750
Golder overall site supervisor and alternate:	Mathew Riopelle	Office: +1 (705) 524-6861 x2521 Cell: +1 (705) 561-3586

You have the right to refuse any work you feel is unsafe, or that you are not trained to do. Choose to work safely and in compliance with all HSE requirements.

It is company policy to complete a HaSEP form including a task-based Health, Safety and Environment (HSE) risk assessment for every project that includes site work, working alone or international travel.



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HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

2.0 PROJECT PROPOSAL DETAILS

Project/Proposal Number	1666131	Start Date	Nov 20, 2016	End Date	Dec 31, 2016
Project Title	CNL NPD Environmental Site Assessment				
Client Name	Canadian Nuclear Laboratories				

Brief description of project and scope of works (include any hazardous activities, if known)

Alpha, beta, gamma scanning, soil sampling (by hand), borehole drilling & soil sampling, groundwater sampling, sediment sampling, (ditches, side of wetlands and Ottawa River)

Many sampling locations are in dense forest – eye protection and slips trips and falls are important at this site.

Steep slopes exist north of the fenced in compounds.

Due to proximity of Des Joachims Dam a portion of the NPD property (very northwest corner) is within the floodway of the dam. Please consult with the NPD point of contact (Kristan Schruder) in order to make appropriate notifications and arrangements with OPG for work in this region

This Health and Safety plan must be read in conjunction with the Radiation Protection Plan

3.0 GOLDER TEAM

Name	Office	Contact number (cell phone)	Office Phone	Role
Mathew Riopelle	Sudbury	+1 (705) 561-3586	+1 (705) 524-6861 x2521	Field Lead
Alex Wood	Ottawa	(613) 328-4804	+1 (613) 592-9600 x.3306	Field technician
Bret Timmis	Mississauga	289 259 8062	+1 (905) 567-4444 x1155	Field technician
Chuck Albert	Ottawa	+1 (613) 266-9017	+1 (613) 592-9600 x3278	Field technician
Paul Hurst	Ottawa	+1 613 880-4598	+1 613 592-9600 x4292	Project Manager
James Doyle	Ottawa	613 298 0765	+1 (613) 592-9600 x3222	Field technician

Project Manager (PM)

- Appoint a competent site supervisor and alternate. For sites with multiple Golder projects/disciplines at work, coordinate with the overall site supervisor
- Oversee/develop hazard controls including work instructions and
- Assign only adequately trained and competent employees to the project

Site Supervisor

- The site supervisor is responsible for the safety of all Golder employees, subcontractors, visitors and public on the parts of the site under Golder control.
- Communicate all site hazards to affected parties, in real time, as hazards, conditions and employees change.
- Ensure that work is undertaken in accordance with the hazard controls included in this HaSEP.

Contractor

- All plant and equipment is maintained in a safe working condition
- All plant and equipment are to be registered/licensed and electrical equipment tagged and tested
- Potential hazards are to be controlled (e.g., cage over rotating parts)
- You will report any identified hazards to the Golder Associates field staff member



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Field Staff

- Inspect your worksite and equipment before starting work
- Apply the controls outlined in this HaSEP
- Look out for the safety of yourself and others
- Report unsafe acts, conditions and incidents to the site supervisor

4.0 CLIENT/SITE LOCATION DETAILS

4.1 Client/Site Location Details

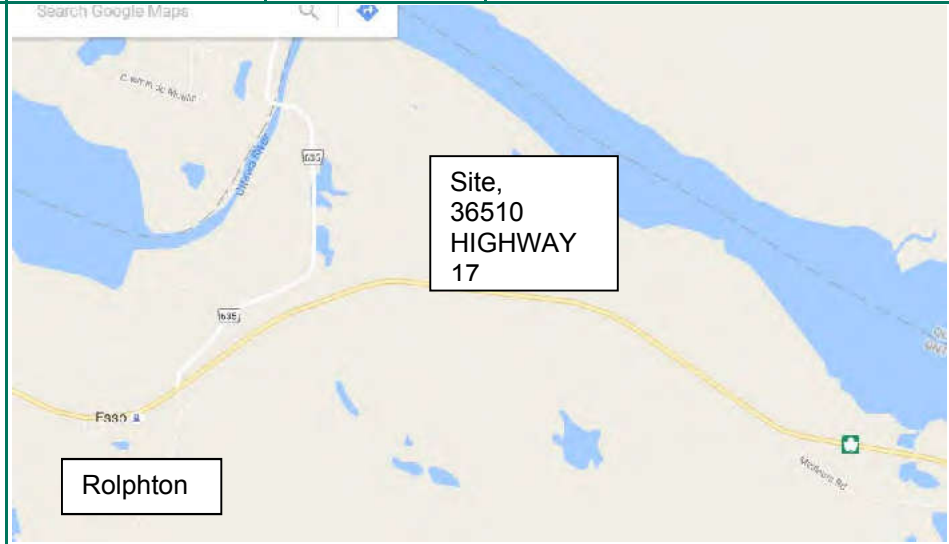
Project location map (paste URL here)	https://www.google.ca/maps/@46.1856995,-77.6643311,14.46z
---------------------------------------	---

4.1.1 Site Description

If the project is near another Golder Office, has the local Office been notified of the work? Yes No

Site Name	NPD CANADIAN NUCLEAR LABORATORIES		
Address	36510 HIGHWAY 17 ROLPHTON, ON K0J 2H0		
Coordinates	46.179593°, -77.664385°		
Access info	Gravel driveway off Highway 17		
Additional Info	This Health and Safety plan must be read in conjunction with the Radiation Protection Plan		
HSE Induction / orientation provider	<input checked="" type="checkbox"/> Golder	<input checked="" type="checkbox"/> Client	<input type="checkbox"/> Contractor
Site Contact Numbers	Field cell phone	+1 (705) 561-3586	Satellite phone
	Other		
Nearest Golder office	Canada - Ottawa	Address	1931 Robertson Road, Ottawa, Ontario, K2H 5B7 Canada
Opening days and hours	7 to 5PM		

Google Maps





HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

5.0 SUBCONTRACTOR DETAILS

Has Golder been assigned the role of Principal Contractor? * Yes No

Name	Subcontractor key staff	Phone	Subcontractor activities	Risk Assessment Supplied	Method Statement Supplied	Approved Golder subcontractor?
ISR	Alex Woof	(613) 854-7043	Radiological scanning and reporting	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
USL-1	Jeff Forrester	(613) 226 8750	Utility Service Locates	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>



5.1 Welfare / Hygiene Facilities

The following issues should be considered when planning welfare provision including: the work to be carried out; the associated health risks; duration and number of different locations; number of people working at different locations and distances from welfare facilities.

Describe the project's welfare facilities below:

Facility	Yes	No	Describe alternate arrangements:
Toilets available?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Rest areas available?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Washing facilities available?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Drinking water available?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Staff to bring wash water, potable water is available at designated water dispensers
Area for changing and storing clothes available?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Mode of transportation to site available?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Smoking permitted on site?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Location where smoking is permitted	Smoking area beside main office trailer. Smoking STRICTLY prohibited in all other areas at the site		

6.0 PERMITS AND APPROVALS

Are permits and approvals required for this project? (e.g Client supplied Permit, Hot Works Permit, Mobile Treatment Permit etc.)

Dig, Drilling and Coring (DDC) permit is required for all investigation locations deeper than 0.20 metres. Staff to ensure they have a DDC permit prior to all investigation work deeper than 0.20 metres.

7.0 CHECK-IN SYSTEM

7.1 Check-in contacts

	Primary	Secondary
Name	Paul Hurst	
Phone/Email	Office: +1 613 592-9600 x4292 Cell: +1 613 880-4598 Email: Paul_Hurst@golder.com	
Check-in frequency*	Daily	
By phone	<input checked="" type="checkbox"/>	<input type="checkbox"/>
By email	<input checked="" type="checkbox"/>	<input type="checkbox"/>
By SMS	<input checked="" type="checkbox"/>	<input type="checkbox"/>
On site	<input type="checkbox"/>	<input type="checkbox"/>

7.2 Missed Check-in Procedure

Within 2 hours of missed check-in time:

1. Attempt to contact employee
2. Contact accommodation or other project personnel to determine last contact with employee
3. Notify Project Manager.
4. Project manager to determine timing of further action, based on project details.



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Within 4 hours of scheduled call-in time:

1. Contact client and request assistance to locate employee.
2. Notify Project Director, Office Manager, and local authorities (as appropriate)
3. Initiate Crisis Response Plan (as appropriate)

Does missed check-in procedure for this project deviate from the standard procedure?

8.0 ACCOMMODATION

Overnight accommodation required

Start Date	End Date	Accommodation	Address	Phone
Nov 20, 2016	Dec 16, 2016	Bear's Den Lodge	33177 Trans-Canada Hwy, Deep River	(613) 584-9795



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

9.0 RISK REGISTER

9.1 Risk Definition

Health & Safety Consequence or Impact Description:

Catastrophic	5	Death, toxic release off-site with detrimental effect, very high financial loss
Major	4	Extensive injuries, loss of production capability, off-site release with no detrimental effects, major financial loss
Moderate	3	Medical treatment required, on-site release contained with outside assistance, high financial loss
Minor	2	First aid treatment, on-site release immediately contained, limited financial loss
Insignificant	1	No injuries, low financial loss

Environmental Consequence or Impact Description:

Catastrophic	5	Release to air, water or land with life threatening impacts on or off site. e.g.: human death(s), destruction of endangered species; habitat destruction; human water supply or food destruction; localized extinction of a species; Protracted or extensive clean up requiring external resources.
Major	4	Release to air, water or land with destructive impacts on or off site. e.g.: destruction of animal /fish life; habitat damage; making air, water or land unfit for use by living things; destruction of known or unknown indigenous people's / heritage sites; irreversible alteration of the natural environment or its aesthetics; dust or noise affecting a region; large volumes of contaminated or hazardous waste. Requires clean up using external resources.
Significant	3	Release to air, water or land with impacts requiring long term recovery. e.g.: habitat disturbance; damage to indigenous people's/heritage sites; alteration of the natural environment or its aesthetics; generation of contaminated or hazardous waste, or large volumes of solid waste; dust or noise affecting the immediate area. Clean-up can be managed by internal resources.
Minor	2	Release to air, water or land with resulting in localised damage to worksite requiring short term recovery. e.g.: readily repairable impacts (physical or aesthetic) to the natural environment, indigenous people's/heritage items, property, or business operations; public nuisance (noise, dust, odours); generation of small quantities of waste. Clean up can be completed by internal resources.
Insignificant	1	Release to or disturbance of air, water or land resulting in no impact or localised (i.e. isolated to worksite) impacts within authorized limits. Short term impact with complete recovery. Clean up can be completed by person(s) involved.

Likelihood Description:

Almost certain	5	Incident will occur in every circumstance (e.g. every time).
Likely	4	Incident will probably occur (e.g. 1 in 10 times).
Possible	3	Incident may occur at sometime (e.g. 1 in 100 times).
Unlikely	2	Incident not expected to occur, but conceivable (e.g. 1 in 1,000 times).
Rare	1	Incident would only occur in exceptional circumstances (e.g. 1 in 10,000 times).

Risk Analysis Matrix:

Likelihood:		Consequence:				
		Catastrophic	Major	Moderate	Minor	Insignificant
Almost certain	5	5	4	3	2	1
Likely	4	25 (VH)	20	15	10	5
Possible	3	20	16 (H)	12	8	4
Unlikely	2	15	12	9 (M)	6	3
Rare	1	10	8	6	4 (L)	2
		5	4	3	2	1 (VL)

0-3 (VL) Very Low Risk	No additional controls necessary. Continue to monitor risk.
4-6 (L) Low Risk	Consider additional controls to further reduce risk.
8-12 (M) Moderate Risk	Controls must be implemented to reduce risk.
15-16 (H) High Risk	Risk Unacceptable, do not proceed without controls, minimum of 'engineering controls'.
20-25 (VH) Very High Risk	Risk Unacceptable, do not proceed without controls, elimination or substitution controls required.



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Header key:

- PA: Persons Affected
- IC: Initial Consequence
- IL: Initial Likelihood
- IR: Initial Risk
- RC: Residual Consequence
- RL: Residual Likelihood
- RR: Residual Risk
- AC: Additional controls

9.2 Hazard Mitigation #1 – Insects

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #1	Stinging Insects	Ants	Employees	2	3	6	Watch your step. Ants are often found on walking paths and if the path is disturbed, they will bite. Prior to traveling, consult with local representative or check International SOS website to determine the potential exposure to biting ants in the area.	2	1	2
Mitigation #1	Stinging Insects	Bees, wasps	Employees	3	3	9	Check the area for nests. Do not disturb nests. Discuss allergies with your crew lead and other crew members. Carry an epipen if required. Train crew members on how to use it and where you keep it.	3	1	3
Mitigation #1	Stinging Insects	Mosquitoes	Employees	3	3	9	Wear full length clothing. Light coloured clothing makes it easier to see mosquitoes. Avoid working at dawn and dusk when mosquitoes are most active. An insect repellent containing diethyl-meta-toluamide (30% DEET) or picaridin should be applied to clothing and skin before going into known dengue or malaria areas. The repellent should be applied and re-applied according to the manufacturer's instructions. Stay in an air conditioned room where possible. Use a permethrin impregnated bed net at night.	3	2	6



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Mitigation #1	Stinging Insects	Spiders (Canada)	Employees	2	3	6	Do not place bare hands in hollow logs, under piles of wood or rubbish. Wear leather gloves or similar when handling these items. If boots or clothing removed (e.g. when camping) check them prior to putting the back on. Bites my most spiders result in local swelling only. If someone is bitten by a spider: 1. Rest the person. 2. Do not wash the remains of venom off as this can assist with identifying the spider. 3. Place a pad over the bite and apply a compression bandage. Bandage from the bite to the extremities of the limb and then back to the torso. The bandage should not restrict blood flow. 4. If the person reports pain from the bandage, remove it and use ice packs. 5. Seek medical assistance. If possible avoid moving the person. 6. Keep an eye on the person and perform CPR if required.	2	2	4
Mitigation #1	Stinging Insects	Ticks	Employees	3	2	6	Wear full length clothing (tucking pants into socks prevents access for ticks). Light coloured clothing makes it easier to see ticks and remove them before they can attach to the skin. An insect repellent containing diethyl-meta-toluamide (DEET) or picaridin should be applied to clothing and skin before going into infested areas. The repellent should be applied and re-applied according to the manufacturer's instructions. All clothing should be removed after visiting tick infested areas and the entire body checked for ticks, paying particular attention to areas behind the ears and the back of the head or neck. Review and understand the signs and symptoms of a tick bite. To remove ticks: 1. Use fine pointed tweezers and grasp the tick as close to the skin as possible. 2. With steady force, gently	3	1	3



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							pull the tick out. 3. Apply disinfectant to the area after removal. 4. Seek medical assistance if you have any difficulty removing the tick.			

9.3 Hazard Mitigation #2 – Vegetation

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #2	Vegetation	Reaction (rash)	Employees	4	2	8	Be aware of local vegetation and potential exposure issues. Be knowledgeable in their identification and signs and symptoms of exposure. Prevent exposure through recognition and avoidance, as well as wearing long pants, long sleeved shirts and gloves hands can be exposed. Do not eat any wild vegetation.	3	1	3

9.4 Hazard Mitigation #3 – Wild Animals

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #3	Wild/feral animals	Bears	Employees	5	2	10	Where exposure to bears is likely, do not work alone. Never feed or approach bears. Reduce or eliminate odours that attract bears. Avoid fish smells. Store food in air tight containers in your vehicle or alternate storage. If you are not close to your vehicle, secure your food in a tree. Store garbage in the same way as the food. Do not bury garbage or throw it into pit toilets. Reduce the chance of surprising a bear by: checking ahead for bears in the distance; if spotted, take a wide detour and leave the area immediately; make warning noises and loud sounds, such as honking your car horn upon arrival and at regular intervals; watch for bear sign such as tracks, droppings, overturned rocks, rotten trees torn apart, clawed	4	1	4



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							<p>or bitten trees, bear trails, fresh diggings or trampled vegetation. Stay clear of dead wildlife. Carry either an air horn to announce your presence from a distance or bear spray. They can be an effective deterrent, but can be an attractant if sprayed in advance (do not use as a perimeter control). Avoidance is still the best control. If you spot a bear nearby or approaching, walk towards your vehicle, do not run, keep an eye on the animal, take refuge in your vehicle and wait for the bear to leave. Do not lose sight of your vehicle when alone. Where available, take a Bear Awareness Course. A Bear Awareness course will teach you how to identify the difference between a black and grizzly bear, between a defensive and aggressive attack and the appropriate response for these situations.</p>			
Hazard Mitigation #3	Wild/feral animals	Wild/feral animals	Employees	3	2	6	<p>Never feed or approach a wild/feral animal. Reduce or eliminate odours that attract animals. Store food in air tight containers in your vehicle or alternate storage device. Store garbage in the same way as food. Do not bury garbage or throw it into pit toilets. Reduce the chance of surprising wildlife by: Checking ahead in the distance for animals. If spotted, take a wide detour and leave the area immediately; make warning sounds and loud noises; watch for fresh signs of animals; carry an air horn to announce your presence from a distance. If you encounter a carcass, leave the area immediately. Carry pepper sprays at hip level in cases designed for that purpose. Bear sprays can be an effective deterrent for all animals, but are an attractant if sprayed in advance (do not use for perimeter control). If</p>	2	2	4



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							you encounter a wild/feral animal: Remain calm, try not to provoke it. Make sure it has an escape route. Do not try to run. In the case of a direct confrontation, attempt to appear larger and use the equipment as a shield when slowly moving away. Creating noise. This will often send animals scurrying.			

9.5 Hazard Mitigation #4 – Compressed Gasses

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #4	Compressed gases	Pressurized container	Employee	4	2	8	Reference D&G CANHSE224 Chemical Safety. Follow CANHSE324.2 Compressed Gases for receiving, handling, storing, using or disposing of compressed gas cylinders. Store cylinders in a dry, well ventilated area. Valve cap always on unless in use. Always secure a cylinder to prevent it from falling. Store and identify empty cylinders separately. Inspect the cylinder for damage. After installation, conduct a leak test of connections. Always use the appropriate cylinder. TDG training may be required based on the chemicals involved. When moving cylinders, wear steel toed footwear, safety glasses and leather gloves. For small cylinders (calibration gases): Remove the regulator when not in use.	3	1	3



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9.6 Hazard Mitigation #5 – Contaminated Water or Soil

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #5	Contaminated water or soil	Handling contaminants	Employee	3	3	9	<p>Reference D&G CANHSE224 Chemical Safety</p> <ul style="list-style-type: none"> · Understand the hazards of the contaminants present. · Consult MSDS, labels and other available information. · Determine material compatibilities. · Develop procedures for work around the contaminants. · Minimize manual handling of the contaminant. · Provide training specific to the contaminant present. · Stay out of areas where contaminant is present if possible. · Know where first aid and emergency response equipment is (shower/eyewash). · Participate in the medical surveillance program based on the type of contact, and the extent of potential exposure (concentration, frequency and duration). · Use PPE that is appropriate for the type of chemical and task being done such as body coverings, gloves, boots, goggles, face shield, respirator. · For indoor work or work in an enclosed space, monitor ambient air concentrations if volatile contaminants are present. 	3	2	6



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9.7 Hazard Mitigation #6 – Cars / Driving

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #6	Cars	Unsafe driving practices	Employee	5	3	15	<p>Drivers must have a valid drivers license.</p> <p>Driver abstracts may be reviewed for company vehicle drivers, based on client/project specific requirements. Follow applicable Provincial rules and regulations. Check weather and routes before departure. Obtain written driving directions prior to travel. In poor weather delay departure. When arranging transport request suitable vehicle that is equipped with seatbelts, roll bar, spare tire, winter tires, scraper, communication equipment, first aid kit, fire extinguisher. Conduct and document a preuse inspection of the vehicle including fluid levels. Carry extra windshield washer fluid if expecting to enter a dirty road area. File a planned route. Drive within your abilities; driver training and/or training on the project specific journey management plan may be required prior to travel. Adjust speed and handling to current road conditions. Extra caution must be taken when reversing. Use a spotter if possible. The spotter must communicate back-up instructions clearly and stand out of the way of a moving vehicle. Honk twice when reversing and once when moving forward from a stop. Cold weather and exhaust can reduce visibility. Reverse into parking spaces when possible. If you are unsure of your ability to control the vehicle in certain terrain, slow down or do not proceed. Check personal communication devices daily. Do not use electronic devices such as cell phones or blackberries while driving. Do not</p>	5	1	5



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							undertake other distracting activities while driving (e.g. eating, programming a GPS, reading a map). Utilize flame arrestors in internal combustion engine when driving on sites where explosive atmospheres exist.			
Hazard Mitigation #6	Driving (FATAL RISK)	Traffic and road conditions (e.g. heavy equipment traffic) (FATAL RISK)	Employee	5	3	15	Check weather conditions before travelling. Inspect your vehicle before use. Plan travel route and verify road conditions where possible. Obtain written driving directions prior to travel. Allow sufficient travel time to reach destination. Do not drive fatigued or after 14 hours or legislated hours. Obey all traffic signs and signals. Reduce speed in construction areas. Contact the owner if traveling on a private road. Always wear a seatbelt. Do not use a cell phone when driving. Verify and follow the rules of the road (speed limit, type of vehicles, rules on passing, signage, method of communication with other vehicles). Always carry the following emergency equipment: cell phone, flashlight, emergency road kit for winter conditions.	5	1	5
Hazard Mitigation #6	Driving (FATAL RISK)	Vehicle-Animal Collisions	Employee	4	2	8	Be alert for wildlife or domestic animals near the road, particularly at dusk, dawn and night. Look ahead across the road from shoulder to shoulder. If you see wildlife on the road, slow down and pass carefully, they may suddenly bolt onto the road. Watch for wildlife warning signs that indicate an area of increased animal population. Take extra precaution when traveling through these areas. Use high beams whenever possible and watch roadside ditches for animals or for reflections from animal eyes. Be aware some animals move in groups and more may be near the road than can be readily	3	1	3



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							seen. If the animal enters the path of the vehicle, do not swerve into the ditch or into on-coming traffic in an attempt to avoid a collision. Brake firmly if an animal is standing on, or crossing the road. Do not assume the animal will move out of your way. In the event of a collision, contact local Fish & Wildlife office or Department of Transportation if animal is still alive or if the carcass is a danger to traffic.			
Hazard Mitigation #6	Driving (FATAL RISK)	Winter driving	Employee	5	3	15	In addition to regular driving requirements, extra caution must be taken in winter driving conditions. Reduce speed. Leave extra distance between vehicles. Stopping on ice takes 8 times the distance as on dry pavement. Leave yourself extra time to get places. Check weather and road conditions before starting out. Extra equipment needed : warm clothing, blankets, food, Vehicle Safety Kit.	4	1	4
Hazard Mitigation #6	Driving on site	Dust generation	Environment	2	4	8	Access site conditions for dust potential and potential impacts on surrounding properties. Reduce vehicle speed in dust sensitive areas and choose appropriate tracks / roads. Monitor dust levels (visually). Monitor weather conditions (particularly wind direction). Inform all site personnel of site air quality management requirements. Consider weather and plan for dust suppression if required. Apply water (or other materials as appropriate) for dust suppression.	2	2	4
Hazard Mitigation #6	Pick-up truck	Carbon monoxide	Employee	5	3	15	Do not stay in the vehicle for long periods of time with the engine running. If the engine must be left running, verify that the exhaust pipe is free from obstructions. Conduct a daily inspection of the truck and its exhaust system	5	1	5



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #6	Pick-up truck	Parking on side of the road	Employee	5	4	20	Use barrier vehicle, pylons, or road signs. Check local regulations for requirements. Pull over as far as possible from the road or park in a pull out/rest area. Turn on 4 way flashers if the stop will be short. 4 way flasher operation will drain the battery unless the engine is running. Wear a high visibility vest.	5	2	10

9.8 Hazard Mitigation #7 – Manual Handling

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #7	Manual Handling (samples, equipment)	Manual handling	Employee	4	3	12	Do not lift loads that are too heavy or awkward. Keep weights of items or loads as low as possible. Avoid bending your back and twisting when lifting, lowering and carrying. Hold the load close to your body to reduce the force required to lift. Lift with feet shoulder width apart, keep natural curve of spine, use leg muscles to lift, do not hunch or twist. Store heavy items at waist level to avoid bending or reaching - most lifting strength is in this zone. Use trolleys and other mechanical lifting aids. Divide the load between containers and/or ask for help and use a two person lift and carry. Stretch before handling loads.	3	2	6



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9.9 Hazard Mitigation #8 – Hunting Season

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #8	Hunting Season	Gun fire	Employees	5	2	10	Know when bear and other game hunting season is in effect. Understand the hunting regulations in the area (what type of equipment is permitted, if bear baiting is permitted). Rearrange your work during hunting season if possible. If you must be in the area during hunting season, make your presence known, make noise to distinguish yourself from animal calls or activity. Work in pairs and be under constant communication. Wear high visibility clothing and bright coloured head gear.	5	1	5

9.10 Hazard Mitigation #9 – Radiation

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #9	Ionizing radiation	x-rays, gamma rays, high frequency ultraviolet, etc.	Employee	3	3	9	Determine the type of contaminate present and the radiation potential. Reference D&G CANHSE228 Radiation Safety . Follow the site rules regarding exposure prevention (shielding, time and distance, PPE), dosimeter testing to monitor exposure, medical surveillance. Establish a procedure to decontaminate equipment before it leaves site. Provide wash-up facilities and decontamination procedures for PPE and site personnel. • On-site client specific orientation. Radiation safety course. REVIEW PROJECT SPECIFIC RADIATION PROTECTION PLAN	2	2	4



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Tasks	Task	External gamma radiation	Employee	3	3	9	REVIEW PROJECT SPECIFIC RADIATION PROTECTION PLAN	3	1	3
Tasks	Task	Inhalation/Ingestion of Radioactive Dust	Employee	3	3	9	REVIEW PROJECT SPECIFIC RADIATION PROTECTION PLAN	3	1	3

9.11 Hazard Mitigation #9 – Slips Trips and Falls

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #10	Slips, trips and falls	Slips, trips and falls	Employee	4	3	12	Use care and attention when walking. Establish level pedestrian footpaths where possible. Level out work areas where possible. Choose a route free of obstacles and slippery or soft ground. Walk, don't run, in a controlled manner. Avoid making sudden changes in direction and speed. · Wear appropriate construction safety boots that offer good support and have a good tread. In snowy and icy conditions, clear snow and control ice with melting agents. Consider boot cleats for added traction. Relay hazard to others, clear or mark and report the potential hazard. Keep your workspace clean, tidy and free of slipping hazards. If any equipment or materials need to be stored, designate pre-approved locations, out of traffic areas.	3	3	9



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #10	Walking/hiking	Walking/hiking	Employee	3	5	15	·Establish route and an alternate communication and check-in system. Check weather. Verify personal limitations capable of handling the terrain. Wear footwear and clothing to provide support and protection. Carry a map, compass and GPS. Verify function of cell, satellite phone or radio on a daily basis. If in a forest fire region, check local hotline or website.	3	2	6

9.12 Hazard Mitigation #11 – Portable Tools

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
General Hazard Mitigation #11	Using hand tools and portable equipment	Damaged tools	Employee	4	3	12	Check handles and heads on hammers, sledges, shovels, picks, mattocks, and other such tools for splinters, soundness, and adequate sharpness. Remove from service and tag all tools having defects that will impair their strength or render them unsafe.	2	2	4
Hazard Mitigation #11	Using hand tools and portable equipment	Entanglement	Employee	3	3	9	Where a tool has rotating parts, do not wear loose or frayed clothing, dangling jewellery, rings, chains that could become caught in the moving parts. Check that guards are in place before using. Tie long hair back.	2	2	4
Hazard Mitigation #11	Using hand tools and portable equipment	Ergonomics	Employee	3	3	9	Consider ergonomic factors such as the weight of the tool, the handle texture, size and shape, vibration and your posture when using and carrying tools. Choose tools that prevent bending at the wrist and reduce gripping pressure. Where possible keep the load close to your body with its weight distributed evenly across the body (i.e. held in two hands). If load is too heavy, ask for help. Where the work is	3	2	6



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							physically demanding: - Avoid exclusively using one hand or muscle group when using tools. - Rotate different people through the task. - Break the task up over the day.			
Hazard Mitigation #11	Using hand tools and portable equipment	Flying objects	Employee	3	2	6	Wear safety glasses or goggles when using equipment that has the potential to eject particles or substances. This may include non-powered hand tools where there is a risk of flying rock fragments.	2	2	4
Hazard Mitigation #11	Using hand tools and portable equipment	Use of incorrect tool	Employee	3	2	6	Before starting work, determine the risk associated with using the incorrect tool. Obtain the correct tool wherever possible. Do not attempt to modify a tool to undertake a task that it was not designed to do.	2	2	4
Hazard Mitigation #11	Using hand tools and portable equipment	Using hand and portable powered tools	Employee	3	3	9	Reference Directive and Guideline CANHSE243 Hand and Portable Powered Tools. Indicate the power sources used to power tools (eg. Pneumatic, Electrical, Explosive) and any required safeguards (e.g. GCFI). List all tools here and attach a Work Instruction for each tool. Identify here the PPE that is required for each tool. List here the necessary training to operate the tools.	3	1	3



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9.13 Hazard Mitigation #12 – Sample Management and Waste Generation

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #12	Groundwater management	Waste management (purge water)	Environment	3	3	9	Remediation debris must not be disposed or released to surface waters, storm water, or sewer catch basins. Deposit remediation debris on-site only if they will not cause adverse impacts to the project site and the practice is permitted by the client. Do not deposit remediation debris near waterways. If the site is likely to contain contaminants, characterize and dispose of potentially waste as required by local legislation. Whenever possible, segregate 'construction debris' from other site waste for recycling.	2	2	4
Hazard Mitigation #12	Sample management	Waste generation	Environment	4	4	16	All samples become waste when they are no longer required. Collect only the number of samples required to meet project excellence demands. Avoid collecting extra samples that may be contaminated or cannot be preserved to ensure analytical quality. Dispose appropriately at approved facilities. Review handling, treatment and disposal requirements. Do not treat waste samples without appropriate permit or approval. Dispose in accordance with local regulatory requirements.	2	2	4
Hazard Mitigation #12	Site consumables	Waste generation	Environment	3	3	9	All waste (gloves etc.) shall be removed from site and disposed appropriately (as required by local law).	2	2	4



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9.14 Hazard Mitigation #13 – Cold

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #13	Cold	Frostbite, hypothermia, sunburn, snow blindness	Employee	5	3	15	<p>Check daily weather reports. If possible reschedule work to a warmer day. Wherever possible, increase temperature through air heating and increased air movement. Assess physical demands of the work. Provide equipment that will reduce the physical demands, to reduce sweating. Work in sheltered areas, or provide barriers to give shelter from the wind. Schedule work to allow workers to acclimatize. Increase the frequency and lengths of break periods. Provide a warm, sheltered place to take breaks. Work in pairs whenever practical to reduce exposure time. The buddy system will allow for frequent checks for frostbite (e.g. white or black spots on skin) and hypothermia. Lone work can only be performed if adequate controls are in place to monitor the employee (e.g. other people on-site). Make sure to have food and drink available. Drink plenty of fluids, not caffeine or alcohol. Wear clothing appropriate for the weather conditions. Wear multiple layers. Foot, hand and facial protection is essential. Eye protection is required against ice particles, snow and sun. Survival kit to include hot packs, blankets and spare clothing. Workers must be trained in the use of survival equipment.</p>	2	2	4



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9.15 Hazard Mitigation #14 – Drilling

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #14	Drilling	Site environmental protection	Environment	2	3	6	Inspect the worksite and identify structures, trees, vegetation, wetlands, watercourses or wildlife habitat that needs to be protected/preserved. Follow guidance contained within the Drilling HSE D&G.	2	2	4
Hazard Mitigation #14	Operating the push-tube rig	Environmental	Employee	2	2	4	If possible replace spoil from drilling. Do not dispose of excess spoil near waterways.	2	1	2
Hazard Mitigation #14	Operating the push-tube rig	Equipment failure	Employee	3	2	6	Prior to undertaking work inspect the vehicle to ensure it is in operational condition. Checks should include the vehicle itself (tires, water, oil etc), rig (hoses, cutting shoes, rod threads) and emergency devices and equipment. Do not use the rig if it cannot be operated safely. Full length clothing, safety glasses, work boots and hard hat shall be worn when the rig is operating.	3	1	3
Hazard Mitigation #14	Operating the push-tube rig	Manual handling	Employee	3	2	6	Use appropriate manual handling techniques when handling augers. Keep the load close to your body and avoid overreaching. Where possible, slide items from the rear of the vehicle rather than lift them. When using lifting devices, verify they have been tested annually. Inspect slings before use. Verify their load capacity. Establish a communication plan for the lift.	3	2	6
Hazard Mitigation #14	Operating the push-tube rig	Moving parts	Employee	4	3	12	Drill rig operator top perform daily pre-start check of drill rig. Stand well clear of the machinery when in operation and be familiar with emergency stop devices fitted to rig. No loose clothing to be worn and all long hair to be tied back. If safety vests are worn they must be fastened at the front. Guarding	2	2	4



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							required around rotating drill string. Golder employees not permitted within 1m of rotating drill string. Sampling must be taken from outside this area or when drill string is stationary. If using continuous flight auger, remain out of the 'line of fire' when drillers are changing drills stems. This is particularly important if D clips are used as these can become projectiles when removed from the drill string.			
Hazard Mitigation #14	Operating the push-tube rig	Overhead obstructions	Employee	3	3	9	Ensure the area is clear of overhead obstructions prior to moving vehicle or raising mast. Check local/provincial legislation for minimum distances from overhead power lines.	3	2	6
Tasks	Operating the push-tube rig	Sharp objects	Employee	2	2	4	Keep hands clear of rod joins when loosening and tightening. Be aware of burrs. Wear protective leather gloves.	2	2	4
Hazard Mitigation #14	Operating the push-tube rig	Underground services	Employee	4	3	12	Check for location of underground services prior to commencing ground - penetrating work. Use a service locator and the following cues to assist in identifying possible underground services.- Look for signs of patching of pavements.- Look for service boxes, pits, manholes as they may indicate the presence or alignment of services.- Make note of services coming into or out of the ground (e.g. power lines, down pipes).If uncertainty exists, consider alternate drilling methods such as vacuum excavation. When possible, shut off any services in the area where the drilling is to occur.	4	2	8

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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #14	Operating the push-tube rig	Uneven ground	Employee	4	3	12	Do not position the rig on steeply sloping or even ground. Ensure the handbrake is applied when the vehicle is correctly positioned. Use stabilizing legs to level the rig prior to raising mast. Use timber blocks under legs on soft ground.	4	2	8
Hazard Mitigation #14	Operating the push-tube rig	Waste generation (consumables)	Environment	2	3	6	Use reusable PPE and sampling equipment where possible (e.g. ear protection, bailers). All waste consumable products (e.g. filters, gloves) must be removed from site and placed in a designated waste bin. Collect bins for removal from the site. Dispose in accordance with provincial / local regulatory requirements.	2	2	4
Hazard Mitigation #14	Operating the push-tube rig	Waste generation (drill cuttings)	Environment	3	5	15	Drill cuttings and sediments, or storm water run-off must not be disposed or released to surface waters, storm water, or sewer catch basins. Replace spoil (drill cuttings) from drilling into the test hole only if they will not cause adverse impacts to the project site and the practice is permitted by the client. Do not deposit drill cuttings near waterways. If the site is likely to contain contaminants, Characterize and dispose of potentially contaminated drilling waste as required by local legislation.	3	2	6
Hazard Mitigation #14	Spills and releases	Land, air, water contamination	Environment	4	4	16	Review drilling equipment maintenance records to assess quality of hydraulic / lubricating systems. Conduct daily pre-work inspection of drill rig hydraulic / lubricating systems. Install hose connections where hydraulic collection systems at locations where hydraulic leaks are probable. Maintain a spill kit (outfitted appropriately to contain/absorb leaked fluid) on site at all times. In the event of a release or spill, shut down equipment.	3	2	6



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Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							Contain and clean-up spilled material and any contaminated soil. Report release / spill to the project manager and Learnings Database. Report to government environmental agencies if required under local laws.			
Hazard Mitigation #14	Waste	Waste generation (consumables)	Environment	2	3	6	Use reusable PPE and sampling equipment where possible (e.g. ear protection, bailers). All waste consumable products (e.g. filters, gloves) must be removed from site and placed in a designated waste bin. Collect bins for removal from the site. Dispose in accordance with provincial / local regulatory requirements.	2	2	4

9.16 Hazard Mitigation #15 – Soil Sampling

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #15	Soil Sampling - Test pit	Contaminants	Employee	4	2	8	Reference D&G CANHSE224 Chemical Safety and CANHSE227 Personal Protective Equipment. Do not enter the excavation if there is a potential for soil contaminant (as this could result in an oxygen deficient atmosphere). Wear gloves and PPE appropriate for the expected contaminants that may be encountered (in selecting PPE consider potential exposure routes associated with the contaminant – e.g. inhalation, ingestion, skin contact), when in work areas and whilst undertaking sampling tasks	4	1	4
Hazard Mitigation #15	Soil Sampling - Test pit	Difficult terrain (e.g. long grass, wet and boggy conditions, icy)	Employee	2	3	6	Plan your fieldwork. Contact the client and request suitable access to the sampling location be provided e.g. grass slashing. Confirm suitability of ground conditions e.g. defined access tracks, creek crossing, wet weather, snow removal.	2	2	4



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #15	Soil Sampling – Test pit	Manual handling	Employee	3	3	9	Reference D&G CANHSE233 Ergonomics. Develop a work instruction for the task. Keep sample bag size to a minimum. If necessary split the same across two bags to reduce the weight. Hold the sample bag against your body when carrying to reduce the strain on your lower back.	3	1	3
Hazard Mitigation #15	Soil Sampling – Test pit	Underground services	Employee	5	3	15	Reference D&G CANHSE220 Locates. Follow the work instruction for conducting utility locates. Check for location of underground services prior to commencing ground - penetrating work. Use a service locator and the following cues to assist in identifying possible underground services.- Look for signs of patching of pavements.- Look for service boxes, pits, manholes as they may indicate the presence or alignment of services.- Make note of services coming into or out of the ground (e.g. power lines, down pipes).	3	2	6
Hazard Mitigation #15	Soil Sampling – Test pit	Water receptors	Employee	3	3	9	Where possible, avoid undertaking test pit sampling within 25 metres of watercourses including dry creek beds. If this cannot be avoided sediment and erosion control measures need to be considered	2	2	4



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

9.17 Hazard Mitigation #16 – Groundwater Sampling

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #16	Groundwater sampling	Contaminants	Employee	3	3	9	Reference D&G CANHSE224 Chemical Safety. Review the chemicals of concern that you are sampling for. Understand the chemical exposure limits, whether monitoring is required and the necessary PPE you should be wearing. Full length clothing, safety glasses and nitrile gloves (under leather gloves if required to protect against shard edges) shall be worn prior to opening the well until analysis is complete. When opening wells avoid placing your face near the opening of the well. Dispose of bailed water away from yourself and avoid splashing on yourself or equipment.	2	3	6
Hazard Mitigation #16	Groundwater sampling	Hazardous substances	Employee	3	2	6	Reference D&G CANHSE224 Chemical Safety and CANHSE227 Personal Protective Equipment. Nitric acid is considered a hazardous substance, primarily due to eye or skin contact. Wear safety glasses and nitrile glove and open the sample container at arm's length to minimize splashing.	2	1	2
Hazard Mitigation #16	Groundwater sampling	Manual handling	Employee	3	3	9	Reference D&G CANHSE233 Ergonomics. Develop a work instruction for the task. If the well lid is trafficable (e.g. gatic cover) use appropriate tools to remove the lid. Hammers, screwdrivers etc shall not be used for this task. Position your work vehicle close to the well location to minimize carrying of equipment. Position yourself in a way that minimizes bending of your lower back. A collapsible stool may be used if the well location is near ground level. Use a pump if large volumes of water need to be removed. A tripod should be used to lower the pump down the well if the pump	3	2	6



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #16	Groundwater sampling	Sharp edges	Employee	3	3	9	Wear leather gloves (or similar) when opening the lid of the well. Use hand tools if the lid is 'trafficable' (i.e. gatic cover designed to be walked on).	2	2	4
Hazard Mitigation #16	Groundwater sampling	Site contamination and waste generation	Environment	3	5	15	Place a sheet of plastic on the ground and fill samples over a bucket to ensure significantly contaminated water does not contact the ground. Golder will containerize all purge water in ULC approved liquid drums for disposal by CNL. Solid waste products (filters, gloves) should also be stored in CNL approved containers for disposal.	2	2	4
Hazard Mitigation #16	Waste generation	Waste management (purge water)	Environment	3	3	9	Purge water, must not be disposed or released to surface waters, storm water, sewer catch basins or the ground. Golder will containerize all purge water in ULC approved liquid drums for disposal by CNL. DRUMS MUST BE PROPERLY LABELLED, including water proof labelling (e.g wrap drum label in clear packing tape)	2	2	4

9.18 Hazard Mitigation #17 – Working Near or On Water

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #17	Working near water	Fast moving water	Employee	4	3	12	Minimize time adjacent to or in water. Carry only equipment needed to complete each task. If bags or belts are used to carry equipment, these should be designed to allow for quick release. Personal Floatation Device shall be worn for activity within 1m of a watercourse. Consider emergency response processes.	4	1	4



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							This may consist of a rope ladder or similar if the river bank is steep. Lifebuoys or a buoyant heaving line must be provided for emergency rescue use. Consideration shall also be given to first aid and emergency provisions if contaminants are likely to be present in the water body. A buddy shall be positioned to assist in emergency. Do not wear waders or similar clothing in fast flowing rivers as these can fill with water and increase the risk of drowning. Rivers with depth above 1m and velocity greater than 1m/s are not safe for wading. Verify employees have the necessary training for working near fast moving water, which may include, and Swiftwater Rescue training, is mandatory for all field crew members working on or adjacent to rivers with these conditions, including training on emergency gear and training on foot entrapments.			
Hazard Mitigation #17	Working near water	Inclement weather	Employee	3	3	9	Assess weather and marine forecast the day prior and on the morning of work. Postpone the activity if weather forecast is not favourable. Remain vigilant at all times and continually re-assess weather conditions and associated risks. Monitor weather conditions and do not enter vicinity of streams if raining in catchment area.	3	2	6
Hazard Mitigation #17	Working near water	Still or slow moving water	Employee	2	3	6	Minimize time adjacent to or in water. Carry only equipment needed to complete each task. If bags or belts are used to carry equipment, these should be designed to allow for quick release. Personal Floatation Device should be worn for activity near a watercourse where there is a sudden drop of greater than 1 meter from the sampling location or any realistic risk	2	2	4



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							of drowning. Consider emergency response processes. This may consist of a rope ladder or similar if the river bank is steep. Lifebuoys or a bouyant heaving line must be provided for emergency rescue use. Consideration shall also be given to first aid and emergency provisions if contaminants are likely to be present in the water body			
Hazard Mitigation #17	Working near water	Traversing wetlands and shoreline	Environment	4	5	20	Plan route to prevent possible damage to ecosystem and wildlife habitat. Chose path to traverse shoreline carefully to ensure worker safety and minimize damage to shoreline ecosystem and fish or wildlife habitat. Identify and avoid areas of high conservation value. Drive with caution to minimize impacts on ecosystem or habitat. Inspect travel path for damage. Develop and implement plan to restore damaged areas as required.	3	3	9
Hazard Mitigation #17	Motorized boat	Motorized boat	Employee	5	3	15	Only trained certified operators may operate a motorized boat (Pleasure Craft Operator Card PCOC). Use only well maintained boats. Conduct a visual inspection prior to departure. Plan the route and an alternate. Check local weather conditions and local navigational hazards and depths. Ask about navigational markers in the area. Never boat alone. Carry sufficient fuel, taking into account the chance of a change in weather that prolongs the trip. Never boat in areas beyond your skill level. Do not overload the boat. Distribute the weight evenly. Keep deck tidy to avoid trips. Use appropriate speed for the water conditions and your familiarity with the area. Pack spare clothing in a water tight bag. Wear a survival suit if water temperature is below 10 C. Carry	5	1	5





HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							and wear life jacket for each passenger, 2 oars, anchor, bailer or bilge pump, fire extinguisher, water tight flashlight, buoyant heaving line, life buoy, first aid kit, pyrotechnics, sound signaling device, navigation lights, depending on size of boat. All field staff working on boats must have water survival suits on.			

9.19 Hazard Mitigation #18 – Working at Heights

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #18	Working at height (FATAL RISK)	Fall from Elevation, falls into hazardous equipment or water (FATAL RISK)	Employee	5	4	20	Reference D&G CANHSE226 Fall Protection. Install guardrails to prevent a fall where possible. When a guardrails cannot be put in place, a control zone can be used. A control zone consists of temporary barriers 2 m from the edge of the elevated work surface. An attendant is required to monitor the control zone and prevent access unless a travel restraint system is used. Use a travel restraint system for flat, elevated work surfaces to prevent workers from falling if guard rails or a controls zone cannot be used. A fall arrest system is to be used when guard rails, controls zones or travel restraint are not practical or cannot be put in place. A rescue plan must be put in place and tested whenever fall arrest is used. Inspect all fall restraint and fall arrest equipment before use. Only trained personnel may use and inspect fall restraint and fall arrest equipment. Verify the strength of the anchor point.	4	2	8



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #18	Ladders	Ladders	Employee	5	3	15	Reference D&G CANHSE234 Ladder Safety. Understand the worksite regulations with respect to working at heights. Choose the right ladder for the job (kind and material of construction). Do not use metal ladders near live electrical equipment or conductors. Do not erect long or heavy ladders by yourself. Do not use ladders in high winds. Inspect the ladder before use. Look for wear, cracks or damaged components. Look up before erecting a ladder to make sure there are no overhead hazards such as power lines. Do not erect ladders in front of doors or access ways unless a spotter prevents through traffic, or the access point can be secured. Erect the ladder on a flat level surface at a 4:1 or 3:1 angle. Secure the base of the ladder against displacement. Climbing ladders requires three point contact. Never carry tools up and down a ladder, use your pockets, a belt clip or a rope and container to move tools and equipment up and down. Tie off the top of the ladder. Make sure the soles of your boots are clean and dry. Never work off of a ladder unless you can maintain three point contact or you are tied off. An extension ladder must extend 0.9 m past the top of the structure you are climbing. Never step on the top step or platform of a step ladder. Keep the top and bottom areas of the ladder free of debris.	4	3	12
Hazard Mitigation #18	Scaffolds	Working at height	Employee	5	4	20	Reference D&G CANHSE236 Scaffolds and Job-Built Work Platforms. Verify that erection contractors are qualified. Verify that the scaffold has been inspected (inspection tag with no cautions). Determine if fall protection equipment is required and the location of	3	2	6



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							anchor points. Verify or develop a rescue plan for extraction of an injured worker.			

9.20 Hazard Mitigation #19 – Confined Space Entry

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
Hazard Mitigation #19	Confined Space Entry	General	Employee	5	4	20	Only trained workers will conduct confined space entry assessments. Only trained workers will enter a confined space. Identify all existing and potential confined space work locations for the project. Where possible, eliminate the need to enter the confined space by adopting an alternate approach to the work. Post a confined space sign at the entry to the confined space. Conduct a hazard assessment. Prepare a confined space entry plan which describes methods, procedures and practices for controlling the identified hazards (e.g. isolation measures, LOTO, control of ignition sources, movement of materials, ventilation or purging, control of flammable or explosive conditions, lighting requirements, alarms, methods of communication, method of egress, PPE, emergency equipment, rescue plan, atmospheric testing, duties of workers, coordination of activities, warning signs, barricades). Conduct atmospheric testing before each entry, continuously and while workers are in the space. Assign a qualified attendant to monitor conditions outside of the confined space and to maintain constant communication with entry workers. Have rescue equipment and a rescue team on-site	4	2	8



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

Mitigation Reference	Initial Risk	Hazard	PA	IC	IL	IR	Controls	RC	RL	RR
							and ready to deploy. PPE will depend on the environment within the confined space and the work being performed within.			



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

10.0 PERSONAL PROTECTIVE EQUIPMENT

Item	Required	Provided by Golder	Provided by Client	Specific Requirement
Cold Weather Gear	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Coveralls				
General	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Gloves				
Chemical resistant	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Nitrile gloves during sample handling
High Visibility Clothing				
Orange	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Other	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Orange hat when in forest areas
Safety Footwear				
Safety boots	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Safety gumboots	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	potentially some samples near wetlands
Eye Protection				
Splash resistant safety goggles	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	During GW Sampling
Eye protection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	During walking through forest
General Protection				
Sun cream or block	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	As necessary
Hand warmers / Glove	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	As necessary
Sediment Sampling Equipment				
Lifejacket	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	During Ottawa River sampling
Water Survival Suit	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	During Ottawa River sampling
Radiation Equipment				
Required meters	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	See Radiation Protection Plan



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

11.0 TRAINING

It is up to the Project Manager to arrange for the following training e.g. Confined Spaces.

Course Name	Employee Name or Role
WHMIS	Alex Wood, Matt Riopelle, Bret Timmis, James Doyle
Ontario Safe Boater Card	Chuck Albert
ISR Certification Course for Radiological Scanning	Alex Wood
Confined Space Training	Based on discussions with CNL, it is not expected this will be required. If Confined Spaces entry is required (or any entry into any manhole), work cannot proceed until all of the following are met A) CNL and Golder have been informed, B) all required training is conducted and verified to be acceptable, C) a confined space entry permit is provided and signed by Golder and D) a work permit is provided and signed by CNL
Contractor Safety Training	Alex Wood, Matt Riopelle, Bret Timmis, James Doyle, Chuck Albert, Thomas Watt, Joseph Vu, Dustin Kelly, Guanle Shi, Lee Williams, Matthew Barnes, Ryan O'Sullivan, Saul Cerna, David Pincince, Ahmad Abudukarim
Group 4 Radiation training	Alex Wood, Thomas Watt, Joseph Vu, Saul Cerna, David Pincince, Alex Wolf, Lee Williams, Ahmad Abudukarim

12.0 HSE PLAN CONTROL

It is the responsibility of the Project Manager to ensure that this HaSEP is prepared and the contents communicated at the pre-start / toolbox meeting to all project staff, Golder or subcontractor, with a copy held on site. The HaSEP has been reviewed or prepared by the Project Manager.

If the project site is remote from the home office, this HaSEP is to be reviewed and approved by the local Golder office whether in another country, province or city.

Role	Name (printed)	Date	Signature
Prepared by	Bret Timmis	November 18, 2016	
Reviewed by	Paul Hurst	November 18, 2016	
Approved by	Dave Smyth	November 18, 2016	
Other			



HEALTH AND SAFETY ENVIRONMENT PLAN (HASEP)

12.1 Golder Sign-off

Signing below indicates you have read and agree to comply with the information contained in this document.

Date	Name	Company	Signature
	Matt Riopelle	Golder	
	Alex Wood	Golder	
	Bret Timmis	Golder	
	James Doyle	Golder	
	Chuck Albert	Golder	
	Thomas Watt	Golder	
	Alex Wolf	ISR	
	Ahmad Abudulkarim	ISR	
	Joseph Vu	ISR	
	Dustin Kelly	ISR	
	Guanle Shi	ISR	
	Lee Williams	ISR	
	Matthew Barnes	ISR	
	Ryan O'Sullivan	ISR	
	Saul Cerna	Drain-All	
	David Pincince	Drain-All	

13.0 OTHER DOCUMENTATION

When reading this HaSEP please refer to the following documentation from clients etc., as required:

Document	Link to Document
Radiation Protection Plan	Attached



APPENDIX D

Radiation Protection Plan

DATE November 21, 2016**DOCUMENT No.** 1666131-2 REV3**TO** Bonnie Bayne, Canadian Nuclear Laboratories**CC****FROM** Paul Hurst**EMAIL** Paul_Hurst@golder.com**RADIATION SAFETY PLAN – NPD REV 3**

CNL's NPD site is the site of a decommissioned nuclear power demonstration and generating station. Golder will be conducting an environmental assessment and the activities include surface radiation measurements, effluent pipe scanning, surface soil sampling, subsurface soil sampling, groundwater sample collection, and sediment sample collection. Work will be conducted in both the Licenced Area and un-licensed area. Subsurface sampling at Landfill #1 and within the Licensed Area has slightly an increased risk for radiological hazards. Any work conducted at Landfill #1 and within the Licensed Area requires Group 4 training and agreement to be designated as a Nuclear Energy Worker.

Monitoring results from CNL supplied documents indicates low ambient gamma dose rates on the order of ~5uR/h. Documents also show that, in addition to naturally occurring radioactive materials (NORM) Cs-137 and tritium are present in soils/water and Sr-90 in water. The concentrations of non-NORM nuclides is typically low.

Past monitoring indicates the radiation hazards are expected to be low; however the historic use of the site could present radiation hazards.

Hazards and Mitigation

Hazards from the extraction and handling of soil containing radionuclides consist of direct gamma radiation, radon and long-lived radioactive dust inhalation, and contamination/ingestion.

Any work in the licensed area will require CNL Group 4 Radiation Protection training and agreement to be a Nuclear Energy Worker.

Direct Gamma

Previous gamma radiation measurements indicate low dose rates across the site and Golder expects low doses for all workers and will not issue licenced dosimetry nor deem workers Nuclear Energy Workers (NEWs). Either may be done at CNL's request and under their radiation protection program. All workers should be willing to be deemed NEWs.

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Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America



While doses are expected to be low, the potential for high levels from a small sources on site are possible. To protect against this hazard, each worker or worker group (i.e. all drilling crew within a small area) will wear an alarming electronic personal dosimeter (EPD). EPDs will be set to alarm in fields of 10uSv/h. Any alarm will trigger staff to leave the area.

Hot spots are assumed to be localized and work in these small areas is only expected to occur over the span of hours. Fields of ~10uSv/h for a few hours does not present significant hazard nor will it allow any individual to exceed the non-NEW dosimeter annual limit of 1mSv.

The potential for elevated samples exists. Given the low volume of a samples and anticipated low activity, elevated doses are unlikely. Field staff sampling will wear an EPD and any alarm will trigger work to be stopped.

A calibrated (as per NSRD regulations) gamma dose rate meter will be available on site to confirm dose rates in areas and when a new sample is retrieved and the worksite upon entering. All staff using dose meter must be appropriately trained and weekly source checks must be completed

Inhalation Hazards

Golder's workplan mainly involves drilling into soil and removing samples for analysis. The soil coring method proposed is "push" method and will limit dust generation and the amount of material extracted. The outdoor environment will further mitigate inhalation hazards.

There will be some concrete coring. To limit dust the area to be cored will be kept wet.

At this time there are no proposed measurements of airborne radionuclides. Likewise, there is no bioassay for ingested radionuclides suggested. CNL may, as per their RPP, choose to collect bioassay samples or perform whole body scans.

Should conditions change and there is visible dust, additional water shall be added. Visible dust may require suppression or the use of respiratory protection.

Contamination

There is a potential hazard is from contamination and subsequently ingestion. To protect against contamination, coveralls and disposable nitrile gloves, in addition to standard PPE, will be worn to protect against skin contact with soils.

Any materials that comes into contact with a soil will be cleaned on site using a portable wash station and scanned for fixed contamination prior to leaving site. Additionally, CNL may require scanning to be completed by their surveyors in the field. The proposed action limit is 0.4 Bq/cm² (averaged over 100cm²) for fixed contamination.

A calibrated RadEye B20 (or similar) meter sensitive to alpha, beta, and gamma will be used. All contaminated waste will be stored on site. We do not anticipate having to sample for loose contamination after cleaning.

Other

Dose rates on contact, and at 1 m of any waste drums will be collected at the end of the field program for characterization purposes. Any elevated levels will cordoned off and identified using detailed signage.

Transportation

Activity for all samples will be calculated and characterized, documented, and labelled as per TDG and PTNS regulations.

Administrative Control Levels

Administrative control levels are provided in Table 1.

Table 1: Administrative Control Levels

Hazard	Limit	Action
Dose Rate (area)	10 μ Sv/h	Suspend work and consult Radiation Specialist. Confirm remaining activities will not exceed overall limit.
Fixed contamination (alpha emitters)	0.4 Bq/cm ²	Re-clean and scan. If it cannot be reduced, contact Radiation Specialist.
Fixed contamination (beta-gamma emitters)	4.0 Bq/cm ²	Re-clean and scan. If it cannot be reduced, contact Radiation Specialist.
Airborne dust	Visible	Wet materials to suppress dust, use P95 dust mask. Stop work and contact Radiation Specialist.
Transport	Not exempt	If not exempt, contact TDG/Radiation Specialist

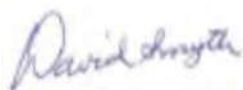
Any work stoppage due to dose rates higher than 10 μ Sv/h will require the elevated area or samples to be evaluated by a radiation specialist prior to work resuming.



Jeff Fleming
National Radiation Specialist



Paul Hurst
Project Manager, Senior Environmental Engineer

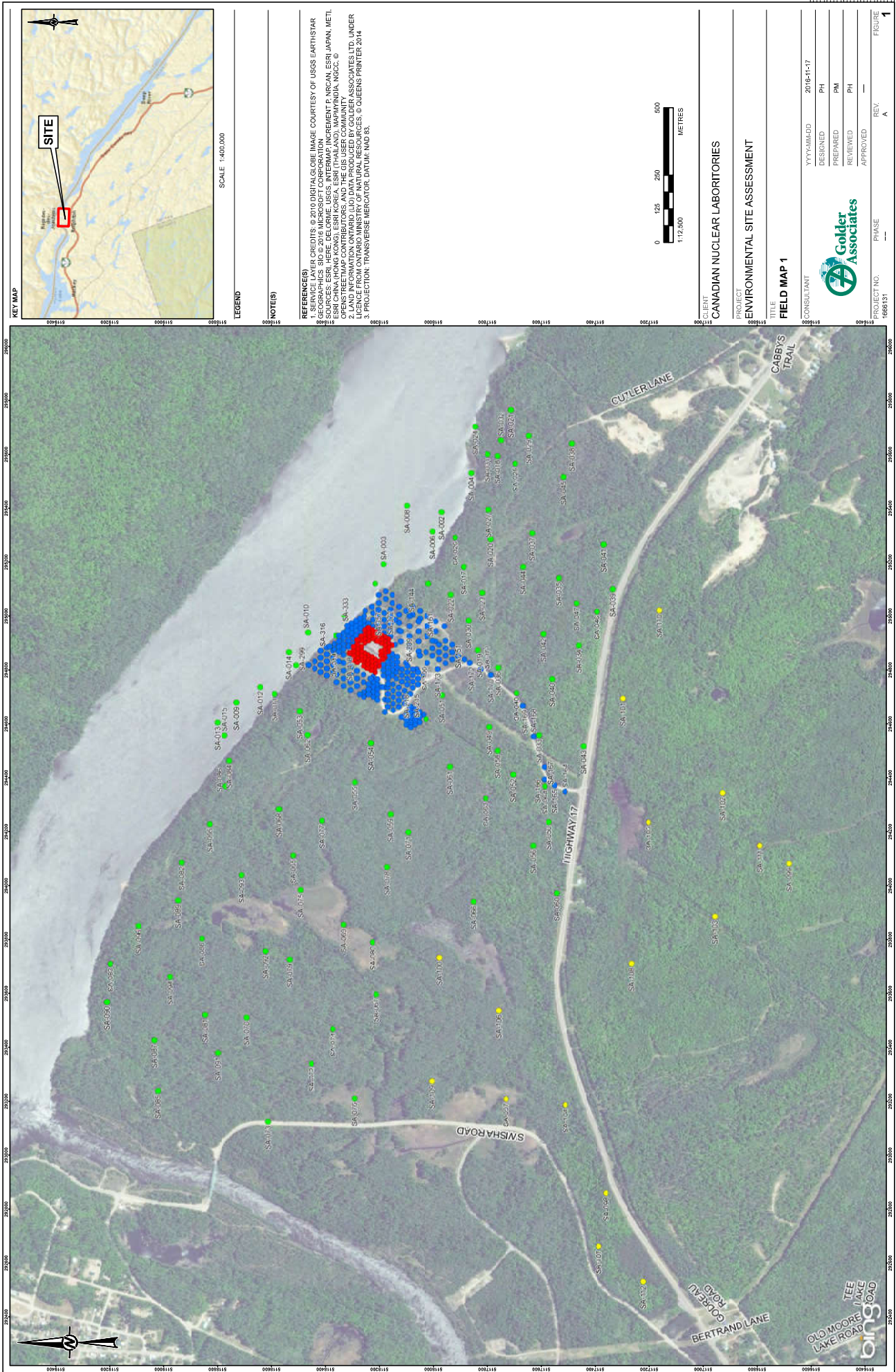


David Smyth
Project Director, Principal, Senior Hydrogeologist



APPENDIX E

Field Maps



KEY MAP

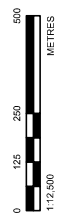


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LEGEND

NOTES

REFERENCES
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 2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDIER ASSOCIATES LTD. UNDER LICENSE FROM THE GOVERNMENT OF ONTARIO.
 3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83.



CLIENT: CANADIAN NUCLEAR LABORATORIES

PROJECT: ENVIRONMENTAL SITE ASSESSMENT

TITLE: FIELD MAP 1

CONSULTANT	YYYYMMDD	2016-11-17
DESIGNED	PH	
PREPARED	PH	
REVIEWED	PH	
APPROVED	PH	



PROJECT NO.	PHASE	REV.	FIGURE
1666131	---	A	1



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LEGEND

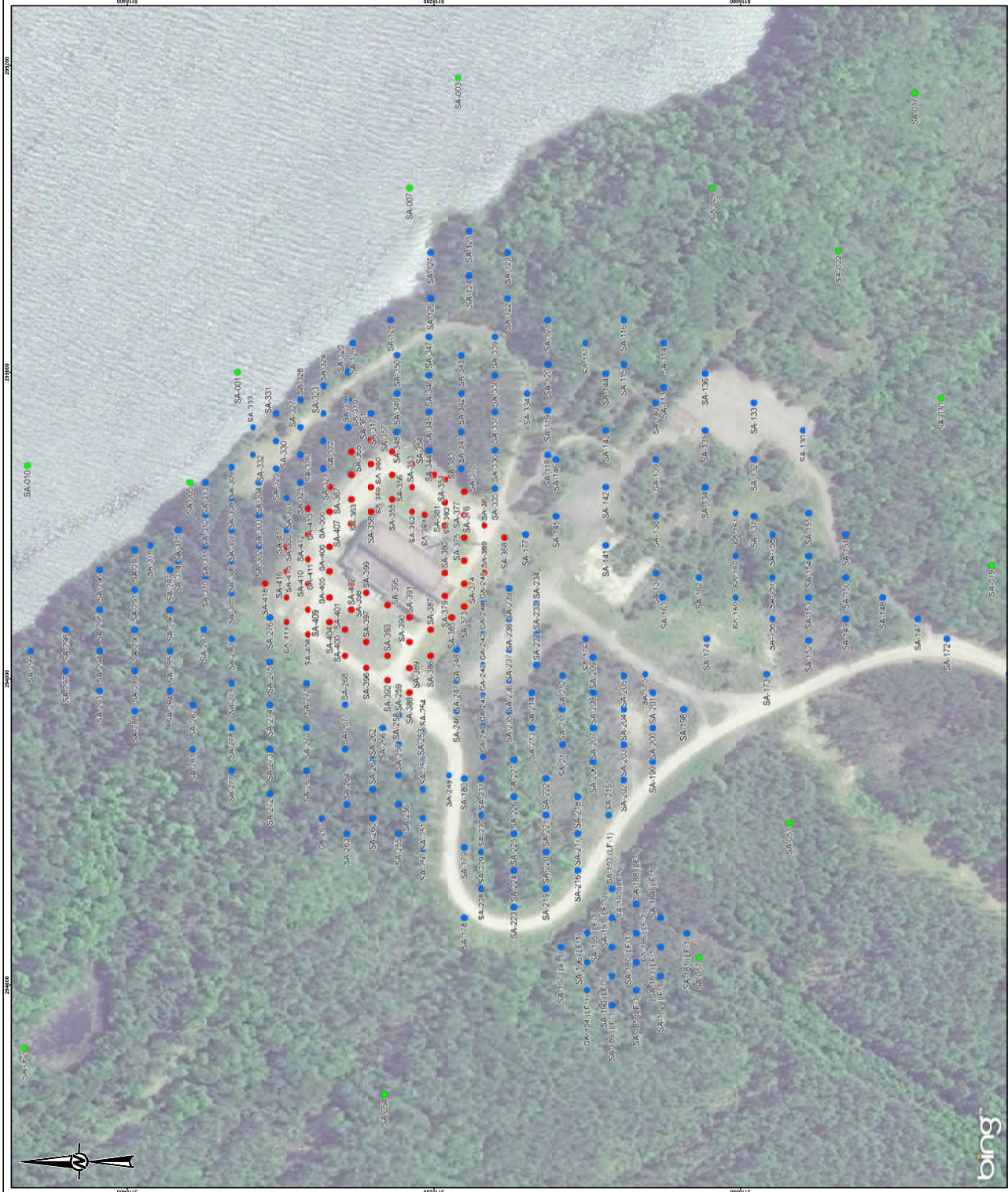
NOTES

- REFERENCES**
- SERVICE LAYER CREDITS. © 2010 DIGITAL GLOBE IMAGE COURTESY OF USGS EARTHSTAR GEOGRAPHICS. SID © 2016 MICROSOFT CORPORATION. ESRI, HERE, DELTA, NAVTEQ, SATELLITE, AIRPHOTO, GEBCO, ESRI CHINA (BEIJING), ESRI KOREA, ESRI (THAILAND), MAPMYINDIA, NAVTEQ, OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY.
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 - PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83.



CLIENT: CANADIAN NUCLEAR LABORATORIES
 PROJECT: ENVIRONMENTAL SITE ASSESSMENT
 TITLE: FIELD MAP 2

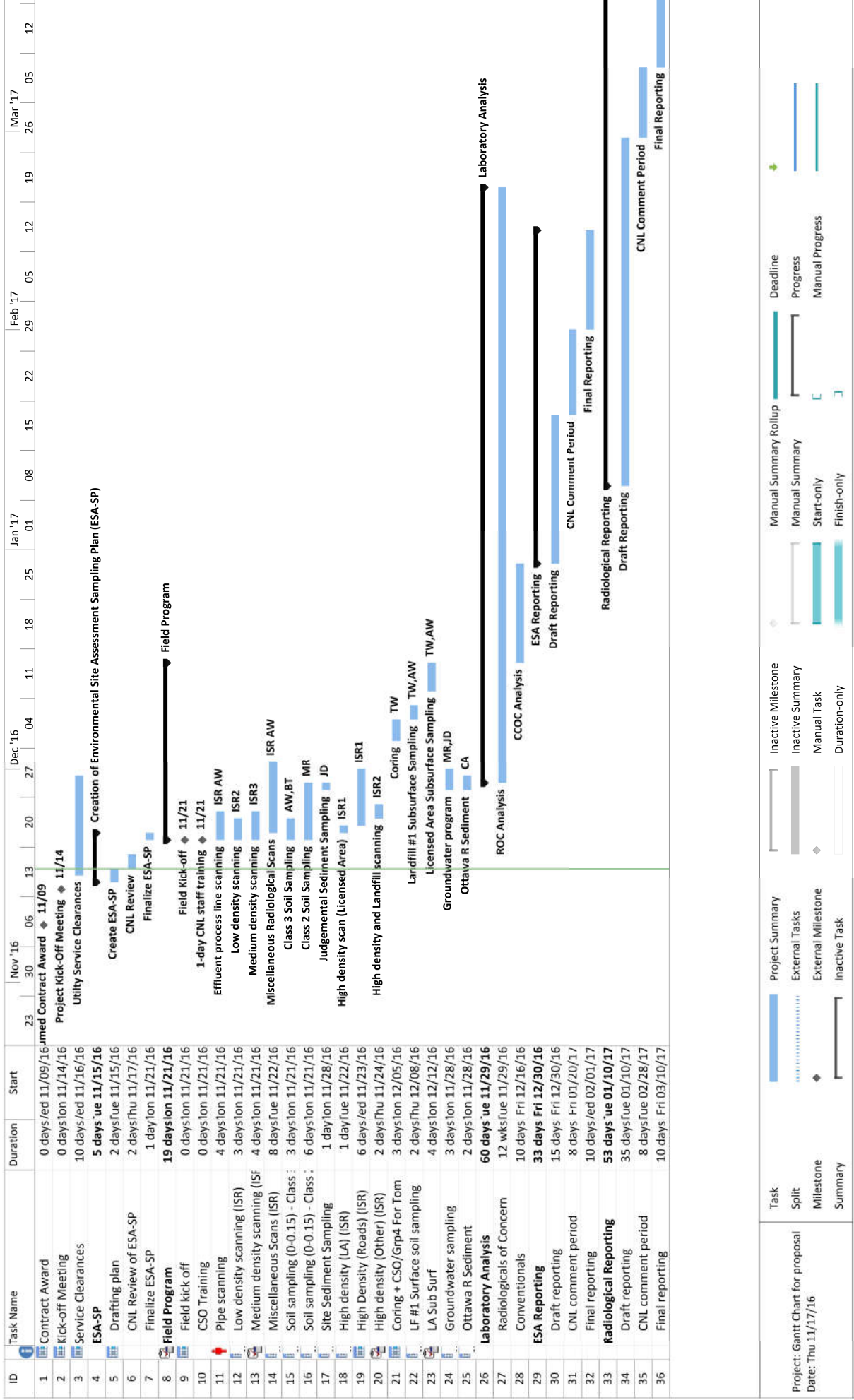
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DESIGNED	PH	
PREPARED	PH	
REVIEWED	PH	
APPROVED	PH	
PROJECT NO.	PHASE	
1666131		
REV.	REV.	
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APPENDIX F

Summary of Investigation Locations and Scope



CNL NPD Sample Summary
Class 1 (Licensed Area)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	P10 (ppm)	Start Depth (inbgs)	End Depth (inbgs)	Radiological (gamma, H-3, C-14)	Conventional (PCB,PHC,BTEX,PAH)
SA-351						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-351B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.15	Required	If evidence of impact
SA-351C	46.186482	-77.657318	CU 20	Soil		-	Required	Required	Required	0.3	0.3	Required	If evidence of impact
SA-351D						Required	Y - base of TP	Required	Required	0.8	0.8	Containerize if indications of impact	
SA-352						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-352B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-352C						-	Required	Required	Required	0.8	0.8	Containerize if indications of impact	
SA-352D						Required	Y - base of TP	Required	Required	0	0.15	Required	If evidence of impact
SA-353						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-353B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-353C						-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-353D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-354						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-354B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-354C	46.18661	-77.657234	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-354D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-355						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-355B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-355C	46.18672	-77.657537	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-355D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-356						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-356B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-356C	46.186725	-77.657233	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-356D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-357						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-357B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-357C	46.18673	-77.657136	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-357D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-358						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-358B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-358C	46.186844	-77.657647	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-358D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-359						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-359B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-359C	46.186849	-77.65744	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-359D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-360						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-360B					Class 1	Required	Y - base of TP	Required	Required	0	0.15	Required	If evidence of impact
SA-360C	46.186853	-77.657245	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-360D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-361						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-361B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-361C	46.186858	-77.657038	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-361D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-362						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-362B					Class 1	Required	Y - base of TP	Required	Required	0	0.15	Required	If evidence of impact
SA-362C	46.186958	-77.657756	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-362D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-363						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-363B					Class 1	Required	Y - base of TP	Required	Required	0	0.15	Required	If evidence of impact
SA-363C	46.186963	-77.657549	CU 20	Soil		-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-363D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-364						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-364B					Class 1	Required	Y - base of TP	Required	Required	0.15	0.3	Required	If evidence of impact
SA-364C	46.186968	-77.657242	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Containerize if indications of impact	
SA-364D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-365						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-365B					Class 1	Required	Y - base of TP	Required	Required	0	0.15	Required	If evidence of impact
SA-365C	46.186972	-77.657147	CU 20	Soil		-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-365D						Required	Y - base of TP	Required	Required	0.8	1.2	Containerize if indications of impact	

CNL NPD Sample Summary
Class 1 (Licensed Area)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	Pb (ppm)	Start Depth (inbgs)	End Depth (inbgs)	Radiological (gamma, H-3, C-14)	Conventional (PCB,PHC,BTEX,PAH)
SA-366						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-366B	46.187087	-77.657658	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-366C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-366D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-367						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-367B	46.187091	-77.657451	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-367C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-367D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-368						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-368B	46.186057	-77.657829	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-368C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-368D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-369						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-369B	46.186166	-77.658132	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-369C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-369D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-370						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-370B	46.186171	-77.657938	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-370C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-370D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-371						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-371B	46.186176	-77.657731	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-371C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-371D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-372						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-372B	46.18618	-77.657937	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-372C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-372D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-373						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-373B	46.186277	-77.658423	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-373C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-373D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-374						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-374B	46.186281	-77.658229	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-374C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-374D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-375						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-375B	46.186286	-77.658034	CU 20	Soil	Class 1	-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-375C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-375D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-376						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-376B	46.18629	-77.65784	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-376C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-376D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-377						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-377B	46.186295	-77.657646	CU 20	Soil	Class 1	-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-377C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-377D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-378						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-378B	46.186299	-77.657452	CU 20	Soil	Class 1	-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-378C						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-378D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-379						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-379B	46.186396	-77.658338	CU 20	Soil	Class 1	-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-379C						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-379D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-380						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-380B	46.1864	-77.658144	CU 20	Soil	Class 1	-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-380C						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-380D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact

CNL NPD Sample Summary
Class 1 (Licensed Area)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	P10 (ppm)	Start Depth (inbgs)	End Depth (inbgs)	Radiological (gamma, H-3, C-14)	Conventional (PCB,PHC,BTEX,PAH)
SA-381						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-381B						Required	Y - base of TP	Required	Required	0.15	0.15	Required	If evidence of impact
SA-381C	46.18641	-77.657742	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.3	Required	If evidence of impact
SA-381D						-	Required	Required	Required	0.8	0.8	Containerize	If indications of impact
SA-382						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-382B	46.186414	-77.657548	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-382C						-	Required	Required	Required	0.8	0.8	Containerize	If indications of impact
SA-382D						-	Required	Required	Required	1.2	1.2	Containerize	If indications of impact
SA-383						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-383B	46.186419	-77.657354	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-383C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-383D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-384						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-384B	46.186529	-77.657657	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-384C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-384D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-385						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-385B	46.186347	-77.658517	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-385C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-385D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-386						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-386B	46.186465	-77.658847	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-386C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-386D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-387						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-387B	46.18647	-77.658626	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-387C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-387D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-388						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-388B	46.186584	-77.659163	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-388C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-388D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-389						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-389B	46.186588	-77.658956	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-389C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-389D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-390						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-390B	46.186593	-77.658736	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-390C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-390D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-391						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-391B	46.186598	-77.658529	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-391C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-391D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-392						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-392B	46.186712	-77.659066	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-392C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-392D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-393						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-393B	46.186717	-77.658859	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-393C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-393D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-394						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-394B	46.186722	-77.658639	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-394C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-394D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-395						Required	Y - base of TP	-	Required	0	0	Required	If evidence of impact
SA-395B	46.186727	-77.658431	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-395C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-395D						-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact

CNL NPD Sample Summary
Class 1 (Licensed Area)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	Pb (ppm)	Start Depth (inbgs)	End Depth (inbgs)	Radiological (gamma, H-3, C-14)	Conventional (PCB,PHC,BTEX,PAH)
SA-396						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-396B	46.18684	-77.658968	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-396C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-396D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-397						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-397B	46.186845	-77.658748	CU 20	Soil	Class 1	-	Required	Required	Required	0.8	1.2	Containerize	If indications of impact
SA-397C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-397D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-398						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-398B	46.18685	-77.658541	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-398C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-398D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-399						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-399B	46.186855	-77.658334	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-399C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-399D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-400						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-400B	46.186968	-77.658871	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-400C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-400D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-401						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-401B	46.186973	-77.658651	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-401C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-401D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-402						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-402B	46.186941	-77.658481	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-402C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-402D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-403						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-403B	46.186947	-77.658261	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-403C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-403D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-404						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-404B	46.187065	-77.65559	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-404C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-404D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-405						-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-405B	46.18707	-77.658383	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-405C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-405D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-406						-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-406B	46.187075	-77.658163	CU 20	Soil	Class 1	-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-406C						-	Required	Required	Required	0.8	1.2	Required	If evidence of impact
SA-406D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-407						-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-407B	46.18708	-77.657956	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-407C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-407D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-408						-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-408B	46.187188	-77.6587	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-408C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-408D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-409						-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-409B	46.187193	-77.658493	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-409C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-409D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-410						-	Required	Required	Required	0	0.15	Required	If evidence of impact
SA-410B	46.187198	-77.658273	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-410C						-	Required	Required	Required	0.3	0.8	Containerize	If indications of impact
SA-410D						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact

CNL NPDP Sample Summary
Class 1 (Licensed Area)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	Pb (ppm)	Start Depth (inbgs)	End Depth (inbgs)	Radiological (gamma, H-3, C-14)	Conventionals (PCB,PHC,BTEX,PAH)
SA-411						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-411B	46.187203	-77.658066	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-411C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-411D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-412						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-412B	46.187208	-77.657859	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-412C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-412D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-413						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-413B	46.187213	-77.657639	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-413C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-413D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-414						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-414B	46.187317	-77.658603	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-414C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-414D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-415						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-415B	46.187321	-77.658395	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-415C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-415D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-416						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-416B	46.187327	-77.658175	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-416C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-416D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-417						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-417B	46.187331	-77.657968	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-417C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-417D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	
SA-418						Required	Y - base of TP	-	Required	0	0.15	Required	If evidence of impact
SA-418B	46.18745	-77.658285	CU 20	Soil	Class 1	-	Required	Required	Required	0.15	0.3	Required	If evidence of impact
SA-418C						-	Required	Required	Required	0.3	0.8	Required	If evidence of impact
SA-418D						-	Required	Required	Required	0.8	1.2	Containerize if indications of impact	

G4 Training required to enter Licensed Area

All Class 1 Samples will use the PowerProbe to advance core to ~ 1.2 metres below ground surface. Potential additional samples include 0.3 to 0.8 mbgs, and 0.8 to 1.2 mbgs. Gamma, Beta and PID readings required. If impacts exist at 0.8 to 1.2 mbgs, contact PM and CNL

PCB - Polychlorinated Biphenyls
PHC Fl-F4 - Petroleum Hydrocarbons Fractions 1-4
BTEX - Benzene, toluene, ethyl benzene, xylenes
PAH - Polycyclic aromatic hydrocarbons
(FD) = Field Duplicate, name as sample location - FD. E.G. SA-414 (FD)
Collect field duplicates at ratio of 1:10 (conventionals) and 1:20 (radiologicals)

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (mbgs)	End Depth (mbgs)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventional (PCB, PHC, PEX, PAH)
SA-017	46.183734	-77.653959	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-018	46.182743	-77.648386	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-019	46.183192	-77.657924	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-020	46.182875	-77.652583	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-021	46.182345	-77.649351	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-022	46.184153	-77.655314	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-023	46.181112	-77.655173	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-024	46.183522	-77.647211	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-025	46.182141	-77.64892	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-026	46.184064	-77.652563	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-027	46.18238	-77.651176	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-028	46.184902	-77.647585	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-029	46.181723	-77.647565	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-030	46.183522	-77.656528	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-031	46.183078	-77.648511	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-032	46.182644	-77.647829	CU 5	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-033	46.181056	-77.661916	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-034	46.179817	-77.657541	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-035	46.180566	-77.654351	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-036	46.18248	-77.658745	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-037	46.181506	-77.65232	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-038	46.180266	-77.647871	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-039	46.178756	-77.654795	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-040	46.180669	-77.659202	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-041	46.179111	-77.652661	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-042	46.181075	-77.657055	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-043	46.179551	-77.662374	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-044	46.181765	-77.653864	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-045	46.180526	-77.64949	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-046	46.179252	-77.655894	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-047	46.179956	-77.655525	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-048	46.181849	-77.659933	CU 4	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-049	46.18271	-77.661607	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-050	46.180626	-77.660097	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-051	46.184328	-77.660156	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-052	46.181866	-77.663847	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-053	46.189057	-77.661149	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-054	46.186648	-77.662562	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-055	46.187135	-77.664477	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-056	46.181121	-77.667231	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-057	46.184832	-77.66321	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-058	46.182414	-77.662723	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-059	46.185912	-77.665947	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-060	46.180277	-77.669471	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-061	46.183988	-77.663573	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-062	46.18877	-77.662275	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-063	46.182757	-77.66503	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-064	46.180792	-77.664965	CU 3	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-065	46.189103	-77.666084	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-066	46.183045	-77.670007	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-067	46.186187	-77.674617	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-068	46.189631	-77.665881	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-069	46.187344	-77.671329	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-070	46.190485	-77.671594	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-071	46.18529	-77.666785	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-072	46.188266	-77.678048	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-073	46.189649	-77.680902	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-074	46.187586	-77.676343	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-075	46.188821	-77.669729	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-076	46.186789	-77.679648	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (mbsg)	End Depth (mbsg)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventional (PCB, PHC, PEX, PAH)
SA-077	46.18818	-77.666368	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-078	46.18597	-77.66849	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-079	46.189103	-77.671086	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-080	46.186362	-77.67124	CU 2	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-081	46.191855	-77.673877	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-082	46.192817	-77.668601	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-083	46.195076	-77.673584	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-084	46.191339	-77.663644	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-085	46.193511	-77.679604	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-086	46.191428	-77.664866	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-087	46.193525	-77.671716	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-088	46.192057	-77.672219	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-089	46.192891	-77.670432	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-090	46.19515	-77.675428	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-091	46.191398	-77.677682	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-092	46.189921	-77.672724	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-093	46.190807	-77.669113	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-094	46.193066	-77.674108	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-095	46.191916	-77.666717	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-096	46.194184	-77.671713	CU 1	Soil	Class 3	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-097	46.181736	-77.679428	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-098	46.178303	-77.685783	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-099	46.176569	-77.667673	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-100	46.184115	-77.672754	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-101	46.178301	-77.66002	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-102	46.17486	-77.664389	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-103	46.174973	-77.670328	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-104	46.179751	-77.679617	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-105	46.1773	-77.665919	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-106	46.182078	-77.675195	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-107	46.178486	-77.686345	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-108	46.177699	-77.672728	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-109	46.184219	-77.678694	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-110	46.177168	-77.655729	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-111	46.173569	-77.668666	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-112	46.176963	-77.687968	Reference	Soil	BRA	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-113	46.185151	-77.656515	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-114	46.18516	-77.65614	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-115	46.185389	-77.656333	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-116	46.185398	-77.655957	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-117	46.185618	-77.656162	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-118	46.185821	-77.657118	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-119	46.18593	-77.656743	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-120	46.185839	-77.656354	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-121	46.185848	-77.655979	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-122	46.186086	-77.655809	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-123	46.186095	-77.655421	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-124	46.186315	-77.656426	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-125	46.186324	-77.656525	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-126	46.186535	-77.656831	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-127	46.186544	-77.656442	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-128	46.186765	-77.656023	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-129	46.186985	-77.656228	CU 6	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-130	46.184324	-77.656838	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-131	46.184595	-77.657577	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-132	46.184606	-77.657098	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-133	46.184618	-77.656619	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-134	46.184889	-77.657345	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-135	46.1849	-77.656866	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-136	46.184911	-77.656387	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (mbsg)	End Depth (mbsg)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventional (PCB, PHC, PEX, PAH)
SA-137	46.185116	-77.658084	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-138	46.185176	-77.657605	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-139	46.185182	-77.657126	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-140	46.185193	-77.656647	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-141	46.185462	-77.657865	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-142	46.185473	-77.657473	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-143	46.185484	-77.656894	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-144	46.185495	-77.656415	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-145	46.185755	-77.657633	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-146	46.185766	-77.657154	CU 7	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-147	46.185863	-77.658398	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-148	46.186036	-77.658227	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-149	46.184036	-77.658418	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-150	46.184044	-77.658009	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-151	46.184052	-77.657706	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-152	46.184247	-77.65861	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-153	46.184256	-77.658248	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-154	46.184284	-77.657898	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-155	46.184272	-77.657536	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-156	46.184467	-77.658439	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-157	46.184475	-77.658009	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-158	46.184484	-77.657727	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-159	46.184687	-77.658268	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-160	46.184695	-77.657919	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-161	46.184704	-77.657556	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-162	46.184907	-77.65811	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-163	46.185119	-77.658289	CU 8	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-164	46.180112	-77.664578	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-165	46.18047	-77.664297	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-166	46.180827	-77.66403	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-167	46.180841	-77.664344	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-168	46.181234	-77.661989	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-169	46.181619	-77.66053	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-170	46.182715	-77.659106	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-171	46.183072	-77.658838	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-172	46.183438	-77.658558	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-173	46.184492	-77.658907	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-174	46.184885	-77.658626	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-175	46.185203	-77.658941	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-176	46.185536	-77.658666	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-177	46.185931	-77.657797	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-178	46.186216	-77.66105	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-179	46.186229	-77.660455	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-180	46.186243	-77.659872	CU 9 ROADS	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-188	46.184971	-77.659228	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-198	46.185174	-77.659677	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-200	46.185147	-77.659392	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-201	46.185154	-77.659094	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-202	46.185308	-77.65984	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-203	46.185315	-77.659543	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-204	46.185322	-77.659245	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-205	46.185328	-77.65896	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-206	46.185491	-77.659694	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-207	46.185498	-77.659409	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-208	46.185505	-77.659111	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-209	46.185512	-77.658813	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-210	46.185674	-77.659596	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-211	46.185681	-77.659262	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-212	46.185688	-77.658977	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-213	46.185857	-77.659426	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (mbsg)	End Depth (mbsg)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventional (PCB, PHC, PEX, PAH)
SA-214	46.185864	-77.659129	CU 11	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-215	46.185391	-77.660142	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-216	46.18556	-77.660617	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-217	46.185567	-77.660306	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-218	46.185574	-77.659996	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-219	46.185781	-77.660781	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-220	46.185752	-77.660471	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-221	46.185759	-77.66016	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-222	46.185766	-77.659849	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-223	46.18593	-77.660946	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-224	46.185937	-77.660635	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-225	46.185944	-77.660325	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-226	46.185952	-77.660014	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-227	46.185959	-77.659703	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-228	46.186122	-77.6608	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-229	46.18613	-77.660489	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-230	46.186137	-77.660178	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-231	46.186144	-77.659868	CU 12	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-232	46.186843	-77.658894	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-233	46.185849	-77.658635	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-234	46.185855	-77.658376	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-235	46.185996	-77.65929	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-236	46.186002	-77.659031	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-237	46.186008	-77.658773	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-238	46.186014	-77.658514	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-239	46.18602	-77.658255	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-240	46.186139	-77.658686	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-241	46.186145	-77.659427	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-242	46.186151	-77.659168	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-243	46.186157	-77.65909	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-244	46.186163	-77.658651	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-245	46.186169	-77.658392	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-246	46.186301	-77.659305	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-247	46.186307	-77.659046	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-248	46.186313	-77.658787	CU 13	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-249	46.186333	-77.659851	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-250	46.186472	-77.66048	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-251	46.186478	-77.660221	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-252	46.186484	-77.659975	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-253	46.186489	-77.659729	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-254	46.186495	-77.659483	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-255	46.186619	-77.660957	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-256	46.186624	-77.660111	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-257	46.18663	-77.659865	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-258	46.186636	-77.659606	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-259	46.186642	-77.659346	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-260	46.186775	-77.660235	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-261	46.18678	-77.659889	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-262	46.186786	-77.659743	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-263	46.186924	-77.660372	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-264	46.18693	-77.660249	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-265	46.187071	-77.66016	CU 14	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-266	46.186729	-77.659468	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-267	46.18695	-77.65966	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-268	46.186959	-77.659285	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-269	46.18717	-77.659852	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-270	46.187179	-77.65949	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-271	46.187188	-77.659115	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-272	46.187382	-77.660057	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-273	46.18739	-77.659682	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (inbgs)	End Depth (inbgs)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventional (PCB, PHC, PEX, PAH)
SA-274	46.187359	-77.659306	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-275	46.187408	-77.658944	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-276	46.187416	-77.658568	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-277	46.187611	-77.659874	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-278	46.187619	-77.659511	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-279	46.187628	-77.659136	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-280	46.187637	-77.659761	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-281	46.18784	-77.659703	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-282	46.187849	-77.659328	CU 15	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-283	46.187801	-77.658691	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-284	46.187986	-77.659218	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-285	46.187994	-77.658881	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-286	46.188002	-77.658532	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-287	46.18801	-77.658195	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-288	46.188189	-77.659396	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-289	46.188197	-77.65906	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-290	46.188205	-77.65871	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-291	46.188213	-77.658374	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-292	46.188221	-77.658037	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-293	46.1884	-77.659238	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-294	46.188408	-77.658901	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-295	46.188416	-77.658552	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-296	46.188424	-77.658215	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-297	46.188602	-77.658079	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-298	46.188812	-77.658873	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-299	46.188812	-77.658921	CU 16	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-300	46.187335	-77.657826	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-301	46.187341	-77.657554	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-302	46.187493	-77.657963	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-303	46.1875	-77.657704	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-304	46.187506	-77.657432	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-305	46.187646	-77.658372	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-306	46.187652	-77.6581	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-307	46.187658	-77.657841	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-308	46.187665	-77.65757	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-309	46.187671	-77.657311	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-310	46.187802	-77.658237	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-311	46.187808	-77.657978	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-312	46.187814	-77.657719	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-313	46.18782	-77.657448	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-314	46.187927	-77.658116	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-315	46.187923	-77.657857	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-316	46.188132	-77.657994	CU 17	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-317	46.188683	-77.656818	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-318	46.186995	-77.656941	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-319	46.187001	-77.656708	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-320	46.187006	-77.656475	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-321	46.187131	-77.657298	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-322	46.187136	-77.657065	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-323	46.187142	-77.656832	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-324	46.187147	-77.656599	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-325	46.187263	-77.657421	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-326	46.187269	-77.657188	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-327	46.187274	-77.656955	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-328	46.187279	-77.65722	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-329	46.18741	-77.657311	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-330	46.187415	-77.657078	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-331	46.187415	-77.656845	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-332	46.187547	-77.657201	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-333	46.187553	-77.656968	CU 18	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Start Depth (mbsgs)	End Depth (mbsgs)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventionals (PCB,PHC,BTEX,PAH)
SA-334	46.186128	-77.656606	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-335	46.186128	-77.657417	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-336	46.186128	-77.657094	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-337	46.186135	-77.65677	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-338	46.186142	-77.656646	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-339	46.18615	-77.656136	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-340	46.186322	-77.657259	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-341	46.186329	-77.656948	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-342	46.186337	-77.656624	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-343	46.186344	-77.656301	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-344	46.186514	-77.657112	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-345	46.186522	-77.656789	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-346	46.186529	-77.656478	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-347	46.186536	-77.656155	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-348	46.186707	-77.656966	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-349	46.186714	-77.656643	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact
SA-350	46.186722	-77.656319	CU 19	Soil	Class 2	Required	Y - base of TP	0	0.15	Required	Required	If evidence of impact

PCB - Polychlorinated Biphenyls

PHC F1-F4 - Petroleum Hydrocarbons Fractions 1-4

BTEX - Benzene, toluene, ethyl benzene, xylenes

PAH - Polycyclic aromatic hydrocarbons

(FD) = Field Duplicate, name as sample location - FD, E.G. SA-414 (FD)

Collect field duplicates at ratio of 1:10 (conventionals) and 1:20 (radiologicals)

If evidence of impact, jars for conventional analysis should be filled, including methanol field preservation of PHC F1-BTEX

Location_ID	Lat	Long	Ref/Surv	Matrix	Class	1 min Gamma (surface)	Gamma Scan (core)	Beta Scan (core)	Start Depth (mbsg)	End Depth (mbsg)	PID (ppm)	Radiological (gamma, H-3, C-14)	Conventionals (PCB, PHC, BTEX, PAH)	Notes
SA-181	46.184909	-77.661117	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-182	46.185053	-77.661487	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-183	46.185059	-77.661241	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-184	46.185065	-77.660995	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-185	46.185194	-77.661611	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-186	46.1852	-77.661377	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-187	46.185206	-77.661131	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-188	46.185211	-77.660885	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-189	46.185335	-77.661747	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-190	46.185341	-77.661555	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-191	46.185347	-77.661255	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-192	46.185352	-77.661009	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-193	46.185358	-77.660763	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-194	46.185482	-77.661624	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-195	46.185488	-77.661391	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-196	46.185493	-77.661145	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	
SA-197	46.185543	-77.661269	CU 10 LANDFILL1	Soil	Class 2	Required	Y - base of TP	-	0	0.15	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-198	46.184909	-77.661131	CU 10 LANDFILL1	Unknown	Class 2	-	-	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-199	46.185053	-77.661487	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-200	46.185059	-77.661241	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-201	46.185065	-77.660995	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-202	46.185194	-77.661611	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-203	46.1852	-77.661377	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-204	46.185206	-77.661131	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-205	46.185211	-77.660885	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-206	46.185335	-77.661747	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-207	46.185341	-77.661555	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-208	46.185347	-77.661255	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-209	46.185352	-77.661009	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-210	46.185358	-77.660763	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-211	46.185482	-77.661624	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-212	46.185488	-77.661391	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-213	46.185493	-77.661145	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-214	46.185543	-77.661269	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-215	46.184909	-77.661131	CU 10 LANDFILL1	Unknown	Class 2	-	-	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-216	46.185053	-77.661487	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-217	46.185059	-77.661241	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-218	46.185065	-77.660995	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-219	46.185194	-77.661611	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-220	46.1852	-77.661377	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-221	46.185206	-77.661131	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-222	46.185211	-77.660885	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-223	46.185335	-77.661747	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-224	46.185341	-77.661555	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-225	46.185347	-77.661255	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-226	46.185352	-77.661009	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-227	46.185358	-77.660763	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-228	46.185482	-77.661624	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-229	46.185488	-77.661391	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-230	46.185493	-77.661145	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer
SA-231	46.185543	-77.661269	CU 10 LANDFILL1	Unknown	Class 2	-	Yes	Yes	0.5	1	Required	Required	If evidence of impact	Sample top 0.5 m of waste layer

G4 TRAINING REQUIRED FOR WASTE SAMPLES

- not applicable

PCB - Polychlorinated Biphenyls

PHC FL-F4 - Petroleum Hydrocarbons Fractions 1-4

BTEX - Benzene, toluene, ethyl benzene, xylene

PAH - Polycyclic aromatic hydrocarbons

(FD) = Field Duplicate, name as sample location - FD, E.G. SA-414 (FD)

Collect field duplicates at ratio of 1:10 (conventionals) and 1:20 (radiologicals)

If evidence of impact, jars for conventional analysis should be filled, including methano field preservation of PHC FL-F4+BTEX

Auger through overburden layer, waste samples are 0 to 0.5 metres (top of waste layer) and 0.5 to 1.0 metres (within waste layer)

Samples in waste layer may be soil or organic waste

Location_ID	X Coord	Y Coord	Matrix	Start Depth (*)	End Depth (ft)	PID (ppm)	Radiological (gamma, H-3, C-14)	Technetium-99	Strontium-90	Strontium-90	Ig
EXAMPLE->	TBD	TBD	Sediment	0	0.15	Required	Required	Required	Required	Required	Required
SA-419											
SA-420											
SA-421											
SA-422											
SA-423											
SA-424											
SA-425											
SA-426											
SA-427											
SA-428											
SA-429											
SA-430											
SA-431											
SA-432											
SA-433											
SA-434											
SA-435											
SA-436											
SA-437											
SA-438											
SA-439											
SA-440											
SA-441											
SA-442											
SA-443											
FD											

Judgemental sediment to be collected from edges of wetlands at Landfill #2 and ditches beside roads
 Maximum up to 2.5 samples

(FD) = Field Duplicate, name as sample location - FD, E.G. SA-432 (FD)

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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APPENDIX B

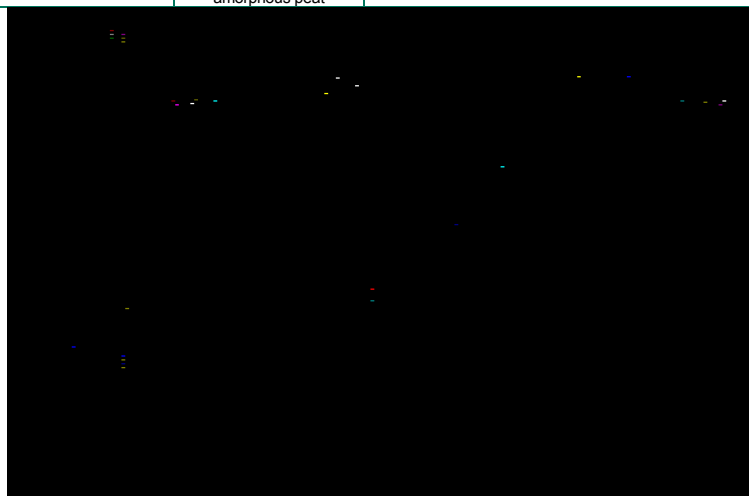
Record of Boreholes



METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil	Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Organic Content	USCS Group Symbol	Group Name			
INORGANIC (Organic Content $\leq 30\%$ by mass)	COARSE-GRAINED SOILS ($>50\%$ by mass is larger than 0.075 mm)	GRAVELS ($>50\%$ by mass of coarse fraction is larger than 4.75 mm)	Poorly Graded	<4	≤ 1 or ≥ 3	$\leq 30\%$	GP	GRAVEL			
			Well Graded	≥ 4	1 to 3		GW	GRAVEL			
			Below A Line	n/a			GM	SILTY GRAVEL			
			Above A Line	n/a			GC	CLAYEY GRAVEL			
		SANDS ($\geq 50\%$ by mass of coarse fraction is smaller than 4.75 mm)	Poorly Graded	<6	≤ 1 or ≥ 3		SP	SAND			
			Well Graded	≥ 6	1 to 3		SW	SAND			
			Below A Line	n/a			SM	SILTY SAND			
			Above A Line	n/a			SC	CLAYEY SAND			
			Field Indicators								
			Laboratory Tests	Dilatancy	Dry Strength		Shine Test	Thread Diameter	Toughness (of 3 mm thread)	Organic Content	USCS Group Symbol
INORGANIC (Organic Content $\leq 30\%$ by mass)	FINE-GRAINED SOILS ($\geq 50\%$ by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PL and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	$<5\%$	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	$<5\%$	ML	CLAYEY SILT
			Liquid Limit ≥ 50	Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
				Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	$<5\%$	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥ 50	None	High	Shiny	<1 mm	High		CH	CLAY
		HIGHLY ORGANIC SOILS (Organic Content $>30\%$ by mass)	Peat and mineral soil mixtures						30% to 75%	PT	SILTY PEAT, SANDY PEAT
			Predominantly peat, may contain some mineral soil, fibrous or amorphous peat						75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with $<5\%$ organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.



ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
SAND	Coarse	2.00 to 4.75	(10) to (4)
	Medium	0.425 to 2.00	(40) to (10)
	Fine	0.075 to 0.425	(200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (i.e., SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

- PH:** Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

NON-COHESIVE (COHESIONLESS) SOILS

Compactness²

Term	SPT 'N' (blows/0.3m) ¹
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
- Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N₆₀ values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _r	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

- Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of naturally occurring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + rem V.		Q - U		Wp			Wi
0	GeoMachine Direct Push	GROUND SURFACE		128.48											Flush Mount Casing Bentonite Seal Silica Sand 51 mm Diam. PVC #10 Slot Screen	
		(SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist		0.00	1	DT	-									
2		(SW) SAND, some gravel; brown, no odour or sheen; non-cohesive, moist		1.52	2	DT	-									
				126.96												
				124.52												
4		BOULDER		3.96												
		(GW) sandy GRAVEL; reddish brown with trace orange sand, no odour or sheen; non-cohesive, wet		4.57	4	DT	-									
				123.91												
6		End of Borehole		122.38												
				6.10												

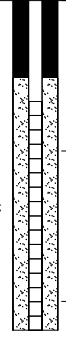
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DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + Q - ● rem V. ⊕ U - ○		Wp		W			Wi
0		GROUND SURFACE		127.60												
	GeoMachine Direct Push	FILL - (SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist	[Cross-hatched pattern]	0.00	1	DT	-								Flush Mount Casing	
2					2	DT	-									
4		FILL - (SW) SAND; brown	[Cross-hatched pattern]	123.64 3.96	3	DT	-									
6		Black GRANITE BEDROCK	[Dotted pattern]	121.81 5.79											▽	
10																
12	Air Hammer														Bentonite Seal	
14																
16																
18																
20																

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DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							20 40 60 80		nat V. + Q - ● rem V. ⊕ U - ○		10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³		Wp -----○----- WI			
20	Air Hammer	--- CONTINUED FROM PREVIOUS PAGE --- Black GRANITE BEDROCK														
22																
24				103.22 24.38												
26		End of Borehole														
28																
30																
32																
34																
36																
38																
40																

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa		WATER CONTENT PERCENT		WATER CONTENT PERCENT			
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
0		GROUND SURFACE		127.50											
		FILL - (SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist		0.00	1	DT	-								Flush Mount Casing
2	GeoMachine Direct Push				2	DT	-								
4					3	DT	-								
					4	DT	-								
6		Black GRANITE BEDROCK		121.71 5.79											Bentonite Seal
12	Air Hammer														Silica Sand
15.24		End of Borehole		112.26 15.24											51 mm Diam. PVC #10 Slot Screen

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DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		
0		GROUND SURFACE		126.69											
		ASPHALTIC CONCRETE		0.15	1	DT	-								
		FILL - (SW) gravelly SAND; brown, no odour; non-cohesive		126.08											
		GRANITE BOULDER		0.61											
		FILL - (GP) sandy GRAVEL; brown brown, no odour or sheen; non-cohesive, moist		125.47											
2				1.22	2	DT	-								
		FILL - (SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist		123.64											
4				3.05	3	DT	-								
					4	DT	-								
					5	DT	-								
					6	DT	-								
					7	DT	-								
					8	DT	-								
12		End of Borehole Refusal		115.26											
				11.43											

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DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.30m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + rem V. ⊕ ⊙		Wp		W			Wi
0	GeoMachine Direct Push	GROUND SURFACE		126.17												
		FILL - (SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist		0.00	1	DT										Flush Mount Casing
		BOULDER		0.46												
		FILL - (SW) gravelly SAND; brown, no odour or sheen; non-cohesive, moist		0.76												
2						2	DT									
4							3	DT								
6						4	DT									
8							5	DT							Silica Sand	
10							6	DT							51 mm Diam. PVC #10 Slot Screen	
10		End of Borehole Refusal		115.96												
				10.21												

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PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-181

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
0		GROUND SURFACE		135.57											
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-								
2															
4															
		End of Borehole		131.00											
6				4.57											
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-182

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	nat V. +	rem V. ⊕		
0		GROUND SURFACE		136.15											
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT									
2															
4															
		End of Borehole		131.58 4.57											
6															
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-183

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
		GROUND SURFACE		135.53											
	Geoprobe Direct Push	FILL - (SW/GP) SAND and GRAVEL; brown, contains cobbles and organic matter, non-cohesive, moist		0.15	A	DT									
		FILL - (SW/GP) SAND and GRAVEL; brown, contains cobbles; non-cohesive, moist													
		End of Borehole		130.96 4.57											

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-184

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa		nat V. + Q - ● rem V. ⊕ U - ○		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵			10 ⁻⁴	10 ⁻³
0		GROUND SURFACE		135.07													
	Geoprobe Direct Push	FILL - (SW) SAND, some gravel; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT											
2																	
4																	
		End of Borehole		130.50 4.57													
6																	
8																	
10																	
12																	
14																	
16																	
18																	
20																	

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002


RECORD OF BOREHOLE: SA-185

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa		nat V. + Q - ● rem V. ⊕ U - ○		WATER CONTENT PERCENT					
							20	40	60	80	Wp	W	WI			20
0		GROUND SURFACE		136.52												
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-									
2																
4																
		End of Borehole		131.95												
6				4.57												
8																
10																
12																
14																
16																
18																
20																

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002


RECORD OF BOREHOLE: SA-186

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + Q - ● rem V. ⊕ U - ○		Wp		W			Wi
0		GROUND SURFACE		135.67												
0		FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-									
2	Geoprobe Direct Push															
4																
4		End of Borehole		131.10												
4.57				4.57												
6																
8																
10																
12																
14																
16																
18																
20																

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-187

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.30m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + rem V. ⊕ ⊙		Q - U - ⊙		Wp			W
0	Geoprobe Direct Push	GROUND SURFACE		135.08												
		FILL - (SP) gravelly SAND; brown, contains organic matter; non-cohesive, moist		0.00	A	DT										
		WASTE - (SP) SAND; brown, contains brick; non-cohesive, moist		0.50	B	DT										
		WASTE - (CL) SILTY CLAY; brown with rust stains, contains brick, metal, and concrete; non-cohesive, moist		1.00	C	DT										
2		End of Borehole		1.50												
4																
6																
8																
10																
12																
14																
16																
18																
20																

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-188

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa		nat V. + rem V. ⊕ ⊙		Q - U - ● ○				WATER CONTENT PERCENT	
								20	40	60	80	10 ⁻⁶	10 ⁻⁵			10 ⁻⁴	10 ⁻³
0	Geoprobe Direct Push	GROUND SURFACE	134.98														
		FILL - (SW) SAND, some gravel; brown, no staining or odours, contains cobbles; non-cohesive, moist	0.00	A	DT	-											
2																	
4																	
6		End of Borehole	130.41														
8			4.57														
10																	
12																	
14																	
16																	
18																	
20																	

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-189

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 7, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.30m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + Q - ● rem V. ⊕ U - ○		Wp		Wi			
0		GROUND SURFACE		136.53												
	Geoprobe Direct Push	FILL - (SP) SAND, some gravel; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT										
2																
		WASTE - (SP/GP) SAND and GRAVEL; brown, no staining or odours, contains scrap metal and textile waste; non-cohesive, moist		134.53	B	DT										
		FILL - (SP) SAND, some gravel; brown, no staining or odours; non-cohesive, moist		2.00	C	DT										
4				132.33												
				4.20												
				131.96												
				4.57												
		End of Borehole														

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-190

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 7, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
0	Geoprobe Direct Push	GROUND SURFACE		135.62											
		FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-								
4		End of Borehole		131.05											
6				4.57											
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-191

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	nat V. +	rem V. ⊕		
0		GROUND SURFACE		135.14											
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-								
2															
4															
		End of Borehole		130.57 4.57											
6															
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-192

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.30m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH				WATER CONTENT PERCENT					
							Cu, kPa		nat V. + rem V. ⊕		Q - U - ● ○		Wp			W
0	Geoprobe Direct Push	GROUND SURFACE		135.02												
		FILL - (SW) SAND, some gravel; brown; non-cohesive, moist		0.00	A	DT										
		WASTE - (SW) SAND; brown, contains brick and scrap metal; non-cohesive, moist		1.00	B	DT										
2		WASTE - (SW) SAND; brown, contains brick and asphalt; non-cohesive, moist		1.50	C	DT										
		End of Borehole		2.00												

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-193

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	20	40		
0		GROUND SURFACE		134.98											
	Geoprobe Direct Push	FILL - (SP) SAND, some gravel; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT									
2															
4															
		End of Borehole		130.41 4.57											
6															
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-194

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
0		GROUND SURFACE		135.27											
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-								
2															
4															
6		End of Borehole		130.70											
8				4.57											
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-195

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 6, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH				WATER CONTENT PERCENT					
								Cu, kPa		nat V. + rem V.		Q - U				Wp	
0		GROUND SURFACE		135.05													
2	Geoprobe Direct Push	FILL - (SP) gravelly SAND, trace silt; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT											
4				130.48													
6		End of Borehole		4.57													
8																	
10																	
12																	
14																	
16																	
18																	
20																	

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-196

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 7, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH		WATER CONTENT PERCENT		WATER CONTENT PERCENT			
								20	40	60	80	10 ⁻⁶	10 ⁻⁵		
0		GROUND SURFACE		135.09											
	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT	-								
2															
4															
		End of Borehole		130.52											
6				4.57											
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:

PROJECT: 1666131-6002

RECORD OF BOREHOLE: SA-197

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 7, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	SHEAR STRENGTH Cu, kPa		WATER CONTENT PERCENT					
								20	40	20	40	60	80		
0		GROUND SURFACE		134.83											
2	Geoprobe Direct Push	FILL - (SP) gravelly SAND; brown, no staining or odours, contains cobbles; non-cohesive, moist		0.00	A	DT									
4				130.26											
6		End of Borehole		4.57											
8															
10															
12															
14															
16															
18															
20															

MIS-BHS 001 1666131-6002.GPJ GAL-MIS.GDT 07/26/17 JEM

DEPTH SCALE

1 : 100



LOGGED: AW

CHECKED:



APPENDIX C

Hydraulic Conductivity Analysis

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH7-01**

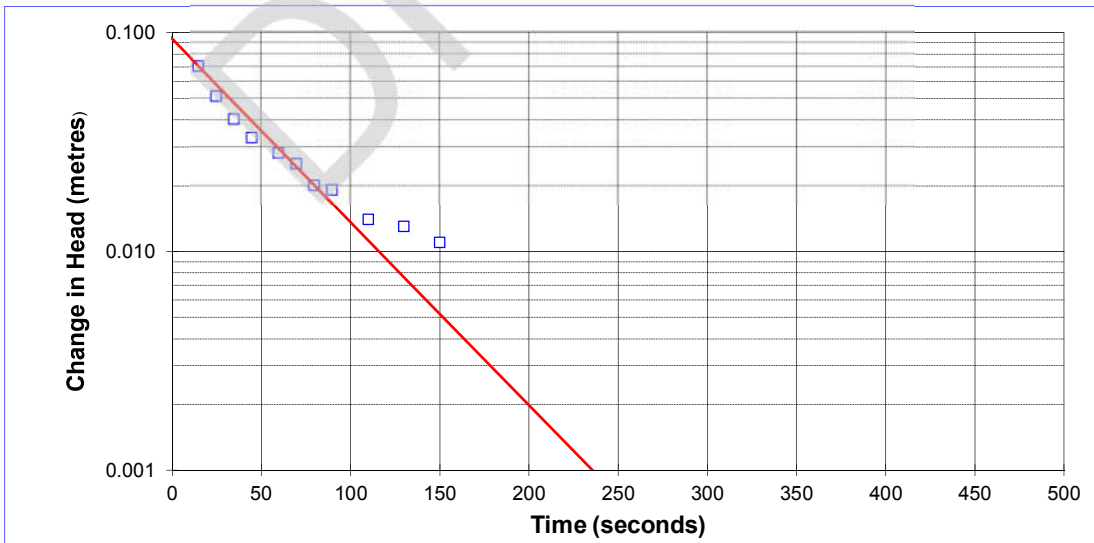
INTERVAL (metres below ground surface)	
Top of Interval =	2.24
Bottom of Interval =	5.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|---|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|---|

INPUT PARAMETERS	RESULTS
$r_c =$ 0.06	<p>K= 3E-05 m/sec</p> <p>K= 3E-03 cm/sec</p>
$r_w =$ 0.10	
$L_e =$ 2.76	
$\ln(R_e/r_w)$ 2.36	
$y_0 =$ 0.07	
$y_t =$ 0.02	
$t =$ 65.0	



Project Name: **CNL NPĐ ESA**
 Project No.: **1666131**
 Test Date: **04/18/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/2/2017**

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST BH9-01**

INTERVAL (metres below ground surface)

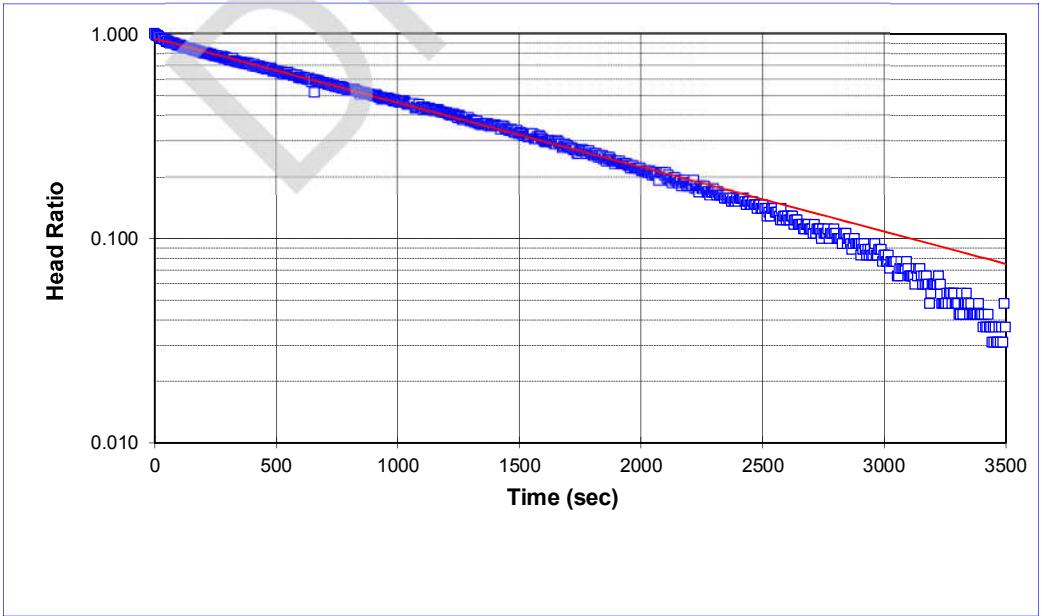
Top of Interval = 1.55
Bottom of Interval = 3.05

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \quad \text{where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS				
$r_c = 1.6\text{E-}02$	<table border="1"> <tr> <td>$K = 2\text{E-}07$</td> <td>m/sec</td> </tr> <tr> <td>$K = 2\text{E-}05$</td> <td>cm/sec</td> </tr> </table>	$K = 2\text{E-}07$	m/sec	$K = 2\text{E-}05$	cm/sec
$K = 2\text{E-}07$		m/sec			
$K = 2\text{E-}05$		cm/sec			
$R_e = 1.0\text{E-}01$					
$L_e = 1.5$					
$t_1 = 0$					
$t_2 = 1520$					
$h_1/h_0 = 0.95$					
$h_2/h_0 = 0.32$					



Project Name: **CNL NPD ESA**
Project No.: **1666131**
Test Date: **4/18/2017**

Analysis By: **CWT**
Checked By: **BTB**
Analysis Date: **5/3/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH-11-01**

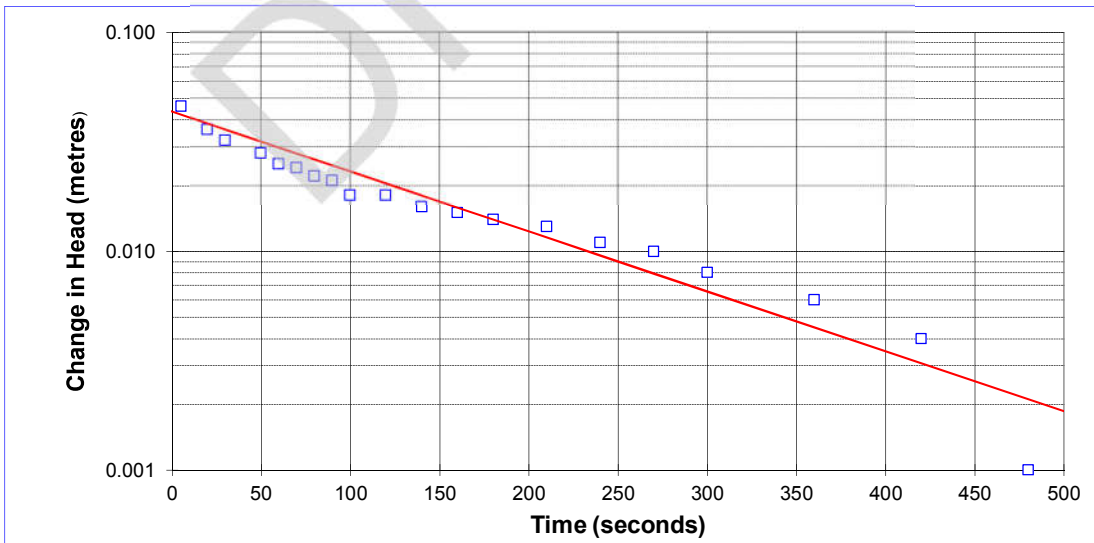
INTERVAL (metres below ground surface)	
Top of Interval =	8.79
Bottom of Interval =	9.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|--|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|--|

INPUT PARAMETERS	RESULTS
$r_c = 0.06$	<p>$K = 3E-05 \text{ m/sec}$</p> <p>$K = 3E-03 \text{ cm/sec}$</p>
$r_w = 0.10$	
$L_e = 0.21$	
$\ln(R_e/r_w) = 0.57$	
$y_0 = 0.04$	
$y_t = 0.02$	
$t = 110.0$	



Project Name: **CNL NPĐ ESA**
 Project No.: **1666131**
 Test Date: **04/18/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/3/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH 12-01**

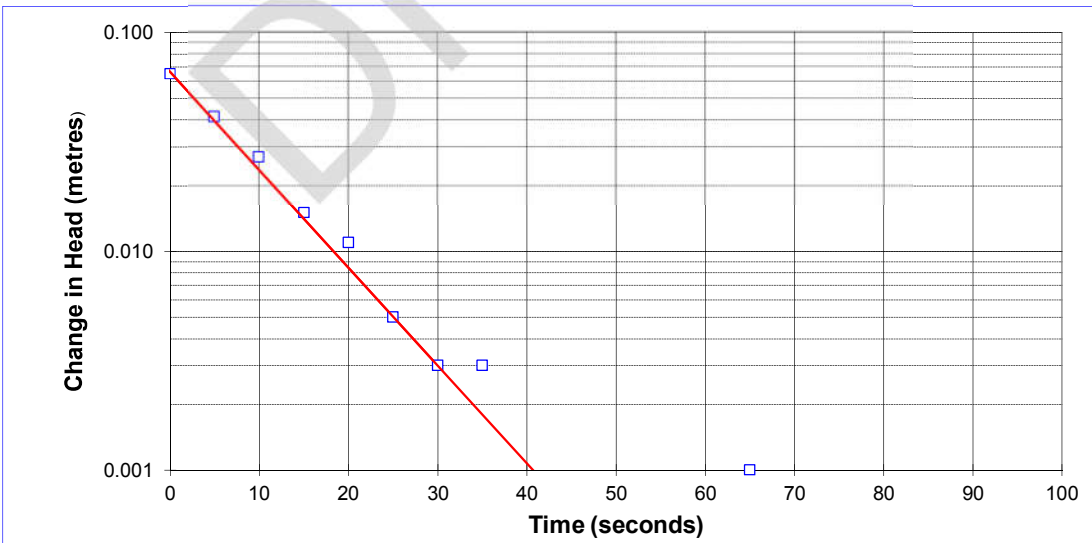
INTERVAL (metres below ground surface)	
Top of Interval =	7.19
Bottom of Interval =	10.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|---|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|---|

INPUT PARAMETERS	RESULTS
$r_c =$ 0.03	<p>K= 4E-05 m/sec</p> <p>K= 4E-03 cm/sec</p>
$r_w =$ 0.05	
$L_e =$ 2.81	
$\ln(R_e/r_w) =$ 2.71	
$y_0 =$ 0.07	
$y_t =$ 0.00	
$t =$ 30.0	



Project Name: **CNL NPD ESA Chalk River**
 Project No.: **1666131**
 Test Date: **04/19/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/2/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH13-01**

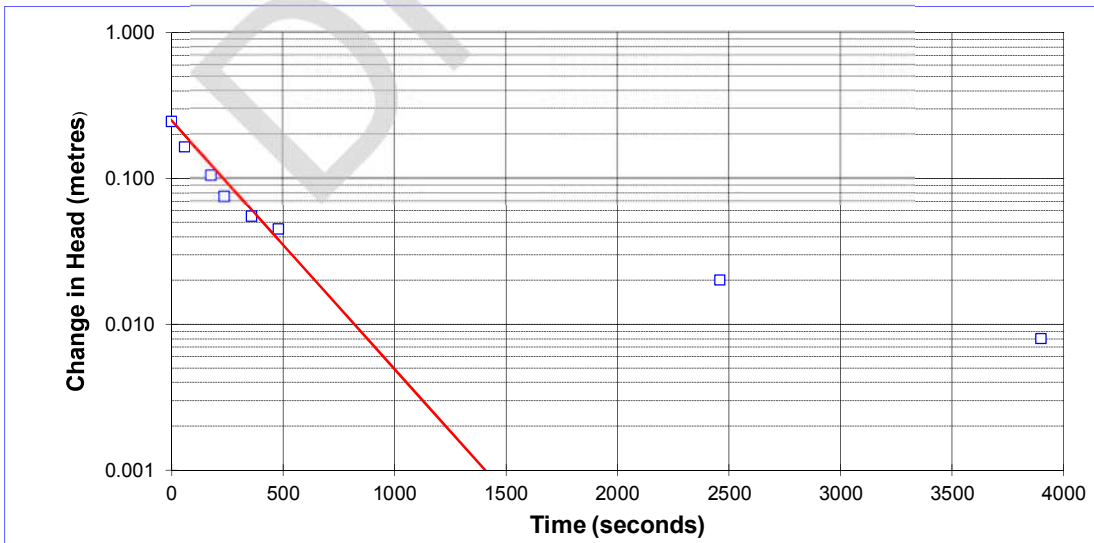
INTERVAL (metres below ground surface)	
Top of Interval =	7.58
Bottom of Interval =	9.91

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|--|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|--|

INPUT PARAMETERS	RESULTS
$r_c = 0.03$	<p>$K = 2\text{E-}06 \text{ m/sec}$</p> <p>$K = 2\text{E-}04 \text{ cm/sec}$</p>
$r_w = 0.04$	
$L_e = 2.34$	
$\ln(R_e/r_w) = 2.73$	
$y_0 = 0.25$	
$y_t = 0.04$	
$t = 480.0$	



Project Name: **CNL NPD ESA**
 Project No.: **1666131**
 Test Date: **04/18/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/3/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH12-01**

INTERVAL (metres below ground surface)

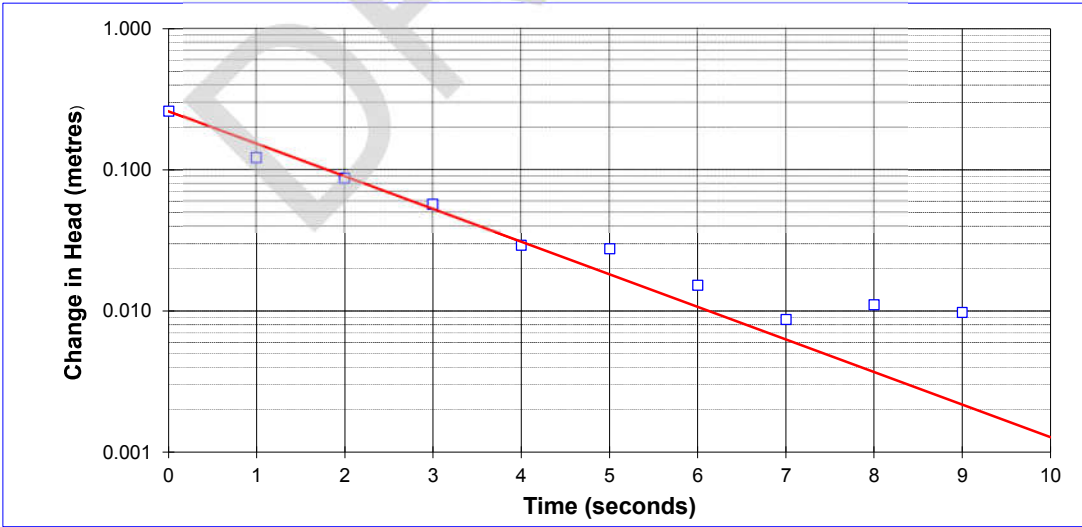
Top of Interval = 5.50
Bottom of Interval = 10.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K=\text{m/sec}$$

where:

r_c = casing radius (metres); r_w = radial distance to undisturbed aquifer (metres)
 R_e = effective radius (metres); y_0 = initial drawdown (metres)
 L_e = length of screened interval (metres); y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS	RESULTS
$r_c = 0.06$	$K = 5E-04 \text{ m/sec}$ $K = 5E-02 \text{ cm/sec}$
$r_w = 0.10$	
$L_e = 4.50$	
$\ln(R_e/r_w) = 2.74$	
$y_0 = 0.26$	
$y_t = 0.03$	
$t = 4.0$	



Project Name: **CNL NPD ESA Chalk River**
 Project No.: **1666131**
 Test Date: **01/18/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **23/01/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
FALLING HEAD TEST BH16-01**

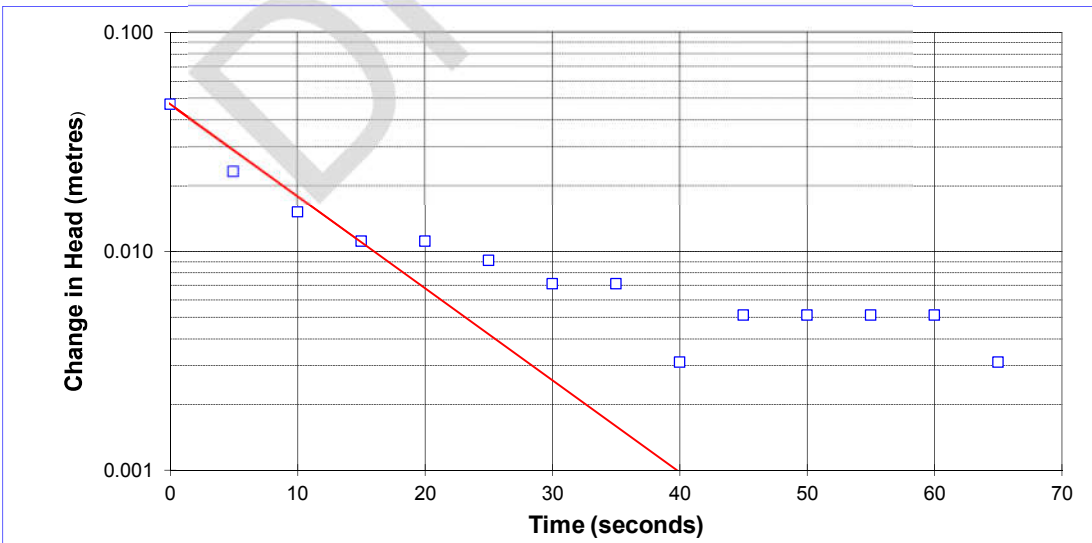
INTERVAL (metres below ground surface)	
Top of Interval =	3.87
Bottom of Interval =	6.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|--|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|--|

INPUT PARAMETERS	RESULTS
$r_c = 0.03$	<p>$K = 5E-05 \quad \text{m/sec}$</p> <p>$K = 5E-03 \quad \text{cm/sec}$</p>
$r_w = 0.04$	
$L_e = 2.13$	
$\ln(R_e/r_w) = 2.65$	
$y_0 = 0.05$	
$y_t = 0.01$	
$t = 15.0$	



Project Name: **CNL NPĐ ESA**
 Project No.: **1666131**
 Test Date: **04/18/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/2/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH16-1**

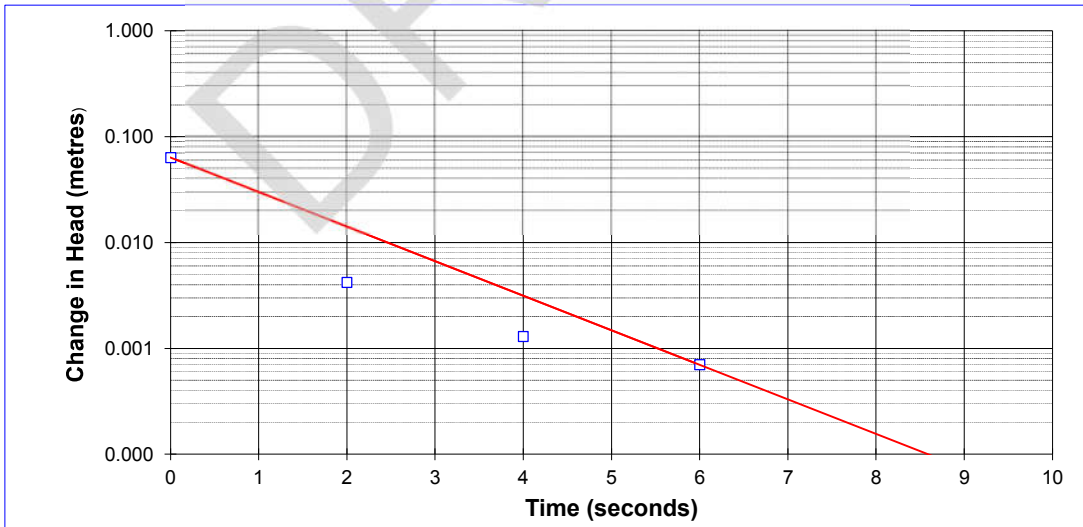
INTERVAL (metres below ground surface)	
Top of Interval =	4.34
Bottom of Interval =	6.00

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|---|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|---|

INPUT PARAMETERS	RESULTS
$r_c =$ 0.03	$K =$ 5E-04 m/sec $K =$ 5E-02 cm/sec
$r_w =$ 0.04	
$L_e =$ 1.66	
$\ln(R_e/r_w) =$ 2.45	
$y_0 =$ 0.06	
$y_t =$ 0.00	
$t =$ 6.0	



Project Name: **CNL NPD ESA Chalk River**
 Project No.: **1666131**
 Test Date: **01/17/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **26/01/2017**

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST BH16-02B**

INTERVAL (metres below ground surface)

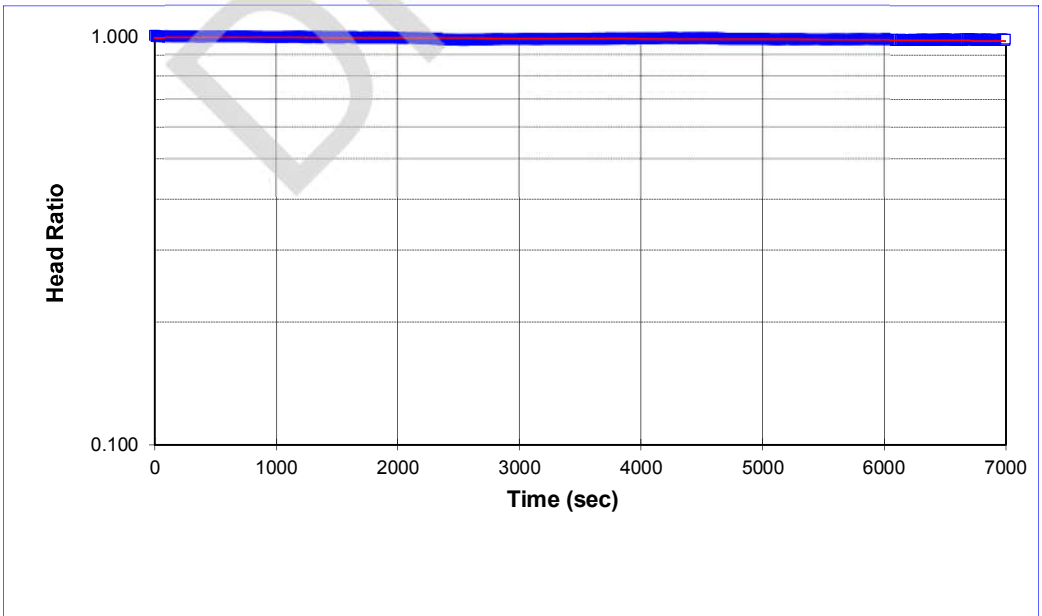
Top of Interval = 12.24
Bottom of Interval = 15.24

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \text{ where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS						
$r_c = 2.5\text{E-}02$	<table border="1"> <tr> <td>K=</td> <td>1E-09</td> <td>m/sec</td> </tr> <tr> <td>K=</td> <td>1E-07</td> <td>cm/sec</td> </tr> </table>	K=	1E-09	m/sec	K=	1E-07	cm/sec
K=		1E-09	m/sec				
K=		1E-07	cm/sec				
$R_e = 3.8\text{E-}02$							
$L_e = 3.0$							
$t_1 = 160$							
$t_2 = 6665$							
$h_1/h_0 = 0.99$							
$h_2/h_0 = 0.98$							



Project Name: CNL NPD ESA
Project No.: 1666131
Test Date: 4/19/2017

Analysis By: CWT
Checked By: BTB
Analysis Date: 5/2/2017

Golder Associates Ltd.

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST BH16-2A**

INTERVAL (metres below ground surface)

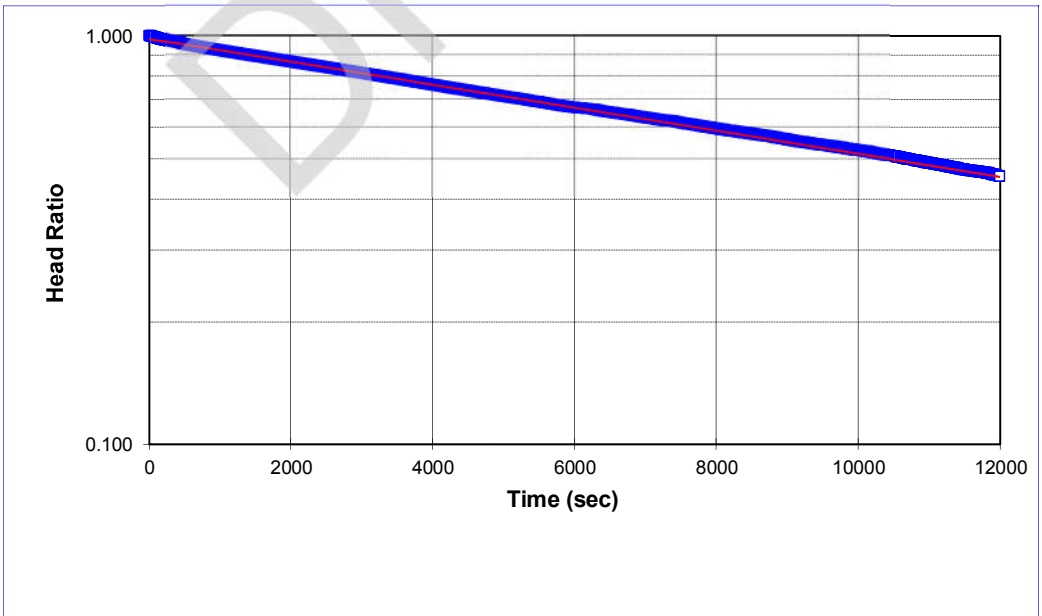
Top of Interval = 21.03
Bottom of Interval = 24.38

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \text{ where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS
$r_c = 2.5\text{E-}02$	$K = 3\text{E-}08 \text{ m/sec}$ $K = 3\text{E-}06 \text{ cm/sec}$
$R_e = 3.8\text{E-}02$	
$L_e = 3.4$	
$t_1 = 2000$	
$t_2 = 4000$	
$h_1/h_0 = 0.86$	
$h_2/h_0 = 0.76$	



Project Name: **CNL NPD ESA Chalk River**
 Project No.: **1666131**
 Test Date: **1/17/2017**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **1/23/2017**

Golder Associates Ltd.

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST BH16-2B**

INTERVAL (metres below ground surface)

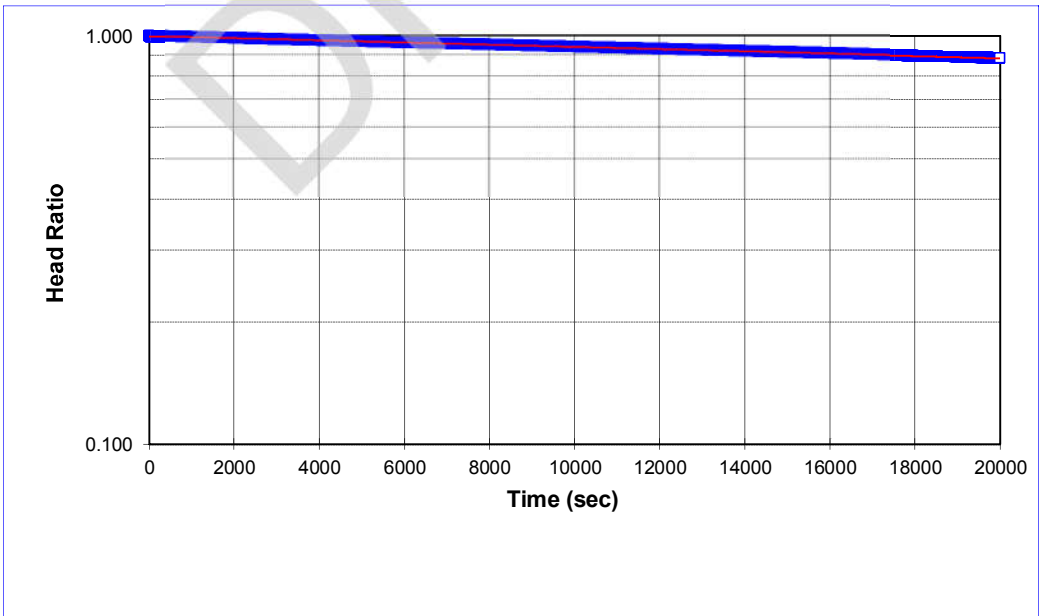
Top of Interval = 11.89
Bottom of Interval = 15.24

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \quad \text{where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS
$r_c = 2.5\text{E-}02$	$K = 3\text{E-}09 \quad \text{m/sec}$ $K = 3\text{E-}07 \quad \text{cm/sec}$
$R_e = 3.8\text{E-}02$	
$L_e = 3.4$	
$t_1 = 3000$	
$t_2 = 4000$	
$h_1/h_0 = 0.98$	
$h_2/h_0 = 0.97$	



Project Name: **CNL NPD ESA Chalk River**
 Project No.: **1666131**
 Test Date: **1/17/2018**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **1/23/2017**

**BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST BH16-03**

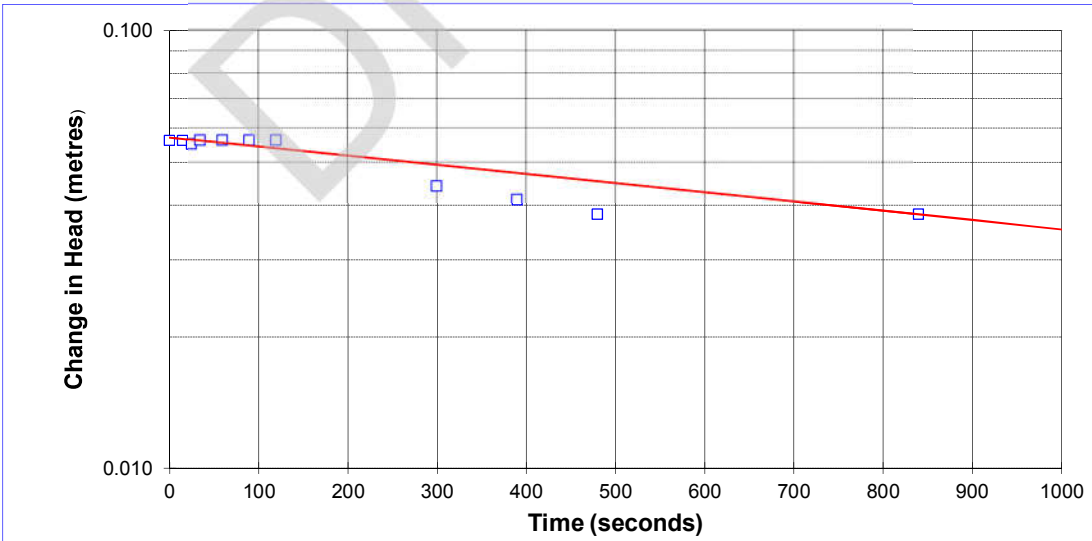
INTERVAL (metres below ground surface)	
Top of Interval =	11.34
Bottom of Interval =	11.43

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{r_w}\right)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t} \quad \text{where } K = \text{m/sec}$$

where:

- | | |
|--|---|
| <p>r_c = casing radius (metres);</p> <p>R_e = effective radius (metres);</p> <p>L_e = length of screened interval (metres);</p> | <p>r_w = radial distance to undisturbed aquifer (metres)</p> <p>y_0 = initial drawdown (metres)</p> <p>y_t = drawdown (metres) at time t (seconds)</p> |
|--|---|

INPUT PARAMETERS	RESULTS
r_c = 0.03	<p>K= 1E-06 m/sec</p> <p>K= 1E-04 cm/sec</p>
r_w = 0.04	
L_e = 0.09	
$\ln(R_e/r_w)$ = 0.52	
y_0 = 0.06	
y_t = 0.04	
t = 840.0	



Project Name: **CNL NPD ESA**
 Project No.: **1666131**
 Test Date: **04/19/17**

Analysis By: **CWT**
 Checked By: **BTB**
 Analysis Date: **5/2/2017**

**HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST MT-5**

INTERVAL (metres below ground surface)

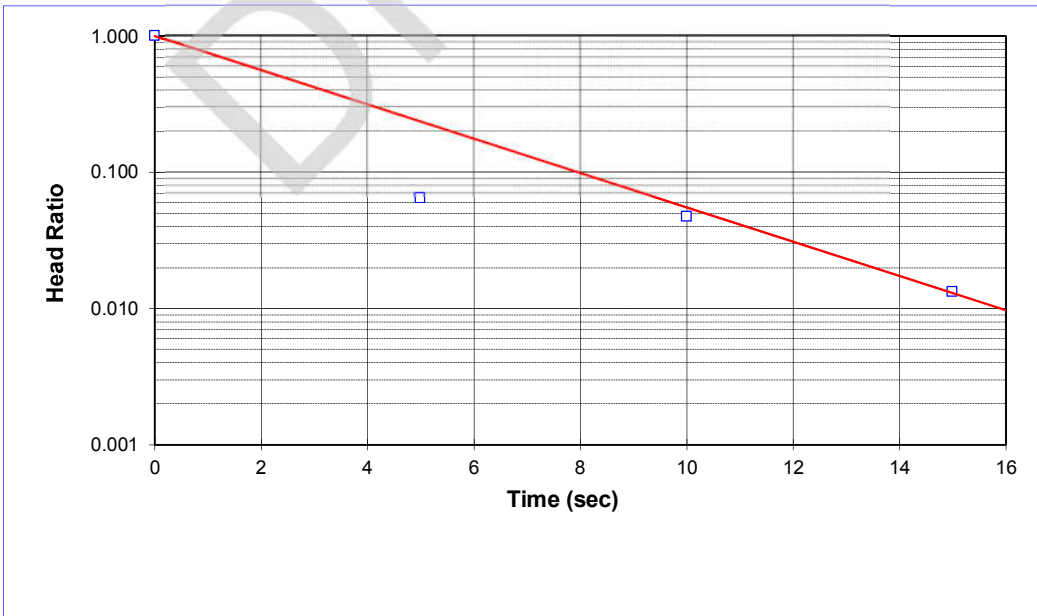
Top of Interval = 5.79
Bottom of Interval = 7.29

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \quad \text{where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS				
$r_c = 2.5\text{E-}02$	<table border="1"> <tr> <td>$K = 2\text{E-}04$</td> <td>m/sec</td> </tr> <tr> <td>$K = 2\text{E-}02$</td> <td>cm/sec</td> </tr> </table>	$K = 2\text{E-}04$	m/sec	$K = 2\text{E-}02$	cm/sec
$K = 2\text{E-}04$		m/sec			
$K = 2\text{E-}02$		cm/sec			
$R_e = 3.8\text{E-}02$					
$L_e = 1.5$					
$t_1 = 0$					
$t_2 = 15$					
$h_1/h_0 = 1.00$					
$h_2/h_0 = 0.01$					



Project Name: **CNL NPD ESA**
Project No.: **1666131**
Test Date: **4/18/2017**

Analysis By: **CWT**
Checked By: **BTB**
Analysis Date: **5/2/2017**

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST MT-5**

INTERVAL (metres below ground surface)

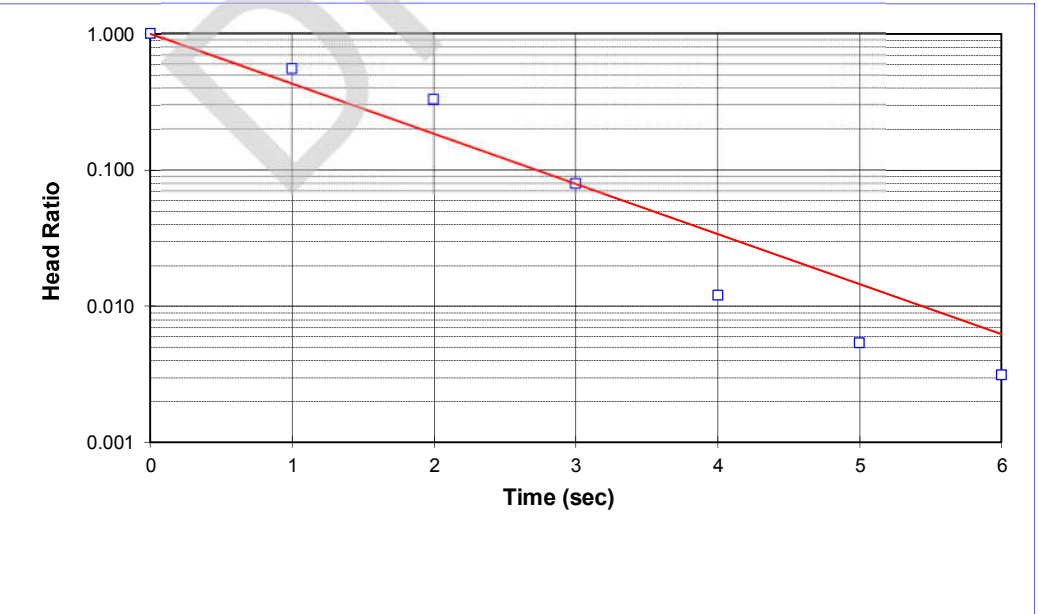
Top of Interval = 5.79
Bottom of Interval = 7.29

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \quad \text{where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS				
$r_c = 2.5\text{E-}02$	<table border="1"> <tr> <td>$K = 7\text{E-}04$</td> <td>m/sec</td> </tr> <tr> <td>$K = 7\text{E-}02$</td> <td>cm/sec</td> </tr> </table>	$K = 7\text{E-}04$	m/sec	$K = 7\text{E-}02$	cm/sec
$K = 7\text{E-}04$		m/sec			
$K = 7\text{E-}02$		cm/sec			
$R_e = 3.8\text{E-}02$					
$L_e = 1.5$					
$t_1 = 0$					
$t_2 = 3$					
$h_1/h_0 = 1.00$					
$h_2/h_0 = 0.08$					



Project Name: CNL NPD ESA Chalk River
Project No.: 1666131
Test Date: 1/18/2017

Analysis By: CWT
Checked By: BTB
Analysis Date: 1/23/2017

**HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST MT-8**

INTERVAL (metres below ground surface)

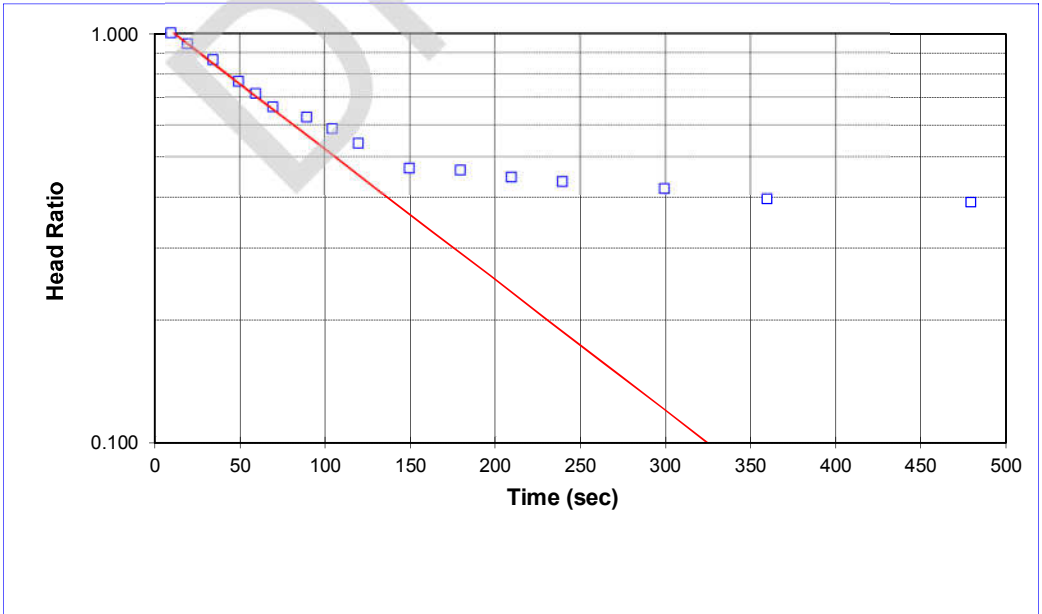
Top of Interval = 5.00
Bottom of Interval = 10.00

$$K = \frac{r_c^2}{2L_e} \ln \left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e} \right)^2} \right] \left[\frac{\ln \left(\frac{h_1}{h_2} \right)}{(t_2 - t_1)} \right] \quad \text{where } K = (\text{m/sec})$$

where:

- r_c = casing radius (metres)
- R_e = filter pack radius (metres)
- L_e = length of screened interval (metres)
- t = time (seconds)
- h_t = head at time t (metres)

INPUT PARAMETERS	RESULTS				
$r_c = 2.5\text{E-}02$	<table border="1"> <tr> <td>$K = 2\text{E-}06$</td> <td>m/sec</td> </tr> <tr> <td>$K = 2\text{E-}04$</td> <td>cm/sec</td> </tr> </table>	$K = 2\text{E-}06$	m/sec	$K = 2\text{E-}04$	cm/sec
$K = 2\text{E-}06$		m/sec			
$K = 2\text{E-}04$		cm/sec			
$R_e = 3.8\text{E-}02$					
$L_e = 5.0$					
$t_1 = 20$					
$t_2 = 70$					
$h_1/h_0 = 0.94$					
$h_2/h_0 = 0.65$					



Project Name: CNL NPD ESA
Project No.: 1666131
Test Date: 4/18/2017

Analysis By: CWT
Checked By: BTB
Analysis Date: 5/3/2017



APPENDIX D

Certificates of Analysis



Groundwater

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/12

Report #: R4513112

Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B4807

Received: 2017/06/02, 18:00

Sample Matrix: Water
Samples Received: 12

Analyses	Quantity	Date		Laboratory Method	Reference
		Extracted	Analyzed		
Petroleum Hydro. CCME F1 & BTEX in Water	6	N/A	2017/06/06	OTT SOP-00002	CCME CWS
Petroleum Hydro. CCME F1 & BTEX in Water	6	N/A	2017/06/08	OTT SOP-00002	CCME CWS
Petroleum Hydrocarbons F2-F4 in Water (1)	4	2017/06/05	2017/06/05	OTT SOP-00001	CCME Hydrocarbons
Petroleum Hydrocarbons F2-F4 in Water (1)	8	2017/06/05	2017/06/06	OTT SOP-00001	CCME Hydrocarbons
PAH Compounds in Water by GC/MS (SIM)	6	2017/06/06	2017/06/07	OTT SOP-00011	EPA 8270D/3510C m
PAH Compounds in Water by GC/MS (SIM)	6	2017/06/06	2017/06/08	OTT SOP-00011	EPA 8270D/3510C m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following "Alberta Environment's Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003". Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Your Project #: 1666131
Your C.O.C. #: 612931-02-01, 612931-03-01

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/12
Report #: R4513112
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B4807
Received: 2017/06/02, 18:00

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Alison Cameron, Project Manager
Email: ACameron@maxxam.ca
Phone# (613) 274-0573

=====
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		EMP782	EMP783	EMP783	EMP784	EMP785	EMP786		
Sampling Date		2017/05/30 09:45	2017/05/30 10:50	2017/05/30 10:50	2017/05/30 10:30	2017/05/30 11:59	2017/05/30 11:59		
COC Number		612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01		
	UNITS	NPD-8	NPD-2	NPD-2 Lab-Dup	NPD-1	NPD-7	DUP-1	RDL	QC Batch

Polyaromatic Hydrocarbons									
Acenaphthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Acenaphthylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(b/j)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(g,h,i)perylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(k)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Chrysene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Dibenz(a,h)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Fluorene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
1-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
2-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Naphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Phenanthrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829

Surrogate Recovery (%)									
D10-Anthracene	%	94	93	94	108	93	93		5014829
D14-Terphenyl (FS)	%	95	93	95	111	99	98		5014829
D8-Acenaphthylene	%	90	88	89	103	92	89		5014829

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		EMP787	EMP788	EMP789	EMP790	EMP791	EMP808		
Sampling Date		2017/05/30 13:45	2017/05/30 13:45	2017/06/02 09:20	2017/06/02 09:56	2017/06/02 10:40	2017/06/02 11:23		
COC Number		612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-03-01		
	UNITS	NPD-4	DUP-2	BH12-01	BH14-01	BH13-01	BH16-01	RDL	QC Batch
Polyaromatic Hydrocarbons									
Acenaphthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Acenaphthylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	0.10	<0.010	<0.010	0.010	5014829
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	0.080	<0.010	<0.010	0.010	5014829
Benzo(b/j)fluoranthene	ug/L	<0.010	<0.010	<0.010	0.10	<0.010	<0.010	0.010	5014829
Benzo(g,h,i)perylene	ug/L	<0.010	<0.010	<0.010	0.035	<0.010	<0.010	0.010	5014829
Benzo(k)fluoranthene	ug/L	<0.010	<0.010	<0.010	0.040	<0.010	<0.010	0.010	5014829
Chrysene	ug/L	<0.010	<0.010	<0.010	0.075	<0.010	<0.010	0.010	5014829
Dibenz(a,h)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Fluoranthene	ug/L	<0.010	<0.010	<0.010	0.18	<0.010	<0.010	0.010	5014829
Fluorene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	<0.010	<0.010	0.025	<0.010	<0.010	0.010	5014829
1-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
2-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Naphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5014829
Phenanthrene	ug/L	<0.010	<0.010	<0.010	0.050	<0.010	<0.010	0.010	5014829
Pyrene	ug/L	<0.010	<0.010	<0.010	0.14	<0.010	<0.010	0.010	5014829
Surrogate Recovery (%)									
D10-Anthracene	%	79	95	96	91	90	94		5014829
D14-Terphenyl (FS)	%	81	94	94	91	89	93		5014829
D8-Acenaphthylene	%	75	90	92	89	87	90		5014829
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		EMP809		
Sampling Date		2017/06/02 13:55		
COC Number		612931-03-01		
	UNITS	MT-S	RDL	QC Batch
Polyaromatic Hydrocarbons				
Acenaphthene	ug/L	<0.010	0.010	5014829
Acenaphthylene	ug/L	<0.010	0.010	5014829
Anthracene	ug/L	<0.010	0.010	5014829
Benzo(a)anthracene	ug/L	<0.010	0.010	5014829
Benzo(a)pyrene	ug/L	<0.010	0.010	5014829
Benzo(b/j)fluoranthene	ug/L	<0.010	0.010	5014829
Benzo(g,h,i)perylene	ug/L	<0.010	0.010	5014829
Benzo(k)fluoranthene	ug/L	<0.010	0.010	5014829
Chrysene	ug/L	<0.010	0.010	5014829
Dibenz(a,h)anthracene	ug/L	<0.010	0.010	5014829
Fluoranthene	ug/L	<0.010	0.010	5014829
Fluorene	ug/L	<0.010	0.010	5014829
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	0.010	5014829
1-Methylnaphthalene	ug/L	<0.010	0.010	5014829
2-Methylnaphthalene	ug/L	<0.010	0.010	5014829
Naphthalene	ug/L	<0.010	0.010	5014829
Phenanthrene	ug/L	<0.010	0.010	5014829
Pyrene	ug/L	<0.010	0.010	5014829
Surrogate Recovery (%)				
D10-Anthracene	%	94		5014829
D14-Terphenyl (FS)	%	94		5014829
D8-Acenaphthylene	%	90		5014829
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				

O.REG 153 PETROLEUM HYDROCARBONS (WATER)

Maxxam ID		EMP782	EMP783	EMP784	EMP785	EMP786	EMP787		
Sampling Date		2017/05/30 09:45	2017/05/30 10:50	2017/05/30 10:30	2017/05/30 11:59	2017/05/30 11:59	2017/05/30 13:45		
COC Number		612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01		
	UNITS	NPD-8	NPD-2	NPD-1	NPD-7	DUP-1	NPD-4	RDL	QC Batch
BTEX & F1 Hydrocarbons									
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5008760
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5008760
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5008760
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5008760
p+m-Xylene	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5008760
Total Xylenes	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5008760
F1 (C6-C10)	ug/L	<25	<25	<25	<25	<25	<25	25	5008760
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	<25	<25	<25	25	5008760
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	<100	<100	100	5013355
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5013355
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5013355
Reached Baseline at C50	ug/L	Yes	Yes	Yes	Yes	Yes	Yes		5013355
Surrogate Recovery (%)									
1,4-Difluorobenzene	%	102	102	99	104	102	105		5008760
4-Bromofluorobenzene	%	127	103	117	125	126	122		5008760
D10-Ethylbenzene	%	120	105	116	112	121	109		5008760
D4-1,2-Dichloroethane	%	114	114	111	114	116	117		5008760
o-Terphenyl	%	93	91	87	87	89	89		5013355
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

O.REG 153 PETROLEUM HYDROCARBONS (WATER)

Maxxam ID		EMP788	EMP788	EMP789	EMP790	EMP791	EMP808		
Sampling Date		2017/05/30 13:45	2017/05/30 13:45	2017/06/02 09:20	2017/06/02 09:56	2017/06/02 10:40	2017/06/02 11:23		
COC Number		612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-02-01	612931-03-01		
	UNITS	DUP-2	DUP-2 Lab-Dup	BH12-01	BH14-01	BH13-01	BH16-01	RDL	QC Batch
BTEX & F1 Hydrocarbons									
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5016652
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5016652
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5016652
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5016652
p+m-Xylene	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5016652
Total Xylenes	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5016652
F1 (C6-C10)	ug/L	<25	<25	<25	<25	<25	<25	25	5016652
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	<25	<25	<25	25	5016652
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/L	<100		<100	<100	<100	<100	100	5013355
F3 (C16-C34 Hydrocarbons)	ug/L	<200		<200	<200	<200	<200	200	5013355
F4 (C34-C50 Hydrocarbons)	ug/L	<200		<200	<200	<200	<200	200	5013355
Reached Baseline at C50	ug/L	Yes		Yes	Yes	Yes	Yes		5013355
Surrogate Recovery (%)									
1,4-Difluorobenzene	%	83	84	92	89	90	74		5016652
4-Bromofluorobenzene	%	108	92	98	88	91	91		5016652
D10-Ethylbenzene	%	95	85	119	106	112	85		5016652
D4-1,2-Dichloroethane	%	117	120	114	124	119	101		5016652
o-Terphenyl	%	84		87	89	88	89		5013355
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

O.REG 153 PETROLEUM HYDROCARBONS (WATER)

Maxxam ID		EMP809		
Sampling Date		2017/06/02 13:55		
COC Number		612931-03-01		
	UNITS	MT-S	RDL	QC Batch
BTEX & F1 Hydrocarbons				
Benzene	ug/L	<0.20	0.20	5016652
Toluene	ug/L	<0.20	0.20	5016652
Ethylbenzene	ug/L	<0.20	0.20	5016652
o-Xylene	ug/L	<0.20	0.20	5016652
p+m-Xylene	ug/L	<0.40	0.40	5016652
Total Xylenes	ug/L	<0.40	0.40	5016652
F1 (C6-C10)	ug/L	<25	25	5016652
F1 (C6-C10) - BTEX	ug/L	<25	25	5016652
F2-F4 Hydrocarbons				
F2 (C10-C16 Hydrocarbons)	ug/L	<100	100	5013355
F3 (C16-C34 Hydrocarbons)	ug/L	<200	200	5013355
F4 (C34-C50 Hydrocarbons)	ug/L	<200	200	5013355
Reached Baseline at C50	ug/L	Yes		5013355
Surrogate Recovery (%)				
1,4-Difluorobenzene	%	86		5016652
4-Bromofluorobenzene	%	105		5016652
D10-Ethylbenzene	%	118		5016652
D4-1,2-Dichloroethane	%	122		5016652
o-Terphenyl	%	88		5013355
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				

TEST SUMMARY

Maxxam ID: EMP782
Sample ID: NPD-8
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/05	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP783
Sample ID: NPD-2
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/05	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP783 Dup
Sample ID: NPD-2
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP784
Sample ID: NPD-1
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/05	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP785
Sample ID: NPD-7
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/05	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

Maxxam ID: EMP786
Sample ID: DUP-1
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

TEST SUMMARY

Maxxam ID: EMP787
Sample ID: NPD-4
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5008760	N/A	2017/06/06	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP788
Sample ID: DUP-2
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP788 Dup
Sample ID: DUP-2
Matrix: Water

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart

Maxxam ID: EMP789
Sample ID: BH12-01
Matrix: Water

Collected: 2017/06/02
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP790
Sample ID: BH14-01
Matrix: Water

Collected: 2017/06/02
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

Maxxam ID: EMP791
Sample ID: BH13-01
Matrix: Water

Collected: 2017/06/02
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

Maxxam Job #: B7B4807
Report Date: 2017/06/12

Golder Associates Ltd
Client Project #: 1666131
Sampler Initials: JO

TEST SUMMARY

Maxxam ID: EMP808
Sample ID: BH16-01
Matrix: Water

Collected: 2017/06/02
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

Maxxam ID: EMP809
Sample ID: MT-S
Matrix: Water

Collected: 2017/06/02
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5016652	N/A	2017/06/08	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5013355	2017/06/05	2017/06/06	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5014829	2017/06/06	2017/06/08	Arezoo Habibagahi

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	8.0°C
Package 2	8.0°C

Revised Report (2017/06/12): Equis facility code included.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5008760	1,4-Difluorobenzene	2017/06/06	100	70 - 130	104	70 - 130	104	%		
5008760	4-Bromofluorobenzene	2017/06/06	116	70 - 130	114	70 - 130	117	%		
5008760	D10-Ethylbenzene	2017/06/06	111	70 - 130	114	70 - 130	108	%		
5008760	D4-1,2-Dichloroethane	2017/06/06	118	70 - 130	107	70 - 130	112	%		
5013355	o-Terphenyl	2017/06/05	92	30 - 130	92	30 - 130	90	%		
5014829	D10-Anthracene	2017/06/08	101	50 - 130	92	50 - 130	91	%		
5014829	D14-Terphenyl (FS)	2017/06/08	104	50 - 130	92	50 - 130	96	%		
5014829	D8-Acenaphthylene	2017/06/08	98	50 - 130	89	50 - 130	86	%		
5016652	1,4-Difluorobenzene	2017/06/08	88	70 - 130	92	70 - 130	88	%		
5016652	4-Bromofluorobenzene	2017/06/08	115	70 - 130	88	70 - 130	97	%		
5016652	D10-Ethylbenzene	2017/06/08	92	70 - 130	113	70 - 130	111	%		
5016652	D4-1,2-Dichloroethane	2017/06/08	116	70 - 130	121	70 - 130	118	%		
5008760	Benzene	2017/06/06	100	70 - 130	89	70 - 130	<0.20	ug/L	NC	40
5008760	Ethylbenzene	2017/06/06	93	70 - 130	91	70 - 130	<0.20	ug/L	NC	40
5008760	F1 (C6-C10) - BTEX	2017/06/06					<25	ug/L	NC	40
5008760	F1 (C6-C10)	2017/06/06	99	70 - 130	96	70 - 130	<25	ug/L	NC	40
5008760	o-Xylene	2017/06/06	96	70 - 130	98	70 - 130	<0.20	ug/L	NC	40
5008760	p+m-Xylene	2017/06/06	99	70 - 130	97	70 - 130	<0.40	ug/L	NC	40
5008760	Toluene	2017/06/06	100	70 - 130	93	70 - 130	<0.20	ug/L	NC	40
5008760	Total Xylenes	2017/06/06					<0.40	ug/L	NC	40
5013355	F2 (C10-C16 Hydrocarbons)	2017/06/06	93	50 - 130	89	80 - 120	<100	ug/L	18	50
5013355	F3 (C16-C34 Hydrocarbons)	2017/06/06	93	50 - 130	89	80 - 120	<200	ug/L	NC	50
5013355	F4 (C34-C50 Hydrocarbons)	2017/06/06	93	50 - 130	89	80 - 120	<200	ug/L	NC	50
5014829	1-Methylnaphthalene	2017/06/07	98	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5014829	2-Methylnaphthalene	2017/06/07	99	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5014829	Acenaphthene	2017/06/07	98	50 - 130	81	50 - 130	<0.010	ug/L	NC	30
5014829	Acenaphthylene	2017/06/07	86	50 - 130	71	50 - 130	<0.010	ug/L	NC	30
5014829	Anthracene	2017/06/07	91	50 - 130	73	50 - 130	<0.010	ug/L	NC	30
5014829	Benzo(a)anthracene	2017/06/07	106	50 - 130	87	50 - 130	<0.010	ug/L	NC	30
5014829	Benzo(a)pyrene	2017/06/07	95	50 - 130	78	50 - 130	<0.010	ug/L	NC	30
5014829	Benzo(b,j)fluoranthene	2017/06/07	107	50 - 130	87	50 - 130	<0.010	ug/L	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5014829	Benzo(g,h,i)perylene	2017/06/07	88	50 - 130	73	50 - 130	<0.010	ug/L	NC	30
5014829	Benzo(k)fluoranthene	2017/06/07	105	50 - 130	90	50 - 130	<0.010	ug/L	NC	30
5014829	Chrysene	2017/06/07	95	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5014829	Dibenz(a,h)anthracene	2017/06/07	60	50 - 130	52	50 - 130	<0.010	ug/L	NC	30
5014829	Fluoranthene	2017/06/07	95	50 - 130	77	50 - 130	<0.010	ug/L	NC	30
5014829	Fluorene	2017/06/07	103	50 - 130	89	50 - 130	<0.010	ug/L	NC	30
5014829	Indeno(1,2,3-cd)pyrene	2017/06/07	86	50 - 130	81	50 - 130	<0.010	ug/L	NC	30
5014829	Naphthalene	2017/06/07	85	50 - 130	68	50 - 130	<0.010	ug/L	NC	30
5014829	Phenanthrene	2017/06/07	91	50 - 130	75	50 - 130	<0.010	ug/L	NC	30
5014829	Pyrene	2017/06/07	91	50 - 130	75	50 - 130	<0.010	ug/L	NC	30
5016652	Benzene	2017/06/08	92	70 - 130	110	70 - 130	<0.20	ug/L	NC	40
5016652	Ethylbenzene	2017/06/08	88	70 - 130	101	70 - 130	<0.20	ug/L	NC	40
5016652	F1 (C6-C10) - BTEX	2017/06/08					<25	ug/L	NC	40
5016652	F1 (C6-C10)	2017/06/08	94	70 - 130	99	70 - 130	<25	ug/L	NC	40
5016652	o-Xylene	2017/06/08	90	70 - 130	108	70 - 130	<0.20	ug/L	NC	40
5016652	p+m-Xylene	2017/06/08	93	70 - 130	103	70 - 130	<0.40	ug/L	NC	40
5016652	Toluene	2017/06/08	94	70 - 130	101	70 - 130	<0.20	ug/L	NC	40
5016652	Total Xylenes	2017/06/08					<0.40	ug/L	NC	40

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

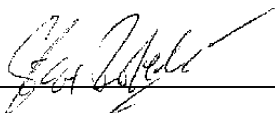
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Paul Rubinato, Analyst, Maxxam Analytics



Steve Roberts, Ottawa Lab Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CHAIN OF CUSTODY RECORD

Maxxam Analytics International Corporation or/a Maxxam Analytics
 6740 Campbellville Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

REPORT TO: Company Name: Alex Wood
 Attention: Alex Wood
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 AP_CustomerService@golder.com

INVOICE TO: Company Name: Golder Associates Ltd
 Accounts Payable
 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 AP_CustomerService@golder.com

PROJECT INFORMATION: Quotation #: B66107
 P.O. #: 1666131
 Project Name: J. Doyle
 Site #: J. Doyle
 Sampled By: J. Doyle

Laboratory Use Only: Maxxam Job #: [Barcode]
 Bottle Order #: 612931
 Project Manager: Alison Cameron
 COC #: [Barcode]
 C612931-02-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED TO THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Table 1 Res/Park Medium/Fine CCME Sanitary Sewer Bylaw
 Table 2 Ind/Comm Coarse Reg 356 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWQO Other

Other Regulations
 CCME Sanitary Sewer Bylaw
 Reg 356 Storm Sewer Bylaw
 MISA Municipality
 PWQO Other

Special Instructions
 (Water) + BTEX-F1/F2/F4
 O Reg 153 Petroleum Hydrocarbons
 O Reg 153 PAHs (Water)

Field Filtered (please circle)
 Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Include Criteria on Certificate of Analysis (Y/N)?

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix
1	NPD-8	May 30/17	9:45	GW
2	NPD-2		10:50	GW
3	NPD-1		10:30	GW
4	NPD-7		11:59	GW
5	DUP-1		11:59	GW
6	NPD-4		13:45	GW
7	DUP-2		13:45	GW
8	BH12-01	June 17	9:20	GW
9	BH14-01		9:56	GW
10	BH13-01		10:40	GW

*** RELINQUISHED BY: (Signature/Print)** J. Doyle

Date: (YY/MM/DD) 17/06/02

Time 6:00p

RECEIVED BY: (Signature/Print) Maxxam Cameron

Date: (YY/MM/DD) 02/10/02

Time 14:00

jars used and not submitted

Temperature (°C) on Receipt 18.8

Time Sensitive Yes

Intact Yes

Custody Seal Intact

Laboratory Use Only

Time Required _____

Rush Confirmation Number _____

Job Specific Rush TAT (if applies to entire submission) _____

Date Required _____

Regular (Standard) TAT: _____

Standard TAT = 5-7 Working days for most tests.

Please provide advance notice for rush projects

Turnaround Time (TAT) Required: _____

Comments RECEIVED IN OTTAWA

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED TO THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENTS IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

**** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGING INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/MP-CONTENT/UPLOADS/ONTARIO-COC.PDF.**

Maxxam Analytics International Corporation or/a Maxxam Analytics

CHAIN OF CUSTODY RECORD

Page 2 of 2

Maxxam Analytics International Corporation
 6740 Campbellville Road, Mississauga, Ontario Canada L5N 2L8
 Tel: (905) 817-5700 Toll-free: 800-563-6286 Fax: (905) 817-5777 www.maxxam.ca

INVOICE TO:
 Company Name: #14090 Golder Associates Ltd
 Attention: Accounts Payable
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 Fax: (613) 592-9601 x
 Email: AP_CustomerService@golder.com

REPORT TO:
 Company Name: Alex Wood
 Attention: Alex Wood
 Address: alex_wood@golder.com
 Tel: alex_wood@golder.com
 Fax: alex_wood@golder.com

PROJECT INFORMATION:
 Quotation #: B66107
 P.O. #: 1666131
 Project Name: J Dele
 Site #: J Dele
 Sampled By: J Dele

Laboratory Use Only:
 Maxxam Job #: [Barcode]
 Bottle Order #: 612931
 Project Manager: Alison Cameron
 COC #: C-4612331-03-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

Table 1
 Table 2
 Table 3
 Table 4
 Table 5
 Table 6
 Table 7
 Table 8
 Table 9
 Table 10

Other Regulations
 Sanitary Sewer Bylaw
 Storm Sewer Bylaw
 MISA Municipality
 PWDO
 Other

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Metals / Hg / Cr VI

O Reg 153 Petroleum Hydrocarbons

O Reg 153 Pests (Water)

Include Criteria on Certificate of Analysis (Y/N)?

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix
1	B416-01	June 21/17	11:23	GW
2	MT-5	↓	13:55	GW
3				GW
4				GW
5				GW
6				GW
7				GW
8				GW
9				GW
10				GW

Field Filtered (please circle):

Time Sensitive

Temperature (°C) on Receipt

Custody Seal Present

Yes No

* RELINQUISHED BY: (Signature/Print) *Jason Dawson* Date: (YYMM/DD) 17/06/02 Time 6:50

RECEIVED BY: (Signature/Print) *Maxxam Dawson* Date: (YYMM/DD) 2017/06/02 Time 17:00

Jars used and not submitted

Time Sensitive

Temperature (°C) on Receipt

Custody Seal Present

Yes No

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENTS ACKNOWLEDGES AND ACCEPTS OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION HOLD TIME AND PACKAGING INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CAMP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

02-Jun-17 18:00

Alison Cameron

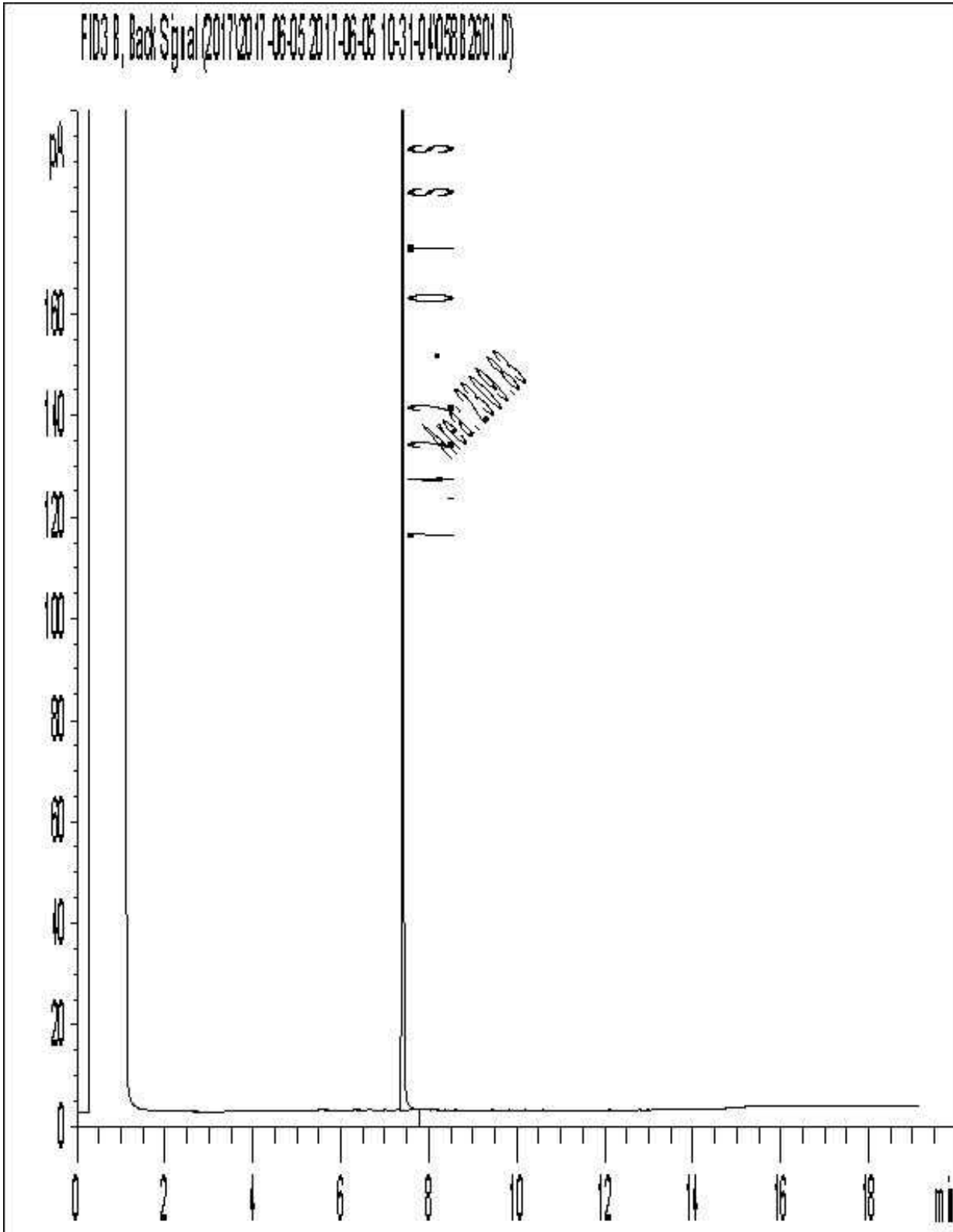
B7B4807

RECEIVED IN OTTAWA

RECEIVED IN OTTAWA

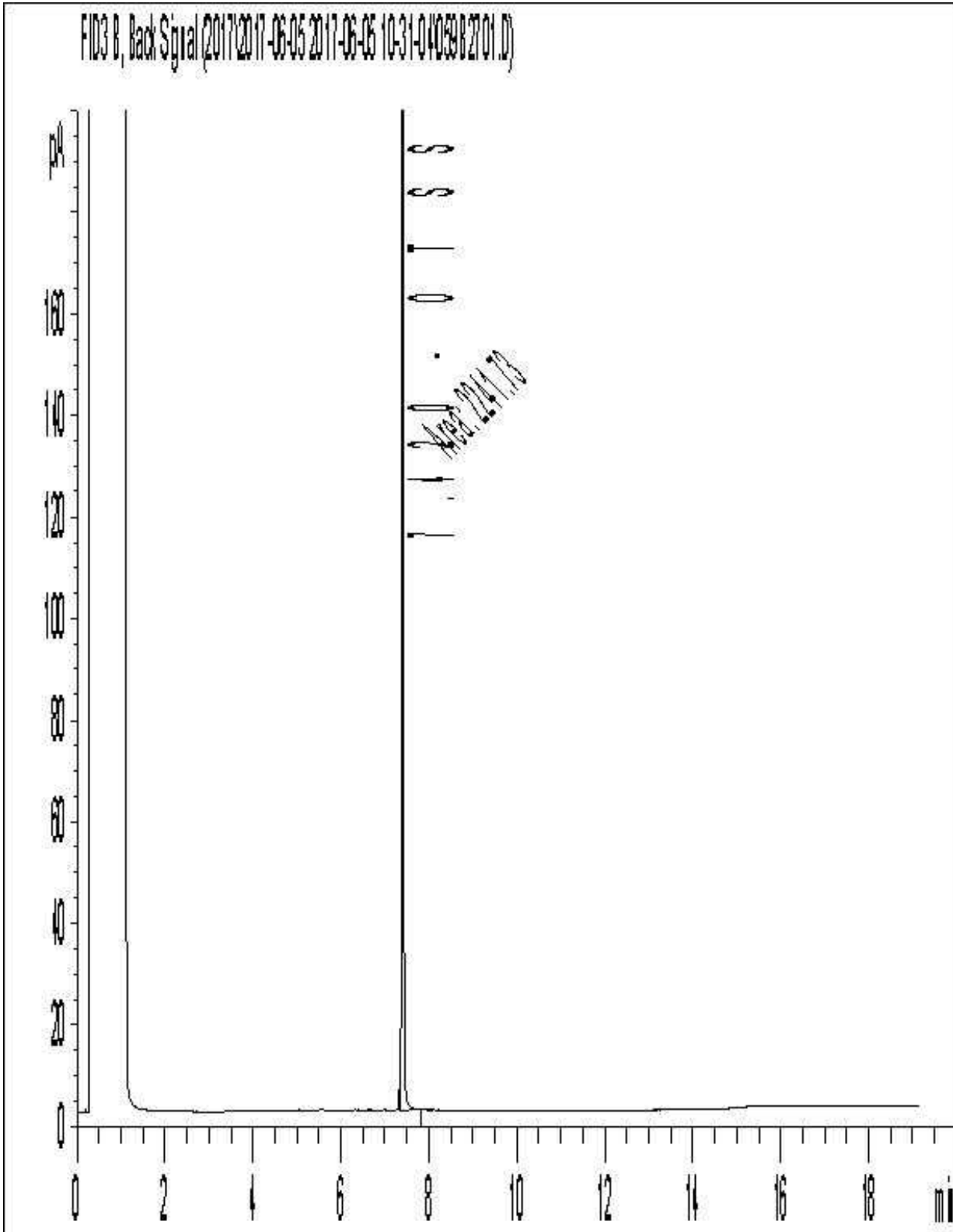
On ice

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



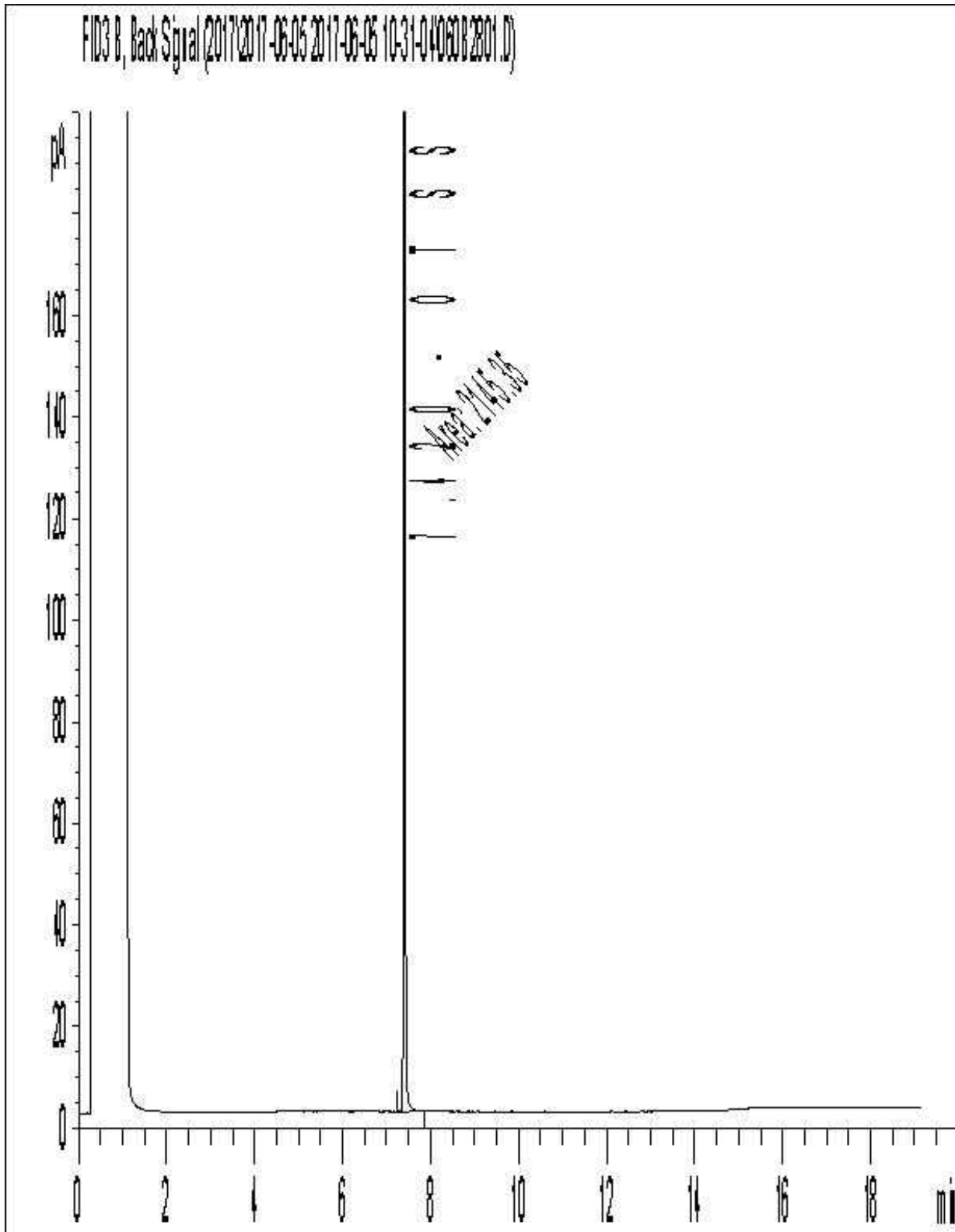
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



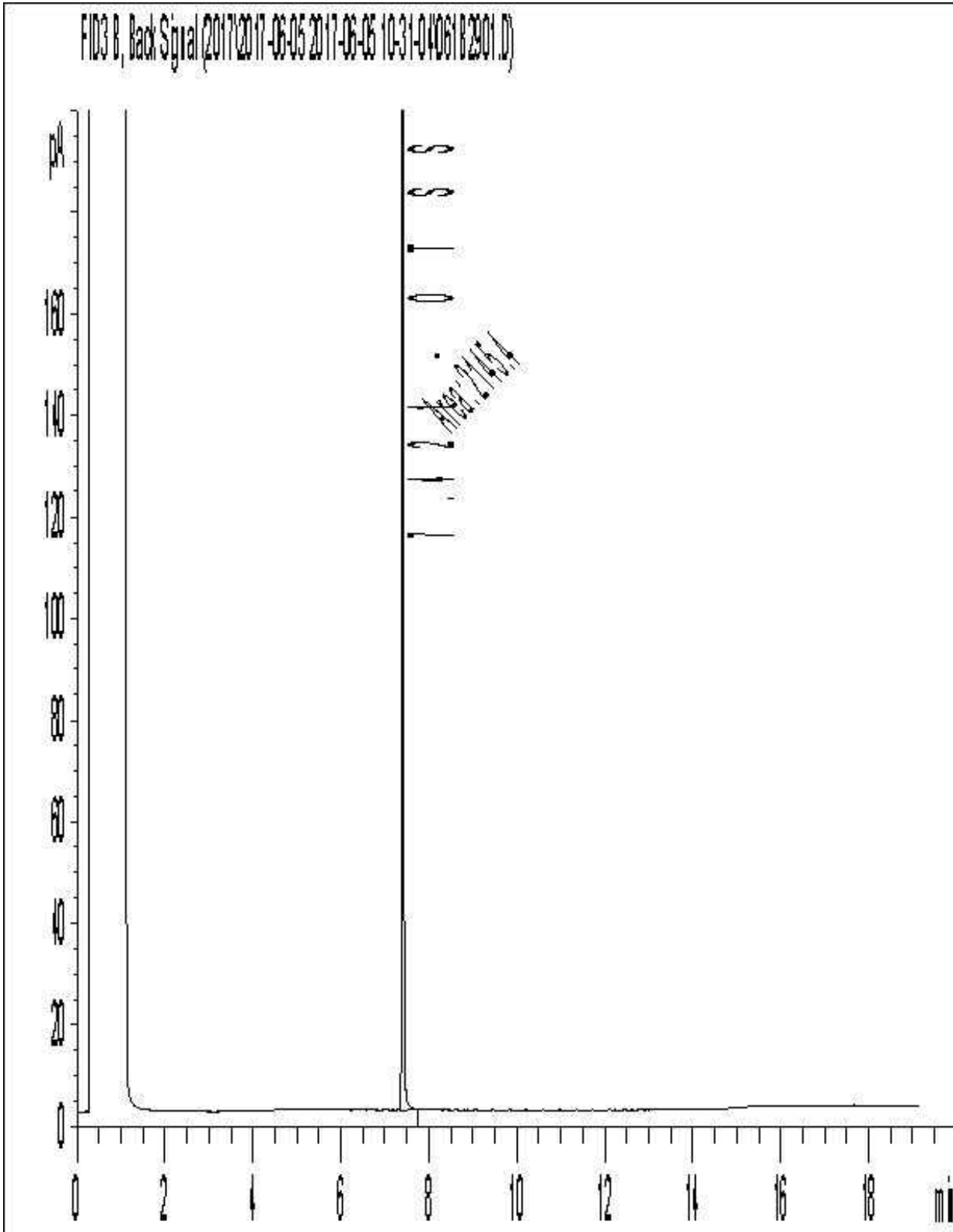
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



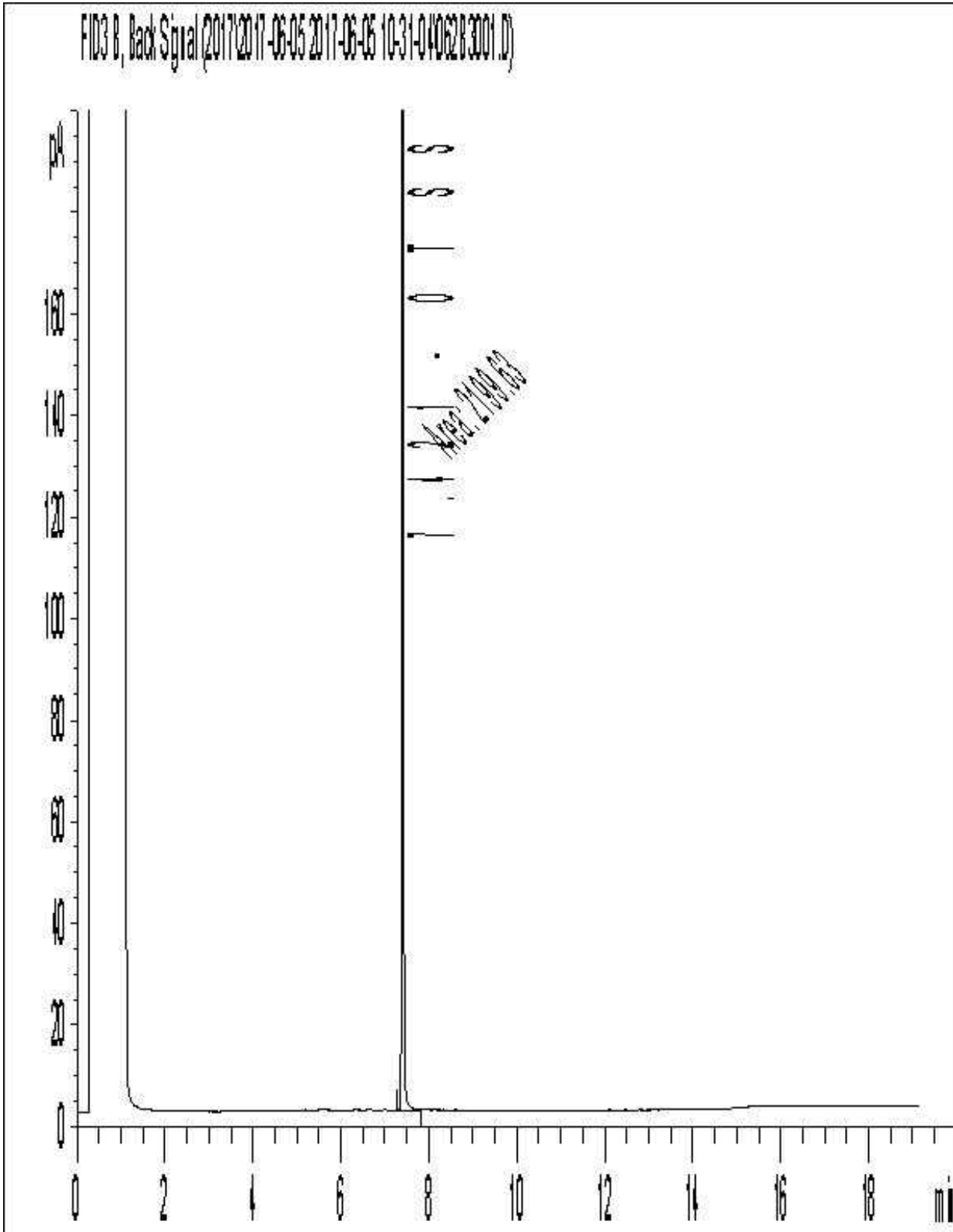
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



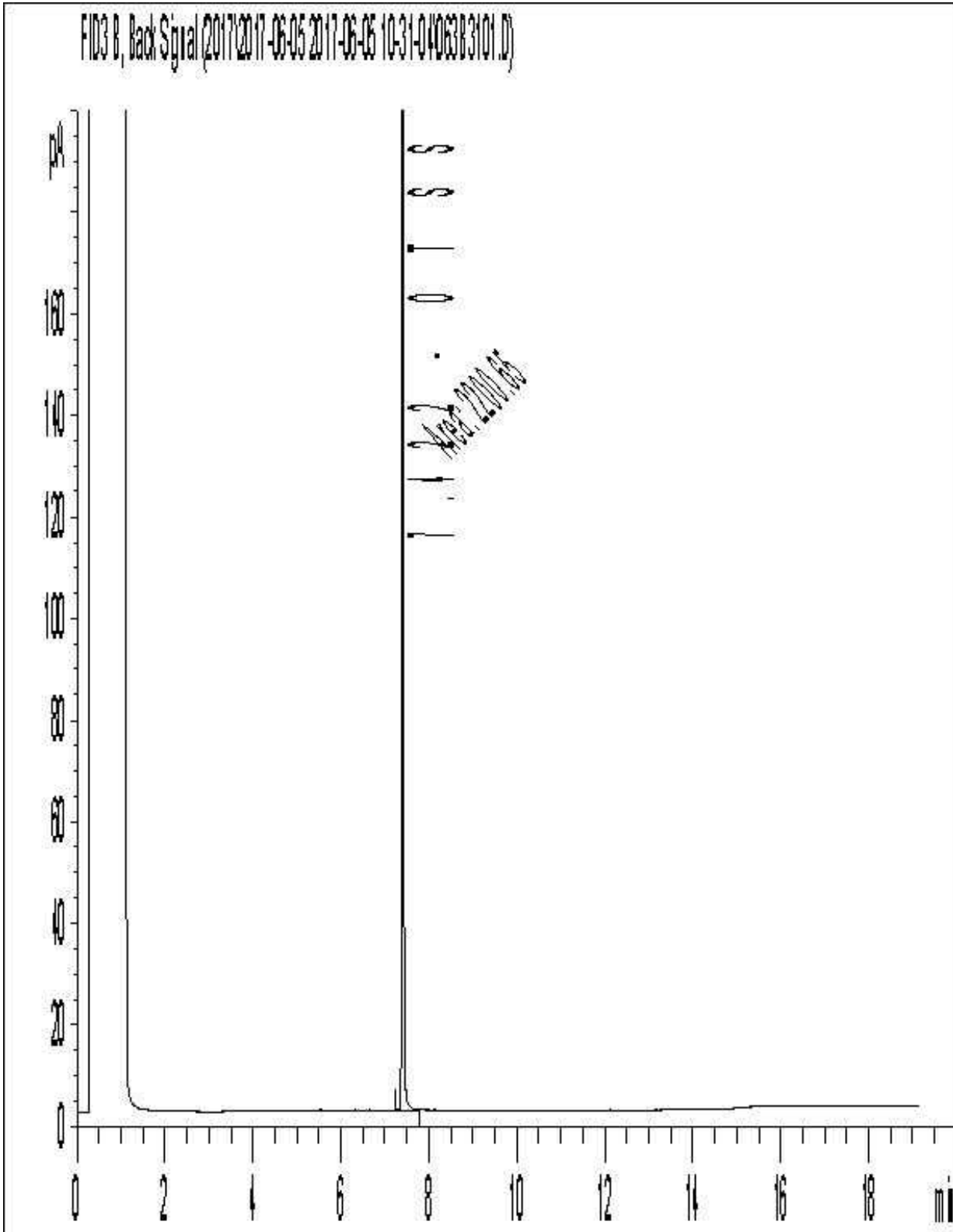
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



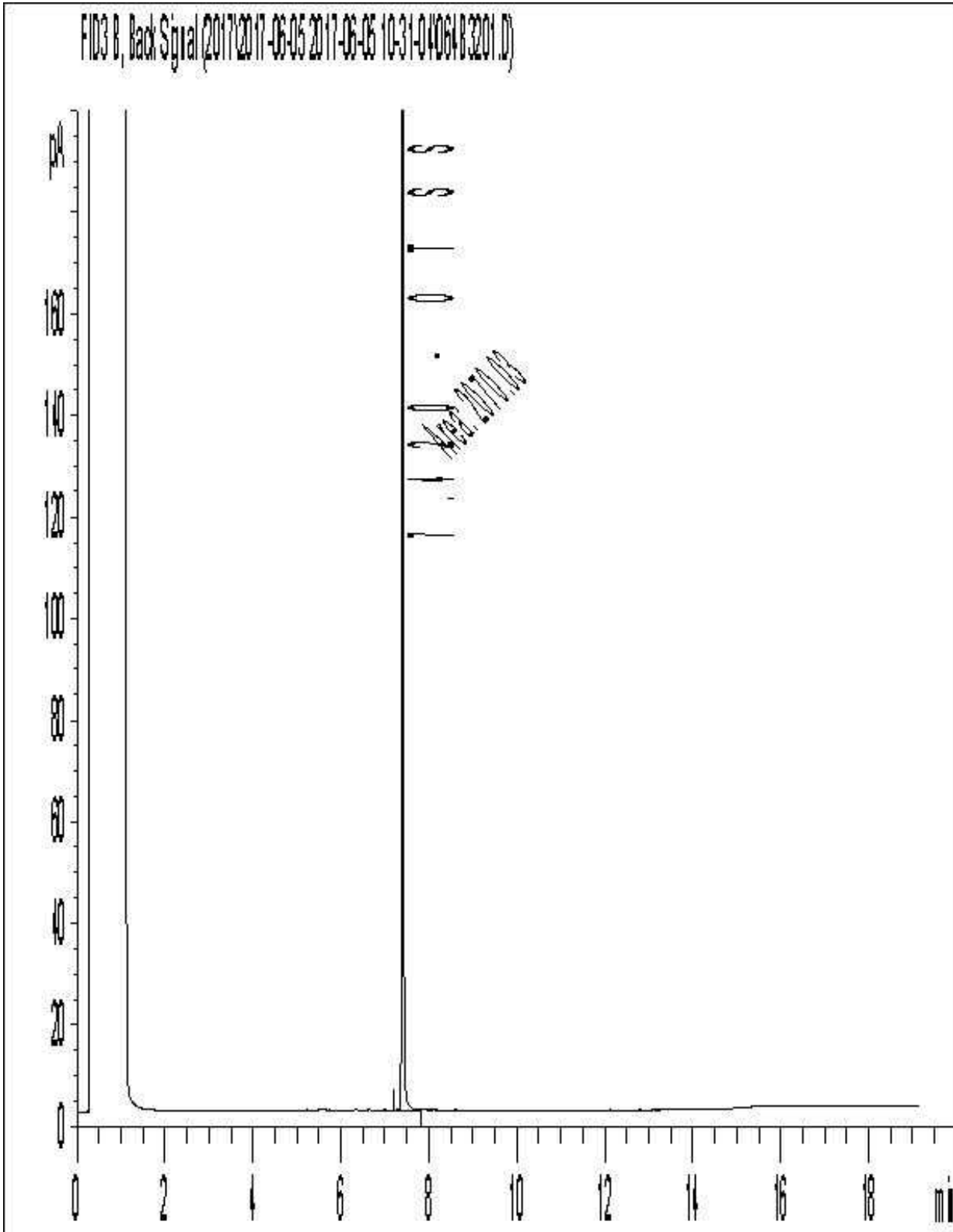
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



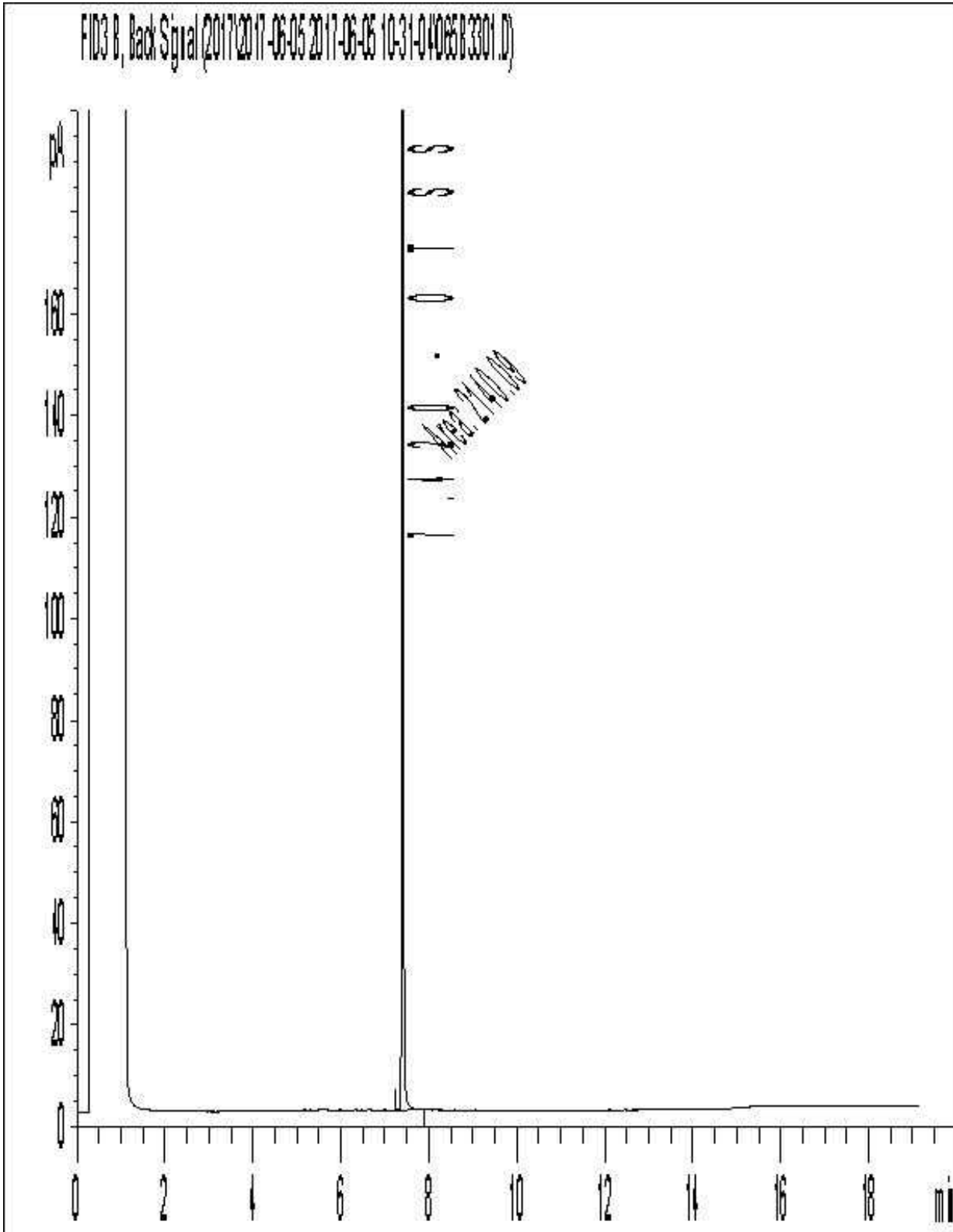
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



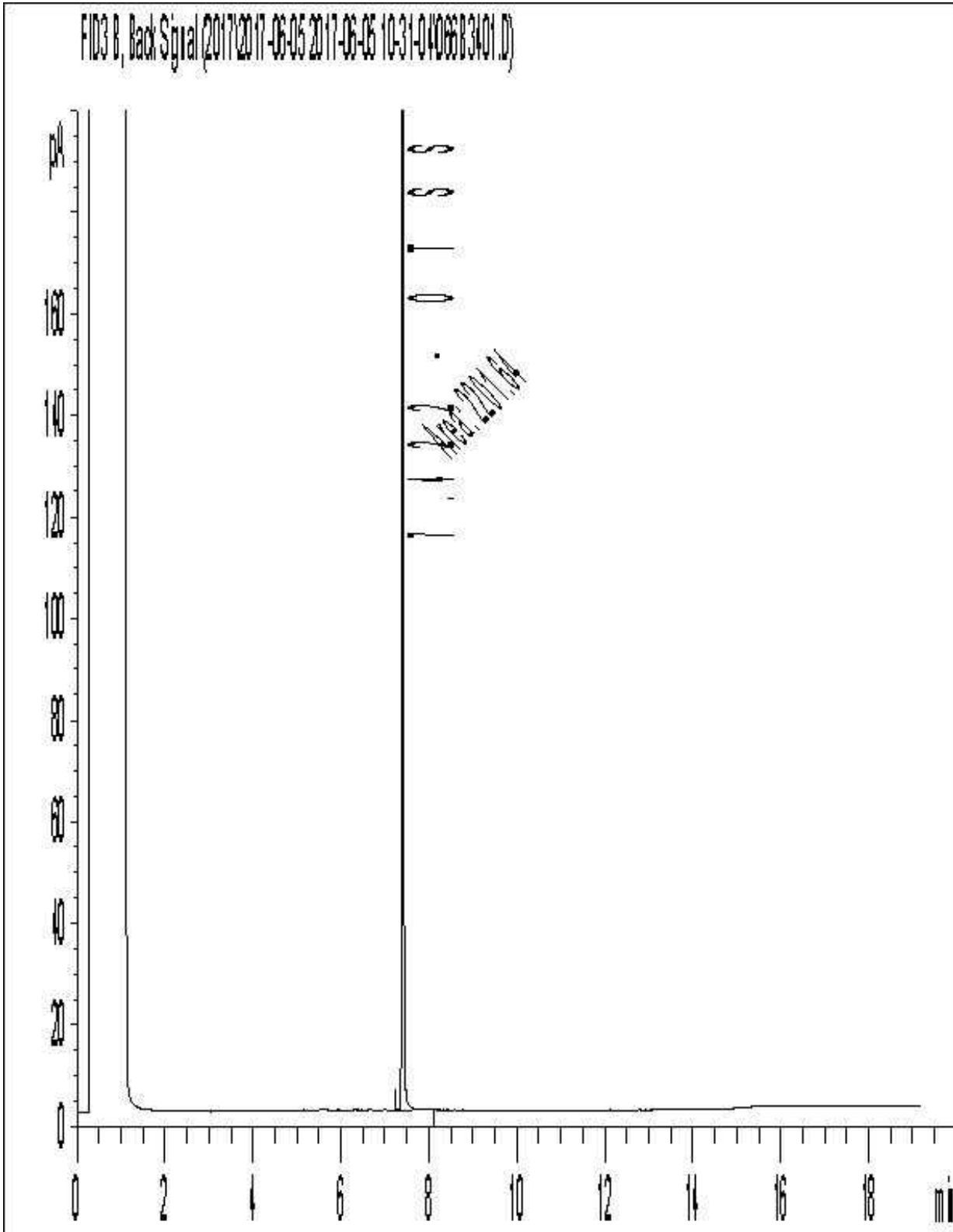
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



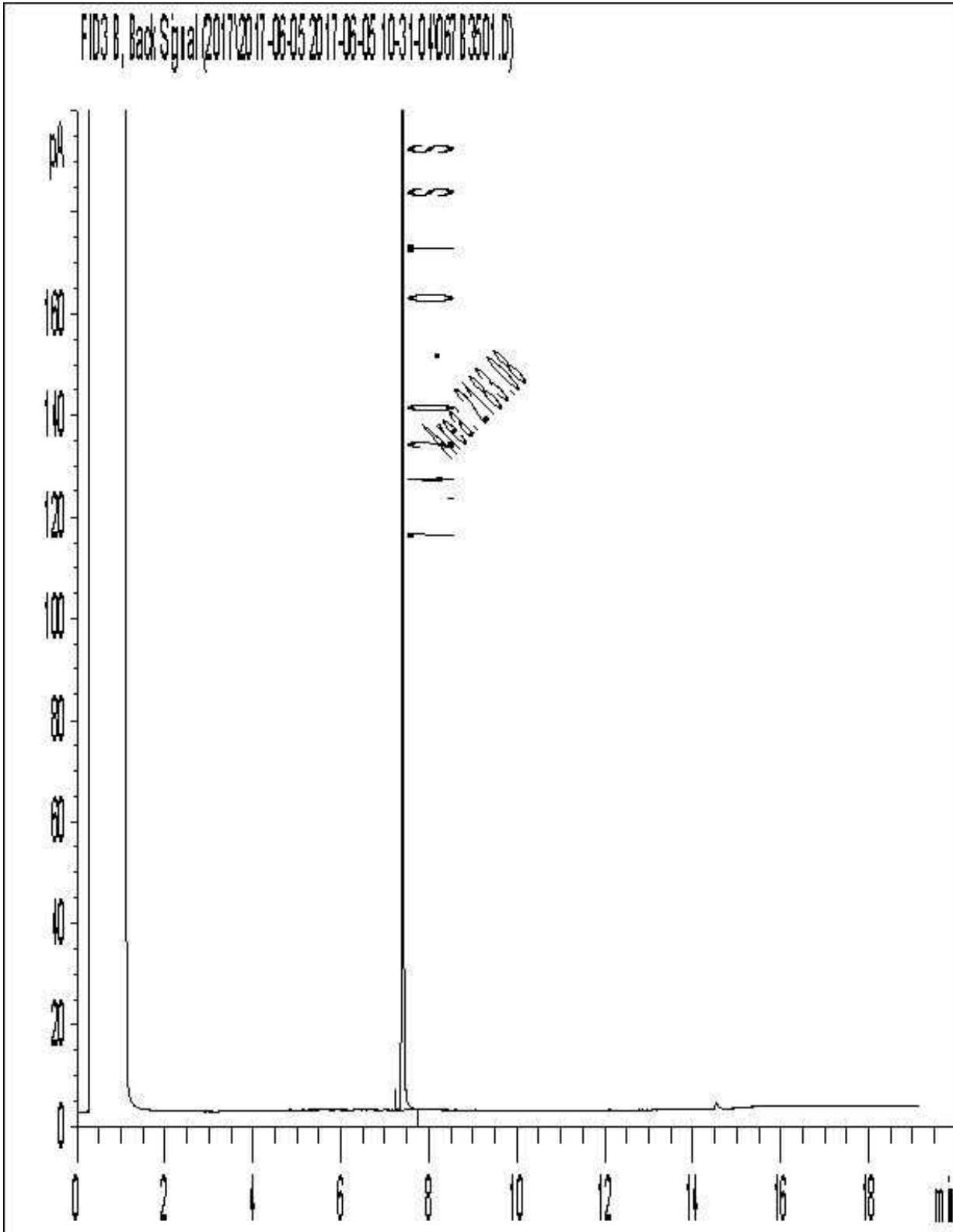
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



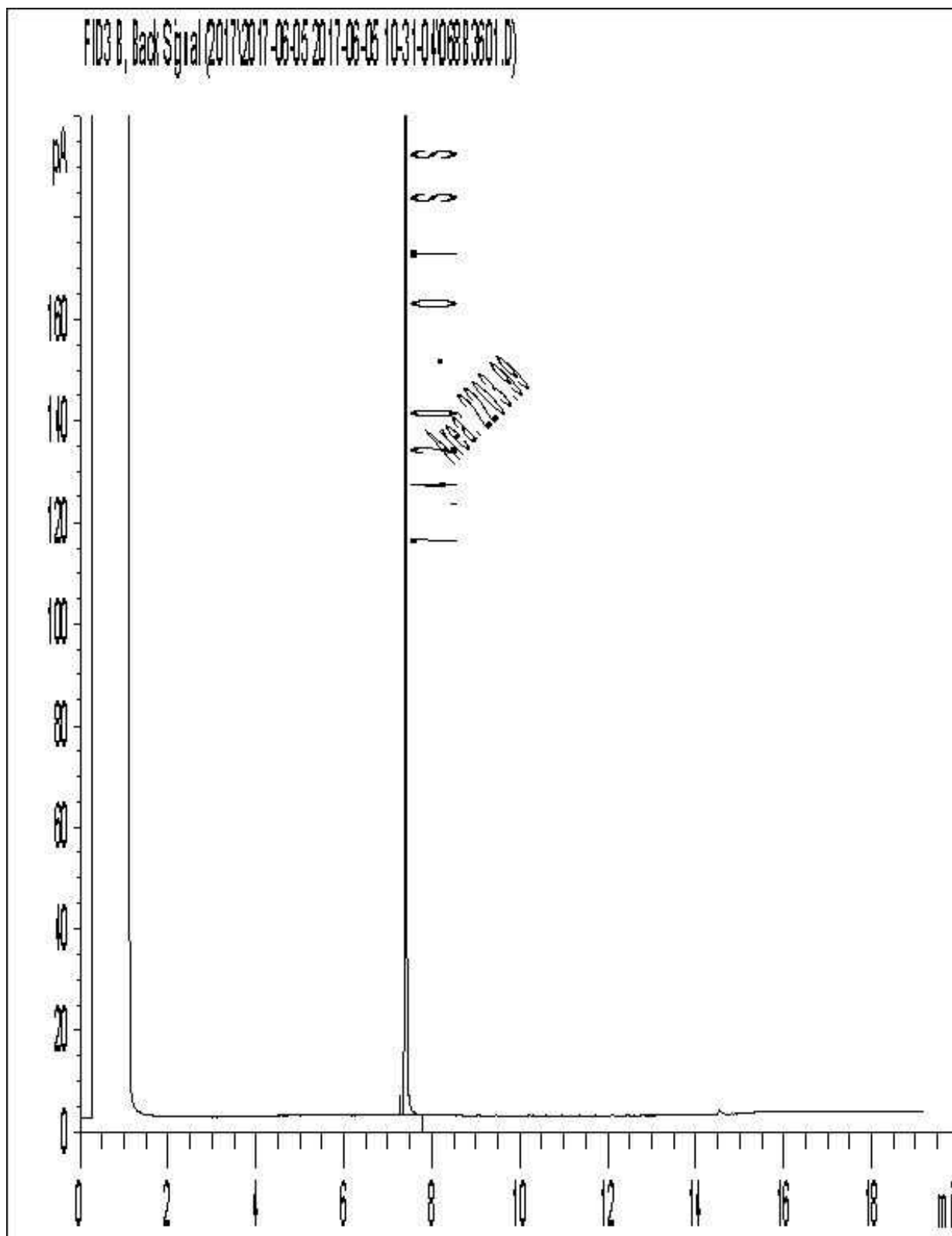
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



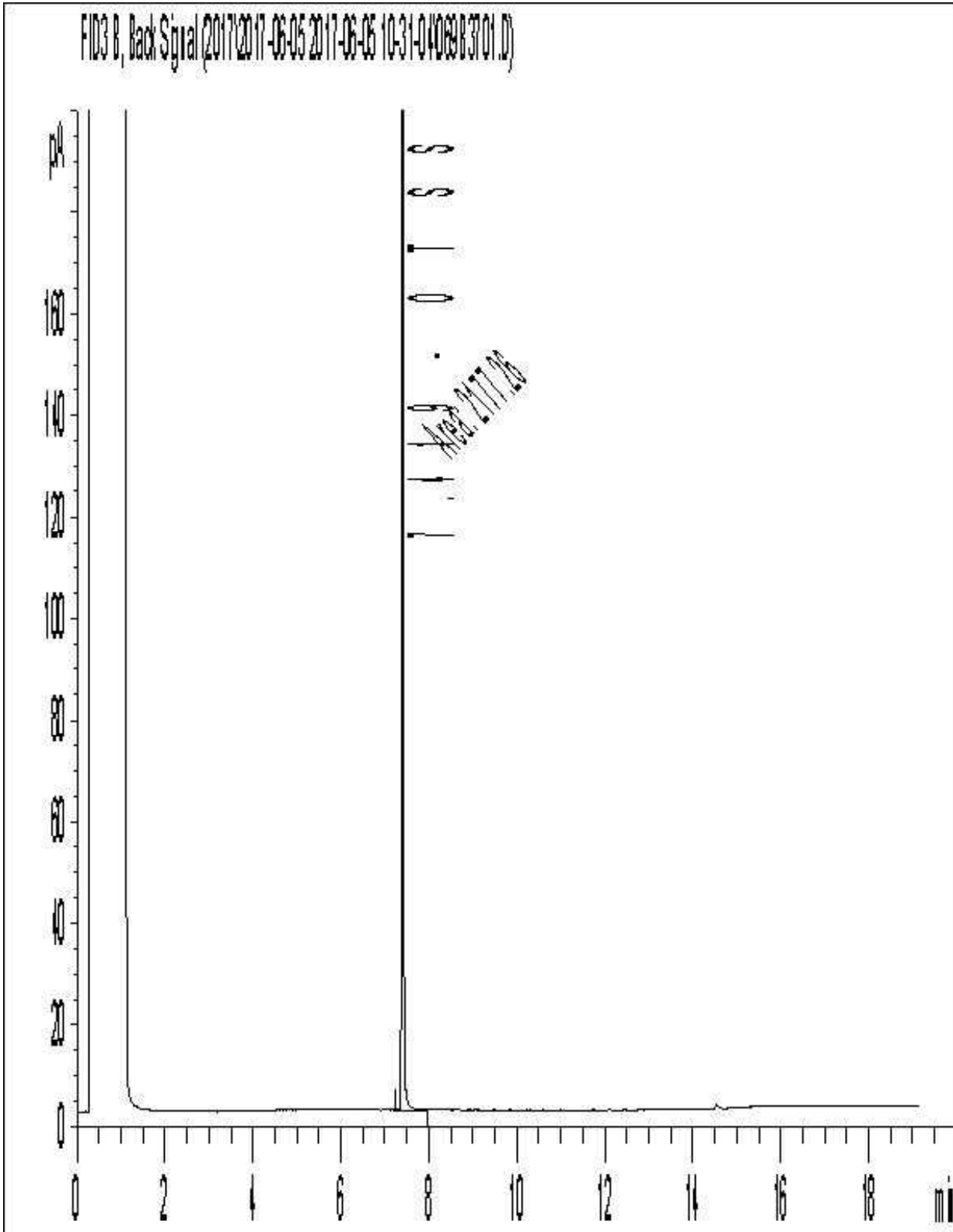
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/22

Report #: R4554408

Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B9311

Received: 2017/06/08, 13:30

Sample Matrix: Water
Samples Received: 15

Analyses	Quantity	Date		Laboratory Method	Reference
		Extracted	Analyzed		
Petroleum Hydro. CCME F1 & BTEX in Water	15	N/A	2017/06/14	OTT SOP-00002	CCME CWS
Petroleum Hydrocarbons F2-F4 in Water (1)	12	2017/06/12	2017/06/12	OTT SOP-00001	CCME Hydrocarbons
Petroleum Hydrocarbons F2-F4 in Water (1)	3	2017/06/12	2017/06/13	OTT SOP-00001	CCME Hydrocarbons
PAH Compounds in Water by GC/MS (SIM)	15	2017/06/12	2017/06/12	OTT SOP-00011	EPA 8270D/3510C m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following "Alberta Environment's Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003". Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Your Project #: 1666131
Your C.O.C. #: 614495-05-01, 612931-04-01

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/22
Report #: R4554408
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B9311
Received: 2017/06/08, 13:30

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Alison Cameron, Project Manager
Email: ACameron@maxxam.ca
Phone# (613) 274-0573

=====
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME PETROLEUM HYDROCARBONS IN WATER (WATER)

Maxxam ID		ENL259	ENL259	ENL260	ENL261	ENL262	ENL263		
Sampling Date		2017/06/05 10:45	2017/06/05 10:45	2017/06/05 12:15	2017/06/05 15:02	2017/06/05 16:13	2017/06/05 11:30		
COC Number		614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01		
	UNITS	NPD-12	NPD-12 Lab-Dup	2" PVC	NPD-13	BH-07-01	NPD-9	RDL	QC Batch
BTEX & F1 Hydrocarbons									
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
p+m-Xylene	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5025140
Total Xylenes	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5025140
F1 (C6-C10)	ug/L	<25	<25	<25	<25	<25	<25	25	5025140
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	<25	<25	<25	25	5025140
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	<100	<100	100	5023388
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5023388
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5023388
Reached Baseline at C50	ug/L	Yes	Yes	Yes	Yes	Yes	Yes		5023388
Surrogate Recovery (%)									
1,4-Difluorobenzene	%	74	80	86	79	79	80		5025140
4-Bromofluorobenzene	%	122	92	101	90	117	96		5025140
D10-Ethylbenzene	%	100	115	111	118	103	116		5025140
D4-1,2-Dichloroethane	%	76	80	84	79	82	80		5025140
o-Terphenyl	%	86	84	86	86	83	81		5023388
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

CCME PETROLEUM HYDROCARBONS IN WATER (WATER)

Maxxam ID		ENL264	ENL265	ENL266	ENL267	ENL268	ENL277		
Sampling Date		2017/06/05 14:19	2017/06/05 16:16	2017/06/05 11:29	2017/06/05 10:40	2017/06/06 09:04	2017/06/06 10:28		
COC Number		614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01	612931-04-01		
	UNITS	NPD-10	BH-06-01	NPD-11	NPD-14	NPD-5	BH-10-01	RDL	QC Batch
BTEX & F1 Hydrocarbons									
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025140
p+m-Xylene	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5025140
Total Xylenes	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.40	5025140
F1 (C6-C10)	ug/L	<25	<25	<25	<25	<25	<25	25	5025140
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	<25	<25	<25	25	5025140
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	<100	<100	100	5023388
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5023388
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	<200	<200	200	5023388
Reached Baseline at C50	ug/L	Yes	Yes	Yes	Yes	Yes	Yes		5023388
Surrogate Recovery (%)									
1,4-Difluorobenzene	%	79	77	83	81	83	82		5025140
4-Bromofluorobenzene	%	91	92	128	101	124	114		5025140
D10-Ethylbenzene	%	116	112	101	120	121	109		5025140
D4-1,2-Dichloroethane	%	78	77	80	81	84	79		5025140
o-Terphenyl	%	82	85	87	86	85	86		5023388
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

CCME PETROLEUM HYDROCARBONS IN WATER (WATER)

Maxxam ID		ENL278	ENL279	ENL280	ENL281		
Sampling Date		2017/06/06 10:28	2017/06/06 11:20	2017/06/06 10:00	2017/06/06 15:56		
COC Number		612931-04-01	612931-04-01	612931-04-01	612931-04-01		
	UNITS	DUP-3	MT-9	BH-09--01	MT-8	RDL	QC Batch
BTEX & F1 Hydrocarbons							
Benzene	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Toluene	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	5025140
Ethylbenzene	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	5025140
o-Xylene	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	5025140
p+m-Xylene	ug/L	<0.40	<0.40	<0.40	<0.40	0.40	5025140
Total Xylenes	ug/L	<0.40	<0.40	<0.40	<0.40	0.40	5025140
F1 (C6-C10)	ug/L	<25	<25	<25	<25	25	5025140
F1 (C6-C10) - BTEX	ug/L	<25	<25	<25	<25	25	5025140
F2-F4 Hydrocarbons							
F2 (C10-C16 Hydrocarbons)	ug/L	<100	<100	<100	<100	100	5023388
F3 (C16-C34 Hydrocarbons)	ug/L	<200	<200	<200	<200	200	5023388
F4 (C34-C50 Hydrocarbons)	ug/L	<200	<200	<200	<200	200	5023388
Reached Baseline at C50	ug/L	Yes	Yes	Yes	Yes		5023388
Surrogate Recovery (%)							
1,4-Difluorobenzene	%	82	78	80	81		5025140
4-Bromofluorobenzene	%	94	94	101	86		5025140
D10-Ethylbenzene	%	101	115	111	120		5025140
D4-1,2-Dichloroethane	%	82	83	82	81		5025140
o-Terphenyl	%	87	82	84	83		5023388
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		ENL259	ENL260	ENL260	ENL261	ENL262	ENL263		
Sampling Date		2017/06/05 10:45	2017/06/05 12:15	2017/06/05 12:15	2017/06/05 15:02	2017/06/05 16:13	2017/06/05 11:30		
COC Number		614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01		
	UNITS	NPD-12	2" PVC	2" PVC Lab-Dup	NPD-13	BH-07-01	NPD-9	RDL	QC Batch

Polyaromatic Hydrocarbons									
Acenaphthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Acenaphthylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(b/j)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(g,h,i)perylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(k)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Chrysene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Dibenz(a,h)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluorene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
1-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
2-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Naphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Phenanthrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528

Surrogate Recovery (%)									
D10-Anthracene	%	91	92	90	90	92	90		5023528
D14-Terphenyl (FS)	%	90	94	95	93	95	95		5023528
D8-Acenaphthylene	%	90	90	89	89	91	90		5023528

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		ENL264	ENL265	ENL266	ENL267	ENL268	ENL277		
Sampling Date		2017/06/05 14:19	2017/06/05 16:16	2017/06/05 11:29	2017/06/05 10:40	2017/06/06 09:04	2017/06/06 10:28		
COC Number		614495-05-01	614495-05-01	614495-05-01	614495-05-01	614495-05-01	612931-04-01		
	UNITS	NPD-10	BH-06-01	NPD-11	NPD-14	NPD-S	BH-10-01	RDL	QC Batch
Polyaromatic Hydrocarbons									
Acenaphthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Acenaphthylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(b/j)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(g,h,i)perylene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(k)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Chrysene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Dibenz(a,h)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluorene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
1-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
2-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Naphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Phenanthrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Surrogate Recovery (%)									
D10-Anthracene	%	95	88	90	88	91	91		5023528
D14-Terphenyl (FS)	%	99	90	93	90	93	92		5023528
D8-Acenaphthylene	%	92	85	87	88	88	88		5023528
RDL = Reportable Detection Limit QC Batch = Quality Control Batch									

SEMI-VOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		ENL278	ENL279	ENL280	ENL281		
Sampling Date		2017/06/06 10:28	2017/06/06 11:20	2017/06/06 10:00	2017/06/06 15:56		
COC Number		612931-04-01	612931-04-01	612931-04-01	612931-04-01		
	UNITS	DUP-3	MT-9	BH-09--01	MT-8	RDL	QC Batch
Polyaromatic Hydrocarbons							
Acenaphthene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Acenaphthylene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(a)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(b/j)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(g,h,i)perylene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Benzo(k)fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Chrysene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Dibenz(a,h)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluoranthene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Fluorene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Indeno(1,2,3-cd)pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
1-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
2-Methylnaphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Naphthalene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Phenanthrene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Pyrene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	5023528
Surrogate Recovery (%)							
D10-Anthracene	%	90	91	92	92		5023528
D14-Terphenyl (FS)	%	90	92	94	94		5023528
D8-Acenaphthylene	%	88	89	90	91		5023528
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

TEST SUMMARY

Maxxam ID: ENL259
Sample ID: NPD-12
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL259 Dup
Sample ID: NPD-12
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici

Maxxam ID: ENL260
Sample ID: 2" PVC
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL260 Dup
Sample ID: 2" PVC
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL261
Sample ID: NPD-13
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL262
Sample ID: BH-07-01
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

TEST SUMMARY

Maxxam ID: ENL263
Sample ID: NPD-9
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL264
Sample ID: NPD-10
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL265
Sample ID: BH-06-01
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL266
Sample ID: NPD-11
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL267
Sample ID: NPD-14
Matrix: Water

Collected: 2017/06/05
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL268
Sample ID: NPD-S
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart

TEST SUMMARY

Maxxam ID: ENL268
Sample ID: NPD-S
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL277
Sample ID: BH-10-01
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL278
Sample ID: DUP-3
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/12	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL279
Sample ID: MT-9
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/13	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL280
Sample ID: BH-09--01
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/13	Liliana Gaburici
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

Maxxam ID: ENL281
Sample ID: MT-8
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Water	HSGC/MSFD	5025140	N/A	2017/06/14	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Water	GC/FID	5023388	2017/06/12	2017/06/13	Liliana Gaburici

Maxxam Job #: B7B9311
Report Date: 2017/06/22

Golder Associates Ltd
Client Project #: 1666131
Sampler Initials: JO

TEST SUMMARY

Maxxam ID: ENL281
Sample ID: MT-8
Matrix: Water

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Water by GC/MS (SIM)	GC/MS	5023528	2017/06/12	2017/06/12	Arezoo Habibagahi

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	22.0°C
Package 2	13.0°C

Samples received at a temperature above 10C. Analysis performed with client's consent.
Revised Report (2017/06/22): Report re-issued for upload to Equis.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5023388	o-Terphenyl	2017/06/12	78	30 - 130	90	30 - 130	81	%		
5023528	D10-Anthracene	2017/06/12	90	50 - 130	89	50 - 130	92	%		
5023528	D14-Terphenyl (FS)	2017/06/12	94	50 - 130	94	50 - 130	95	%		
5023528	D8-Acenaphthylene	2017/06/12	89	50 - 130	90	50 - 130	91	%		
5025140	1,4-Difluorobenzene	2017/06/14	79	70 - 130	81	70 - 130	83	%		
5025140	4-Bromofluorobenzene	2017/06/14	129	70 - 130	106	70 - 130	104	%		
5025140	D10-Ethylbenzene	2017/06/14	120	70 - 130	116	70 - 130	119	%		
5025140	D4-1,2-Dichloroethane	2017/06/14	80	70 - 130	77	70 - 130	82	%		
5023388	F2 (C10-C16 Hydrocarbons)	2017/06/12	97	50 - 130	100	80 - 120	<100	ug/L	NC	50
5023388	F3 (C16-C34 Hydrocarbons)	2017/06/12	97	50 - 130	100	80 - 120	<200	ug/L	NC	50
5023388	F4 (C34-C50 Hydrocarbons)	2017/06/12	97	50 - 130	100	80 - 120	<200	ug/L	NC	50
5023528	1-Methylnaphthalene	2017/06/12	88	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5023528	2-Methylnaphthalene	2017/06/12	89	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5023528	Acenaphthene	2017/06/12	86	50 - 130	77	50 - 130	<0.010	ug/L	NC	30
5023528	Acenaphthylene	2017/06/12	78	50 - 130	71	50 - 130	<0.010	ug/L	NC	30
5023528	Anthracene	2017/06/12	79	50 - 130	71	50 - 130	<0.010	ug/L	NC	30
5023528	Benzo(a)anthracene	2017/06/12	87	50 - 130	81	50 - 130	<0.010	ug/L	NC	30
5023528	Benzo(a)pyrene	2017/06/12	74	50 - 130	72	50 - 130	<0.010	ug/L	NC	30
5023528	Benzo(b,j)fluoranthene	2017/06/12	83	50 - 130	79	50 - 130	<0.010	ug/L	NC	30
5023528	Benzo(g,h,i)perylene	2017/06/12	71	50 - 130	70	50 - 130	<0.010	ug/L	NC	30
5023528	Benzo(k)fluoranthene	2017/06/12	81	50 - 130	72	50 - 130	<0.010	ug/L	NC	30
5023528	Chrysene	2017/06/12	79	50 - 130	73	50 - 130	<0.010	ug/L	NC	30
5023528	Dibenz(a,h)anthracene	2017/06/12	62	50 - 130	56	50 - 130	<0.010	ug/L	NC	30
5023528	Fluoranthene	2017/06/12	85	50 - 130	77	50 - 130	<0.010	ug/L	NC	30
5023528	Fluorene	2017/06/12	91	50 - 130	82	50 - 130	<0.010	ug/L	NC	30
5023528	Indeno(1,2,3-cd)pyrene	2017/06/12	82	50 - 130	73	50 - 130	<0.010	ug/L	NC	30
5023528	Naphthalene	2017/06/12	78	50 - 130	69	50 - 130	<0.010	ug/L	NC	30
5023528	Phenanthrene	2017/06/12	79	50 - 130	72	50 - 130	<0.010	ug/L	NC	30
5023528	Pyrene	2017/06/12	81	50 - 130	75	50 - 130	<0.010	ug/L	NC	30
5025140	Benzene	2017/06/14	89	70 - 130	97	70 - 130	<0.20	ug/L	NC	40
5025140	Ethylbenzene	2017/06/14	104	70 - 130	109	70 - 130	<0.20	ug/L	NC	40

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5025140	F1 (C6-C10) - BTEX	2017/06/14					<25	ug/L	NC	40
5025140	F1 (C6-C10)	2017/06/14	110	70 - 130	119	70 - 130	<25	ug/L	NC	40
5025140	o-Xylene	2017/06/14	97	70 - 130	98	70 - 130	<0.20	ug/L	NC	40
5025140	p+m-Xylene	2017/06/14	109	70 - 130	117	70 - 130	<0.40	ug/L	NC	40
5025140	Toluene	2017/06/14	99	70 - 130	103	70 - 130	<0.20	ug/L	NC	40
5025140	Total Xylenes	2017/06/14					<0.40	ug/L	NC	40

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

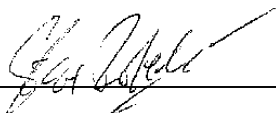
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Paul Rubinato, Analyst, Maxxam Analytics



Steve Roberts, Ottawa Lab Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CHAIN OF CUSTODY RECORD

Maxxam Analytics International Corporation
 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L6
 Tel: (905) 617-5700 Fax: (905) 617-5777 www.maxxam.ca

Maxxam
 A Division of
 Laboratory Services Corporation

Page 22

INVOICE TO:
 Company Name: #14090 Golder Associates Ltd
 Attention: Accounts Payable
 Address: 1931 Robertson Rd, Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x Fax: (613) 592-9601 x
 Email: AP_CustomerService@golder.com

REPORT TO:
 Company Name: Alex Wood
 Attention: Alex Wood
 Address: alex_wood@golder.com
 Tel: Fax:

PROJECT INFORMATION:
 Quotation #: B66107
 P.O. #: 1686131
 Project: J. Oyle
 Project Name: J. Oyle
 Site #: J. Oyle
 Sampled By: J. Oyle

Laboratory Use Only:
 Maxxam Job #: _____
 Bottle Order #: _____
 COC #: _____
 Project Manager: Alison Cameron
 C#612931-04-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Metals / Hg / Cr VI
 O Reg 153 Petroleum Hydrocarbons (Water)
 O Reg 153 PAHs (Water)

Regular (Standard) TAT:
 Please provide advance notice for rush projects
 (will be applied if Rush TAT is not specified)
 Standard TAT - 5-7 Working days for most tests.
 Please note: Standard TAT for certain tests such as BOD and Dissolved Solids are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
 Date Required: _____ Time Required: _____
 Rush Confirmation Number: _____ (call job for #)

Turnaround Time (TAT) Required:

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle)	Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons (Water)	O Reg 153 PAHs (Water)	Date: (YY/MM/DD)	Time	# bars used and not submitted	Time Sensitive	Laboratory Use Only	
													Temperature (°C) on Receipt	Custody Seal Intact
BH-10-01	BH-10-01	Jun 6/17	10:28	GW	✓		✓	✓	20/11/06/08	13:30			22.22	13/11/17
DUP-3	DUP-3		10:28	GW										
MT-9	MT-9		11:20	GW										
BH-09-01	BH-09-01		10:00	GW										
MT-8	MT-8		15:56	GW										
08-Jun-17 13:30 Alison Cameron B7B9311 YTY VTT 001														

RECEIVED BY: (Signature/Print)
 Alex Wood
 Date: 17-06-08 1:30p
 Location: Mariana Dawson

RECEIVED BY: (Signature/Print)
 Mariana Dawson
 Date: 20/11/06/08
 Time: 13:30

LABORATORY USE ONLY
 Temperature (°C) on Receipt: 22.22
 Custody Seal Intact: 13/11/17

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENTS IS AN ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

** IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

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Page 17 of 34

CHAIN OF CUSTODY RECORD

Maxxam Analytics International Corporation
 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L6
 Tel: (905) 817-5700 Fax: (905) 817-5777 www.maxxam.ca

INVOICE TO:
 Company Name: #14090 Golder Associates Ltd
 Attention: Central Accounting
 Address: 1931 Robertson Rd, Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x (613) 592-9601 x
 Email: AP-CustomerService@golder.com

REPORT TO:
 Company Name: Tony Lyon Alex Wood
 Attention: Tony Lyon Alex Wood
 Address: Tony Lyon Alex Wood
 Tel: Alex Wood
 Email: TonyLyon@golder.com; tlyon@golder.com

PROJECT INFORMATION:
 Quotation #: B70916
 P.O. #: 1666131
 Project Name:
 Site #: 3044
 Sampled By:

Laboratory Use Only:
 Maxxam Job #:
 Bottle Order #: 614495
 Project Manager: Alison Cameron
 COC #: C9614495-05-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Table 1 Res/Park Medium/Fine CCME Sanitary Sewer Bylaw
 Table 2 Ind/Comm Coarse Reg 558 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWOO Other

Other Regulations
 Regular (Standard) TAT: (Will be applied if Rush TAT is not specified; Standard TAT = 5-7 Working days for most tests. Please note Standard TAT for certain tests such as BOD and Dissolved Metals are > 5 days - contact your Project Manager for details.)
 Job Specific Rush TAT (if applies to entire submission)
 Date Required: _____ Time Required: _____
 Rush Confirmation Number: _____ (Call lab for #)

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle):	Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons	O Reg 153 PHS (S&M) (WMS)	O Reg 153 PCBs (S&M)	Metals (Including Cr VI and Hg)	# Jars used and not submitted	Time Sensitive	Laboratory Use Only	Custody Seal Present	Yes	No
1	NPD-12	Jun 17	10:45	GW	Metals / Hg / Cr VI											
2	2" PVC		12:15													
3	NPD-13		15:02													
4	BH-07-01		16:13													
5	NPD-9		11:30													
6	NPD-10		14:19													
7	BH-06-01		16:16													
8	NPD-11		11:29													
9	NPD-14		10:40													
10	NPD-5	Jun 6/17	9:04													
* RELINQUISHED BY: (Signature/Print) Alex Wood		Date: (YY/MM/DD) 17/06/18	Time	RECEIVED BY: (Signature/Print) Mariano Daxan		Date: (YY/MM/DD) 20/06/18	Time	Date: (YY/MM/DD) 20/06/18		Time	Laboratory Use Only Temperature (°C) on Receipt 22.122		Custody Seal Present Intact	Yes	No	White: Maxxa Yellow: Client

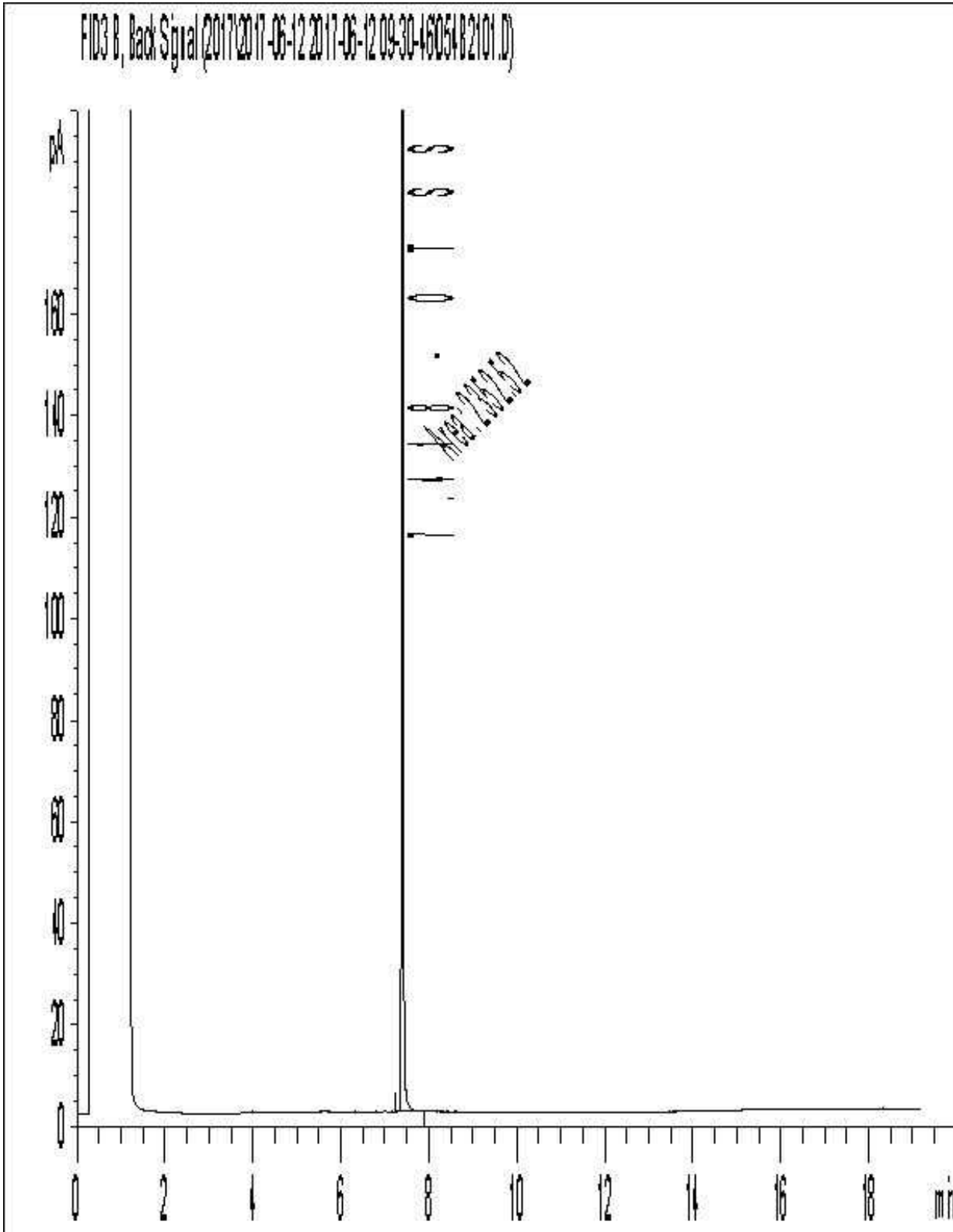
UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

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SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/MP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

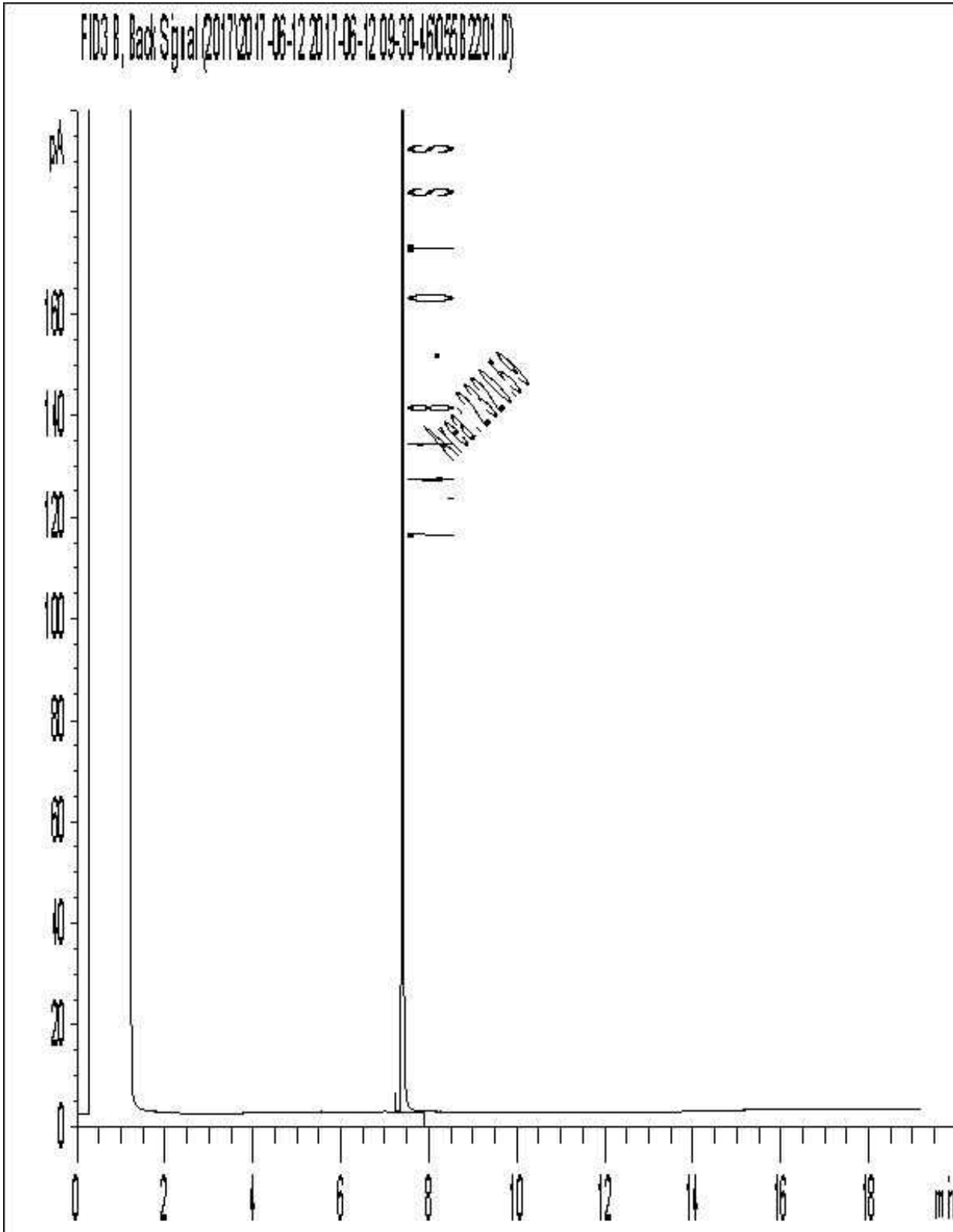
13,13,13

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



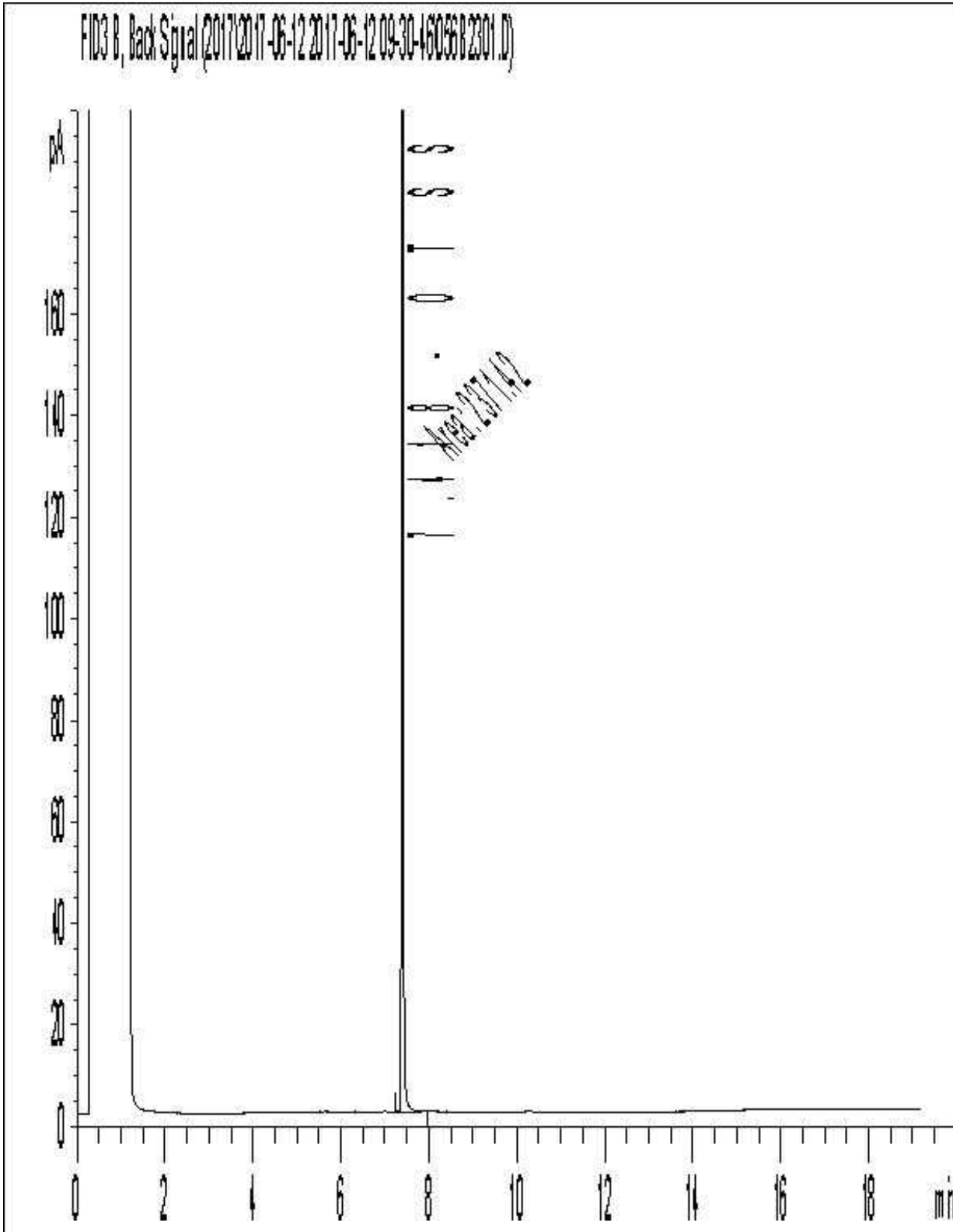
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



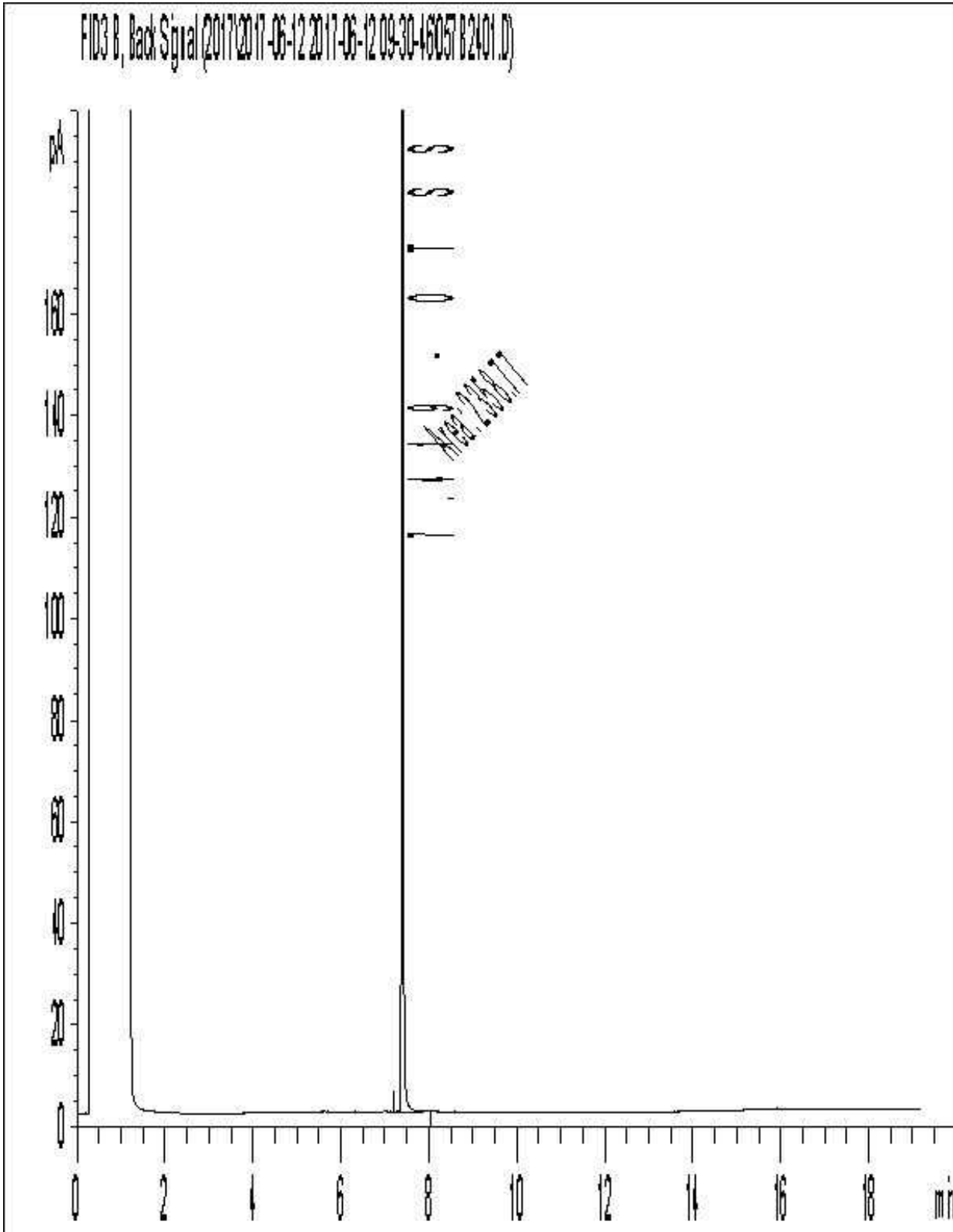
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



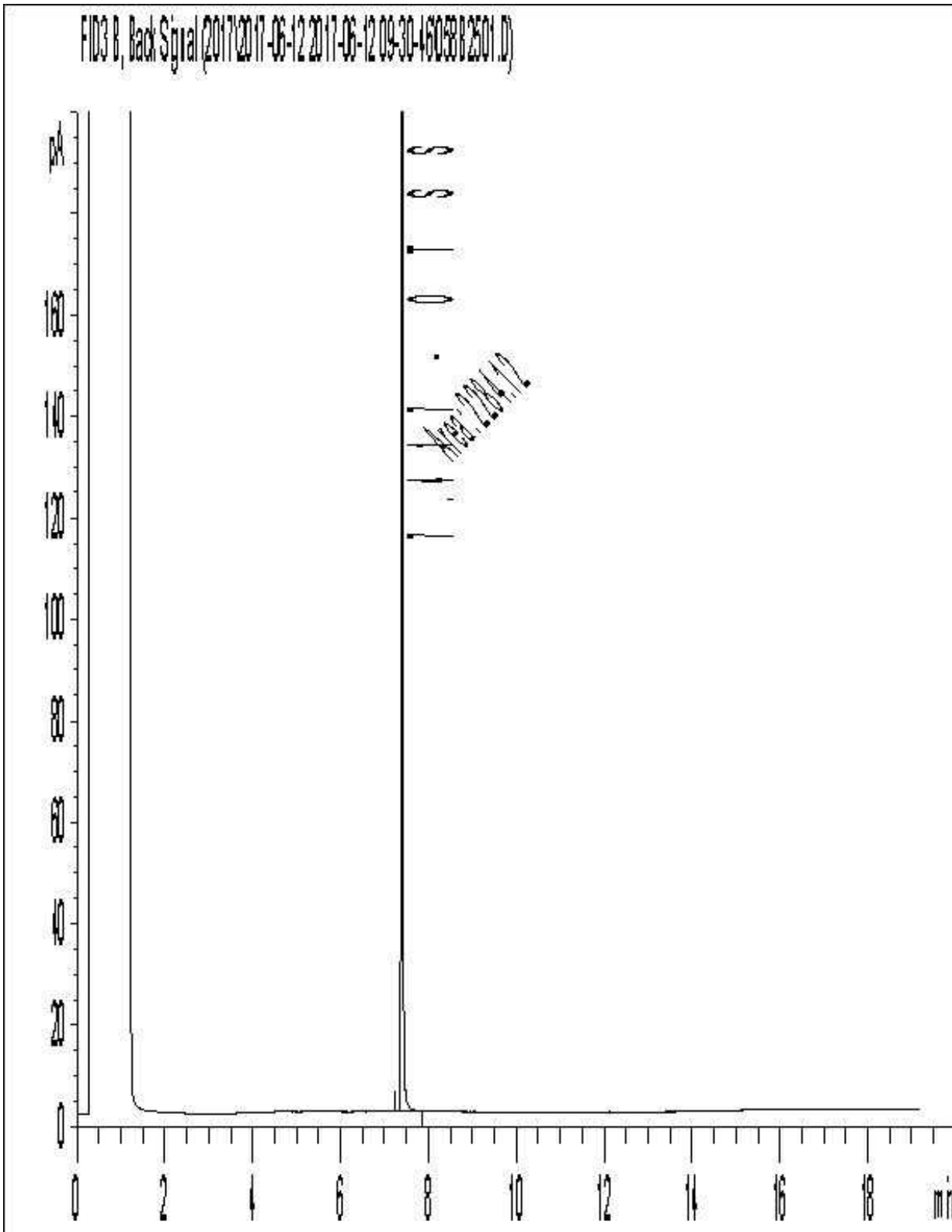
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Water Chromatogram



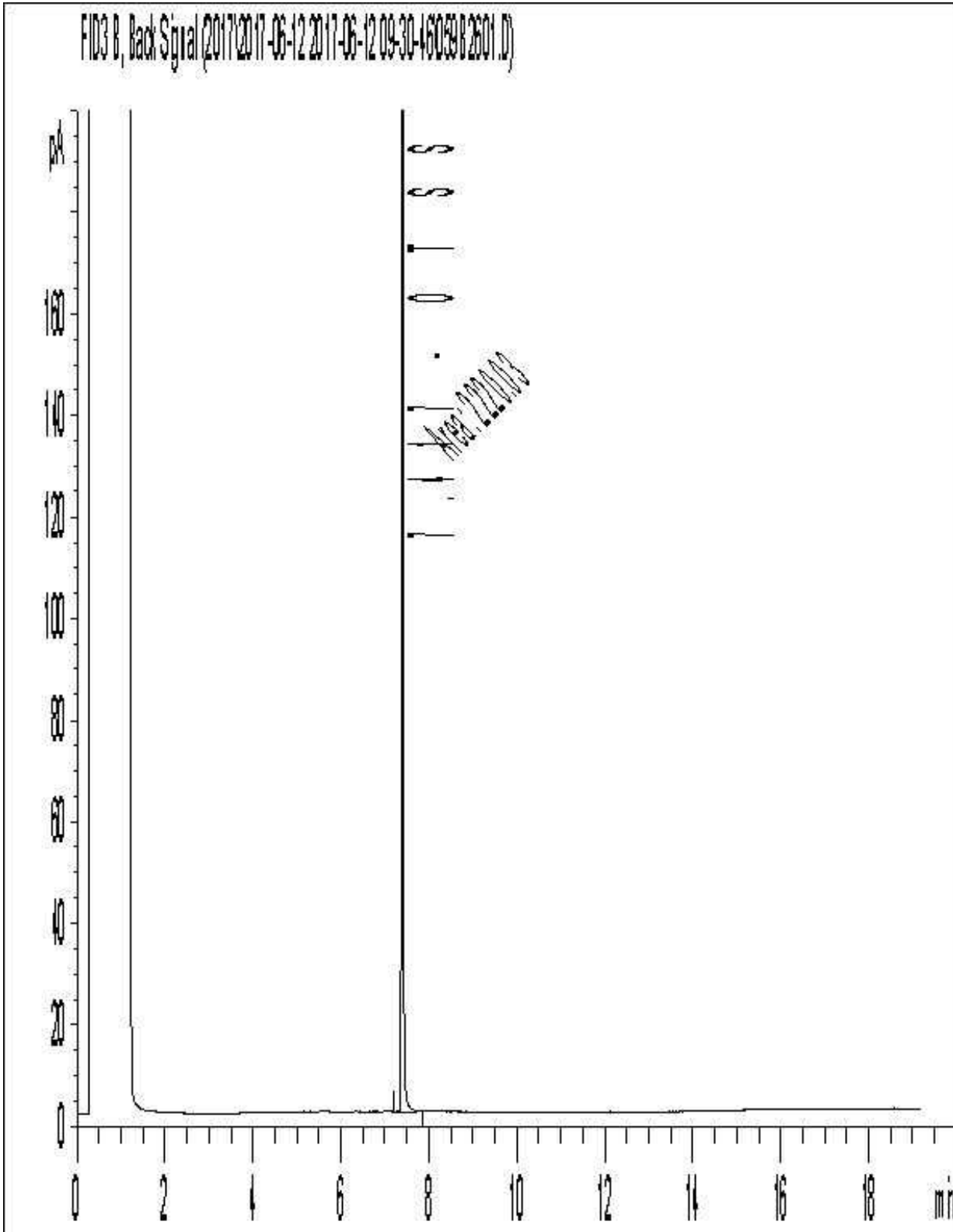
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



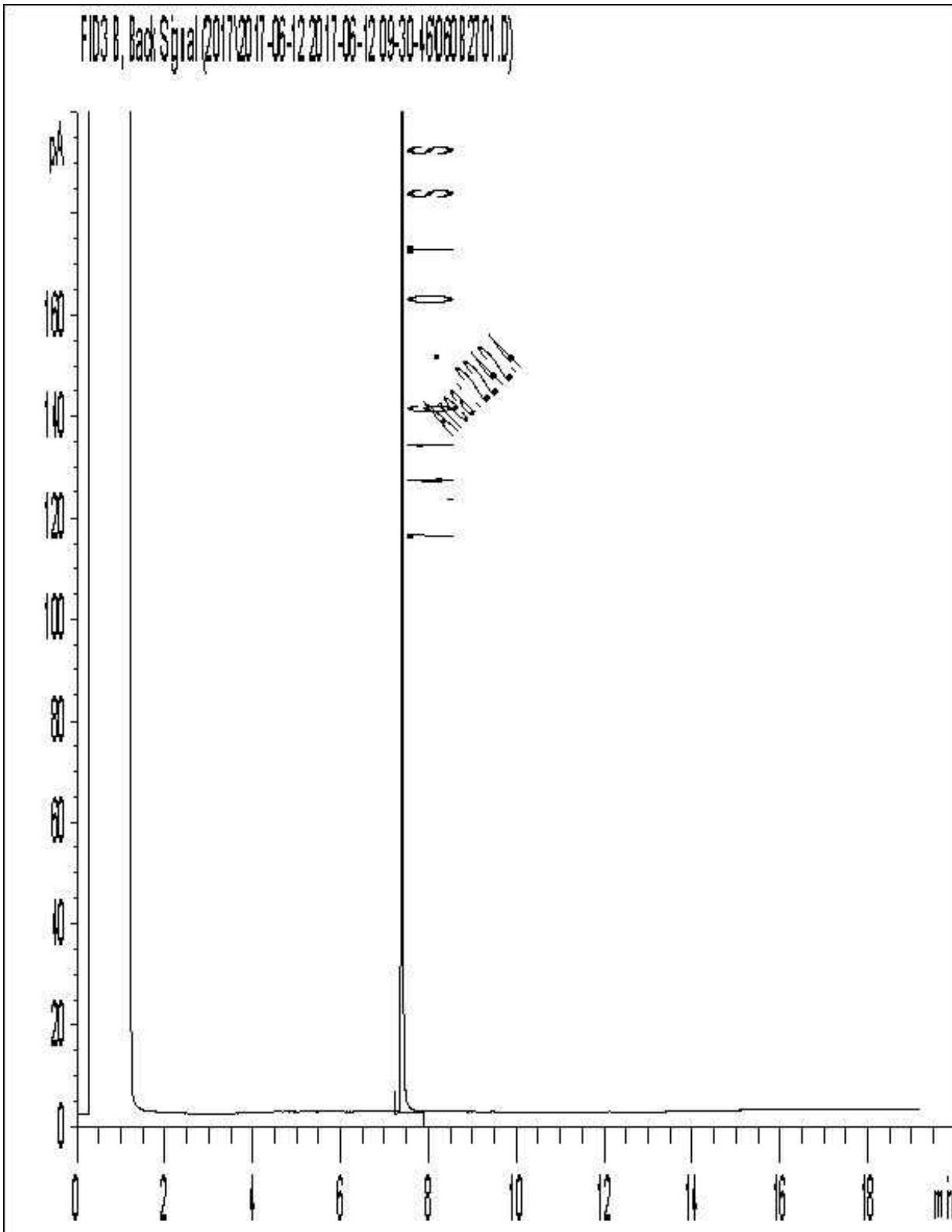
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



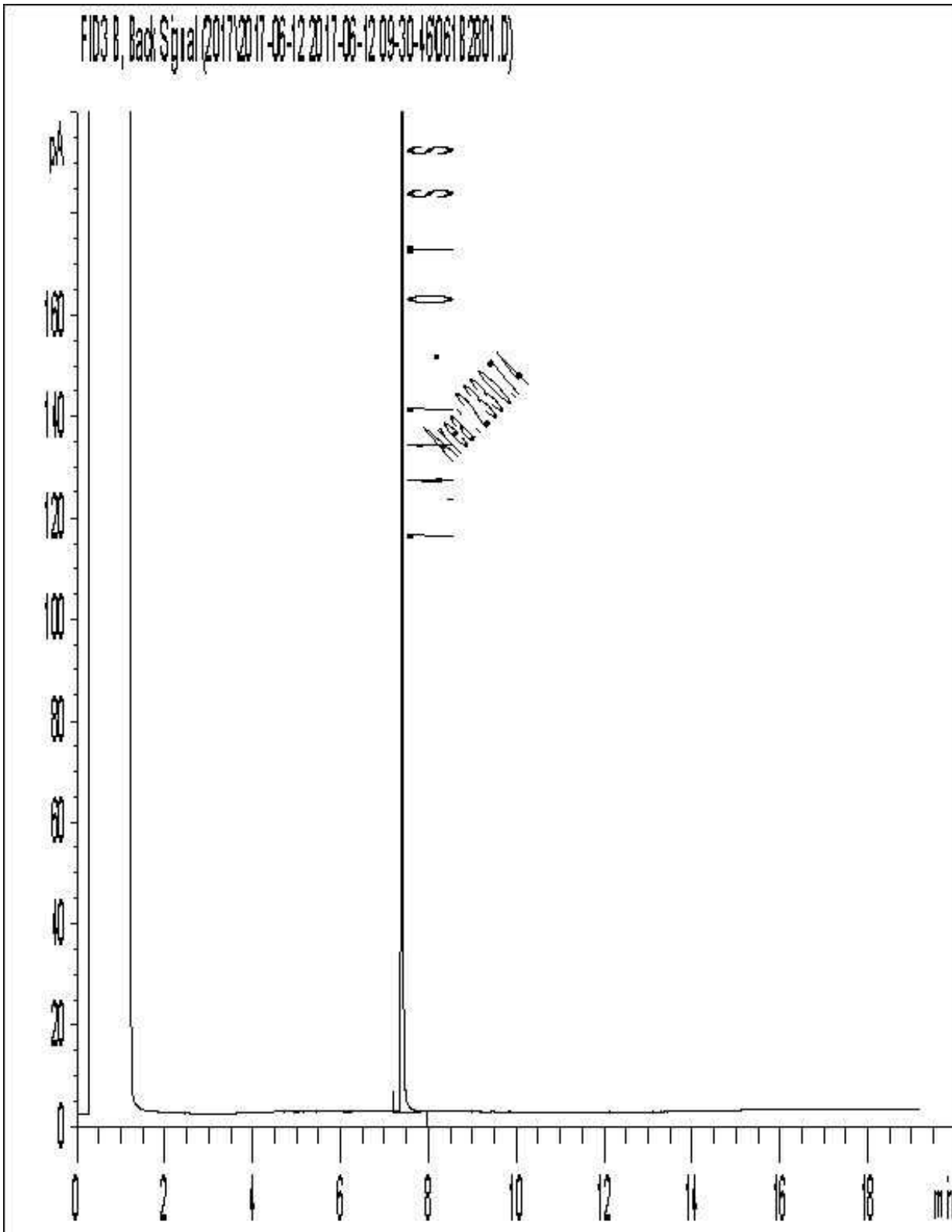
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



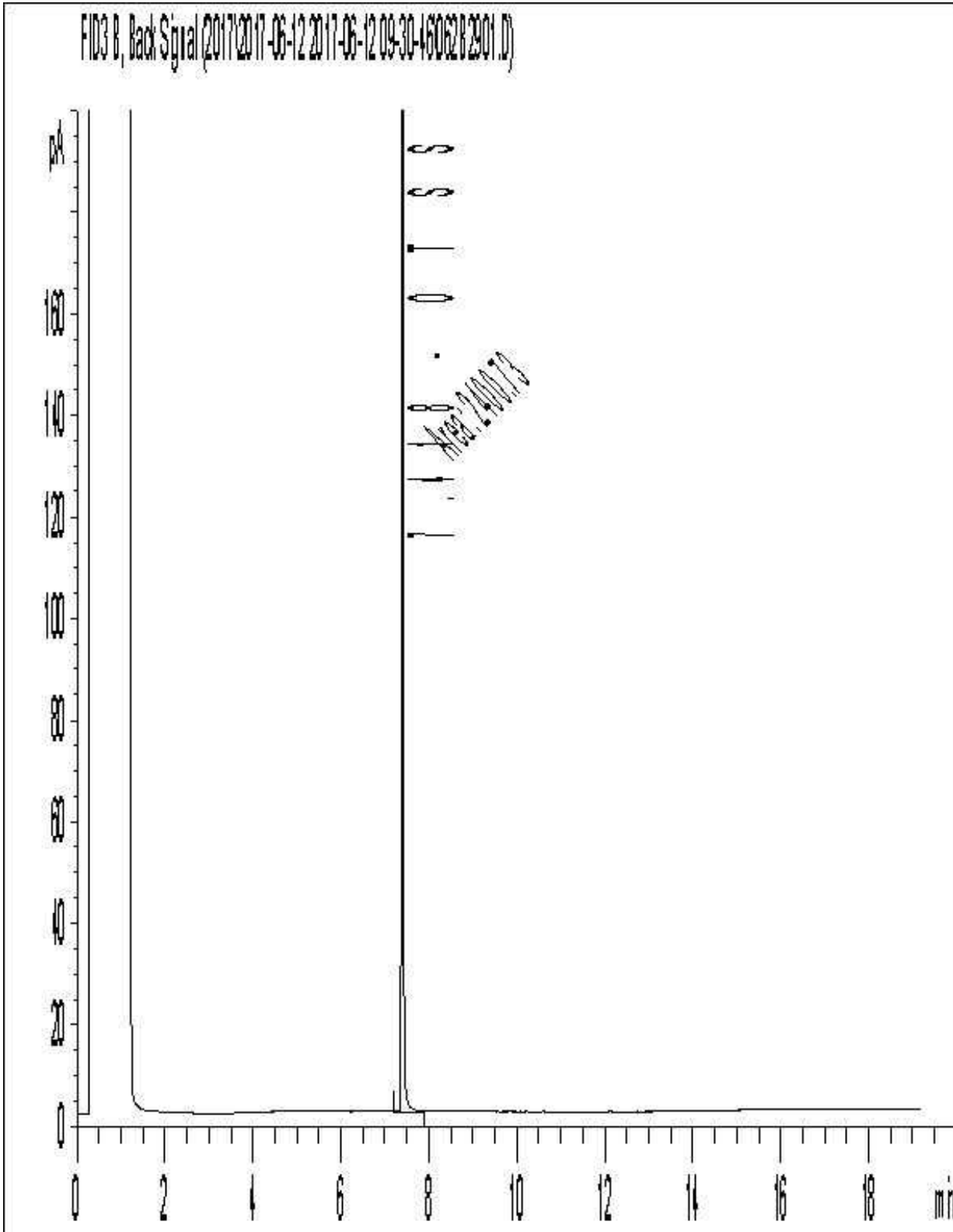
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



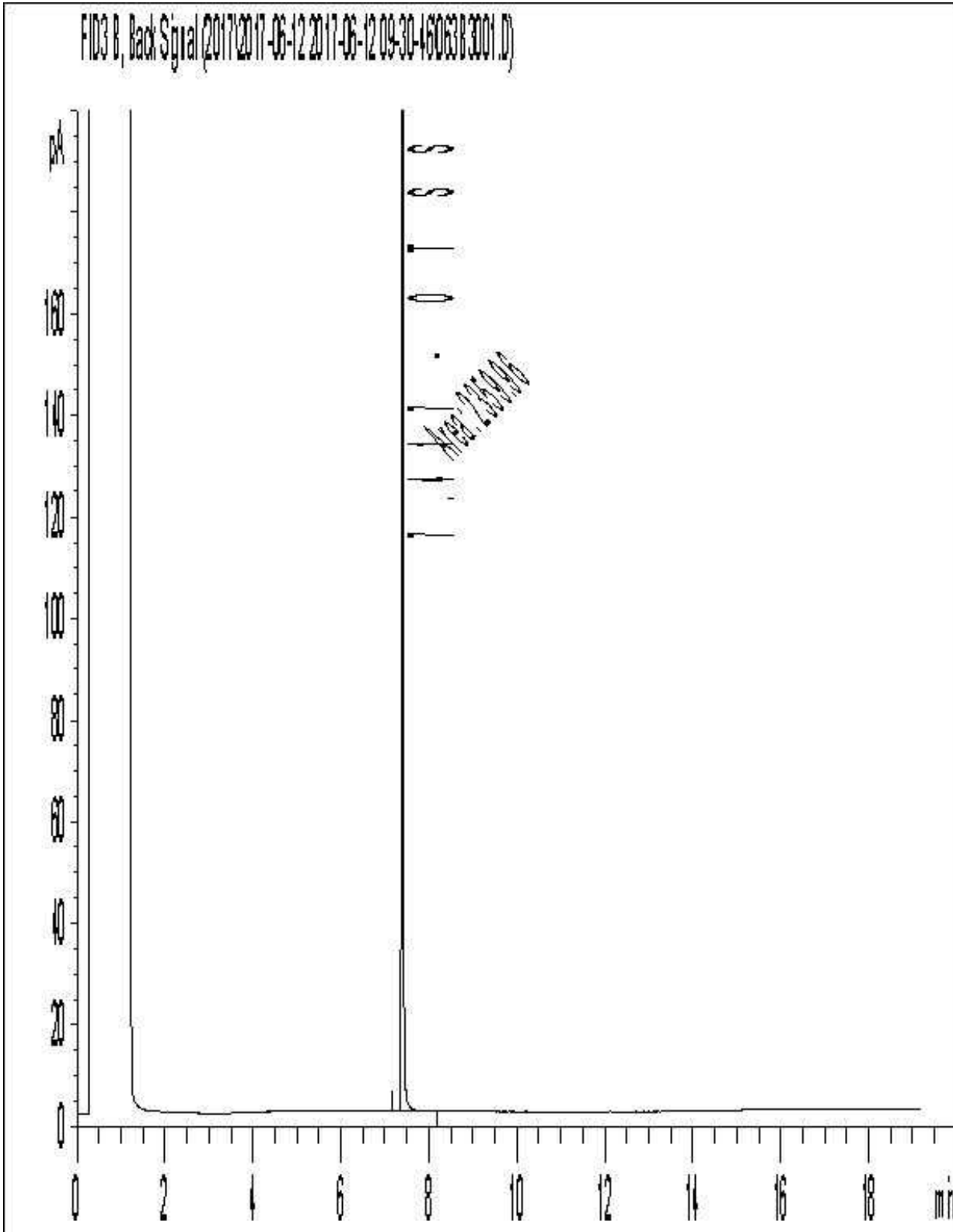
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



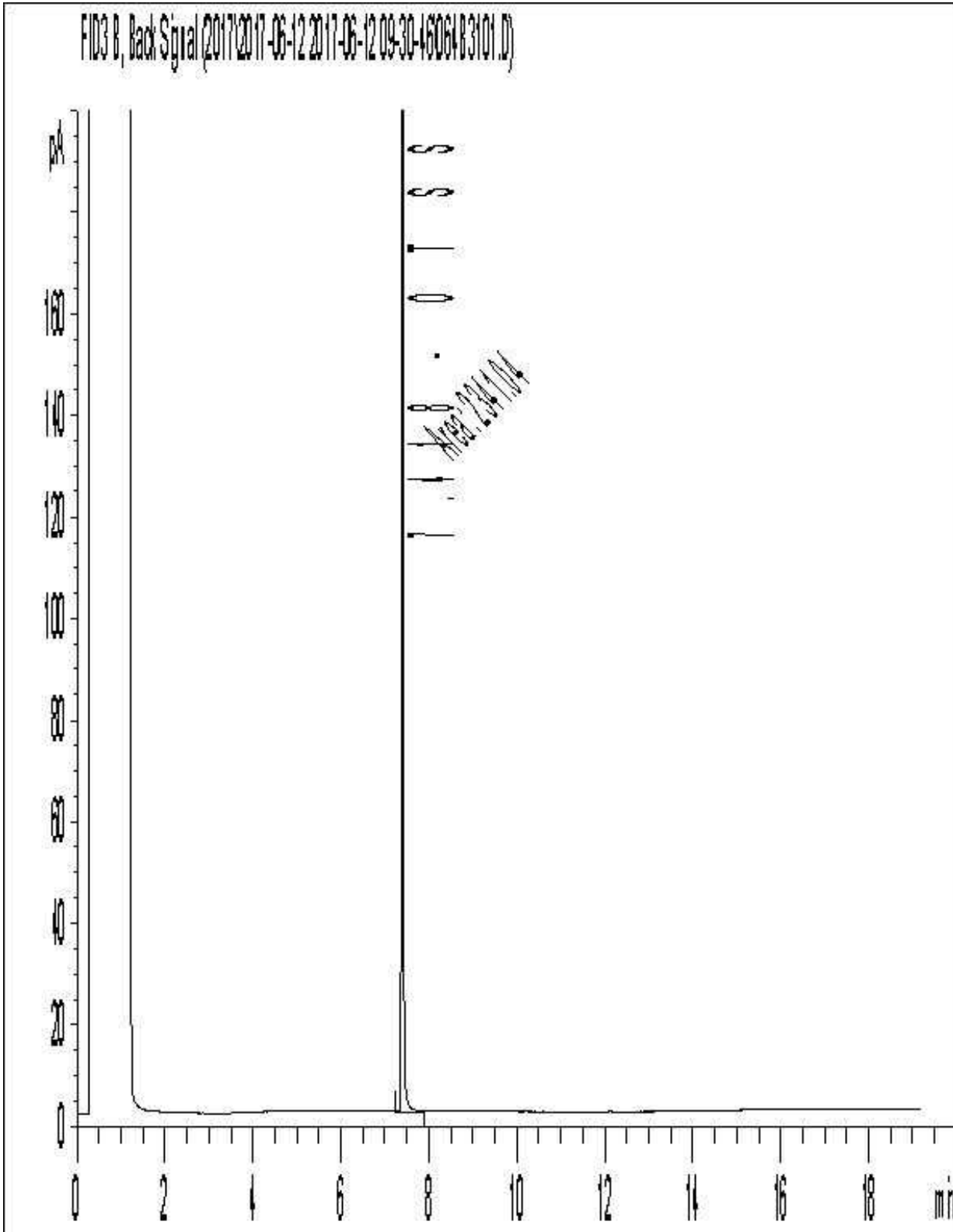
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



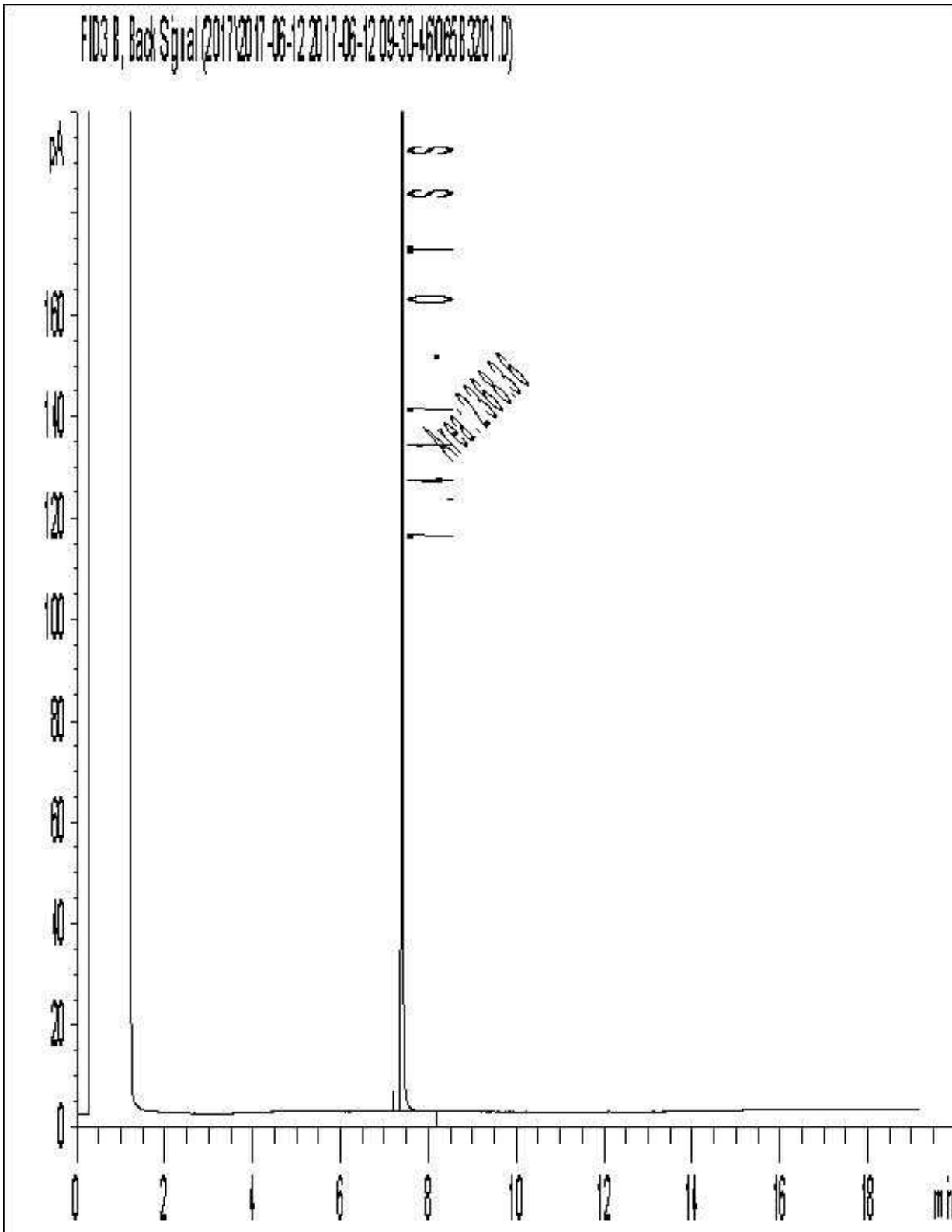
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



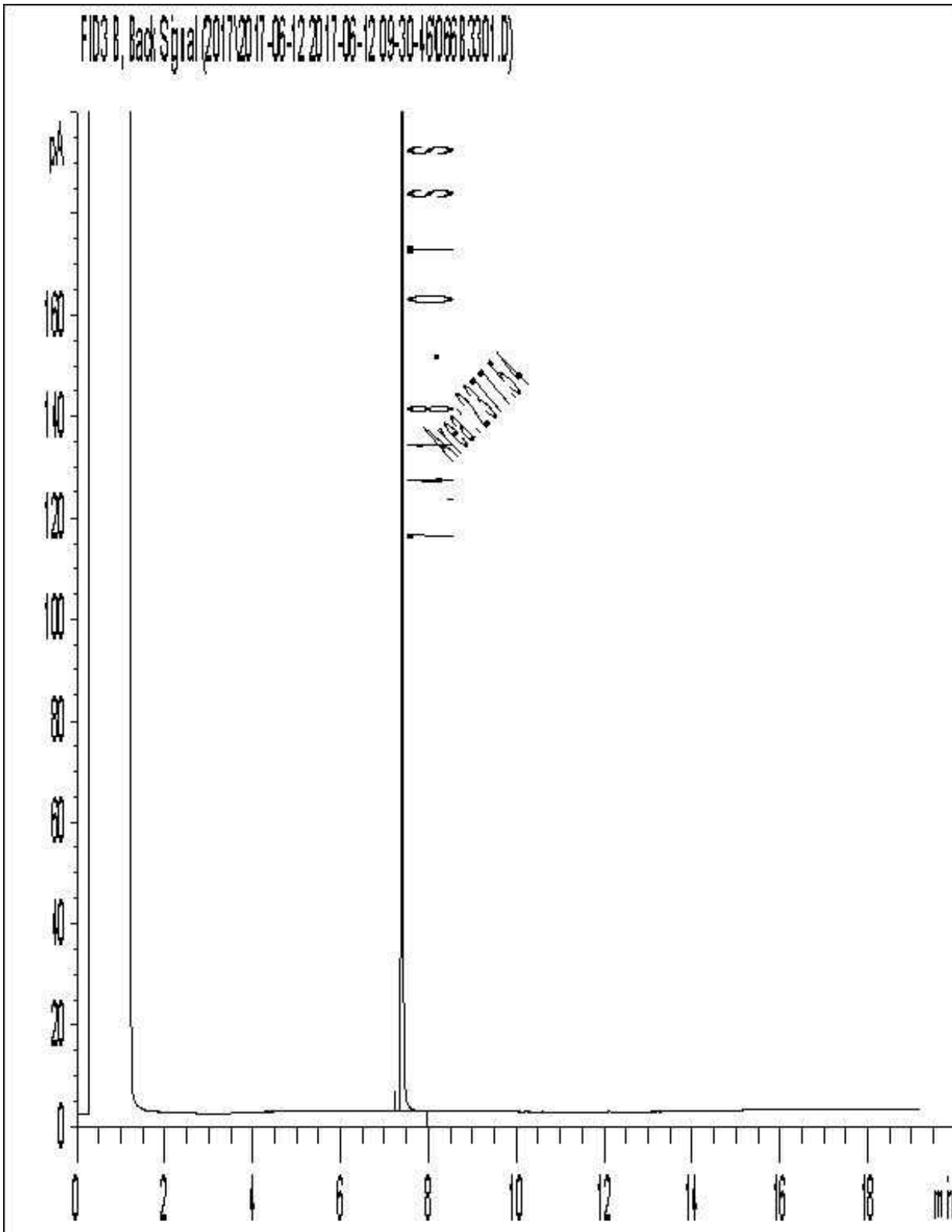
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



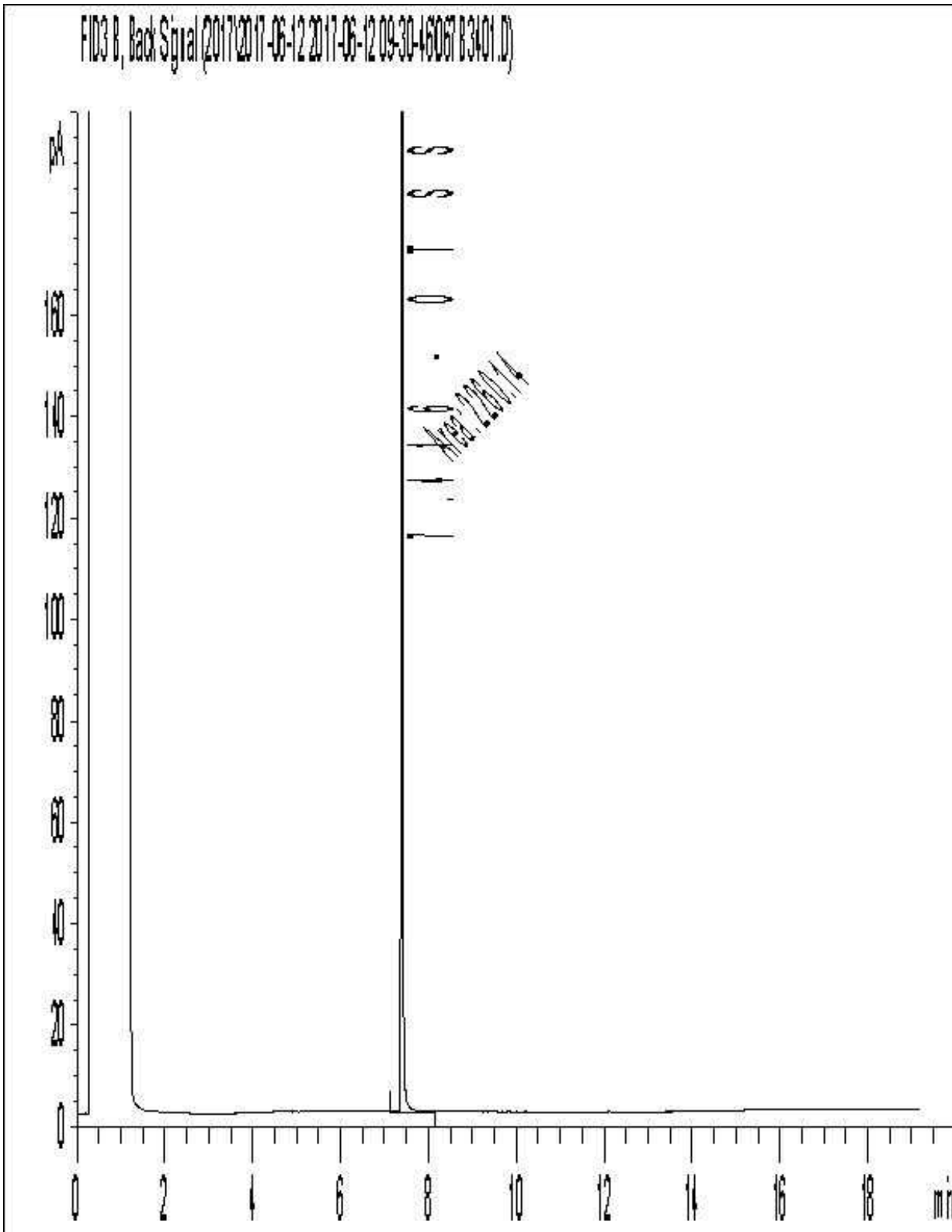
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



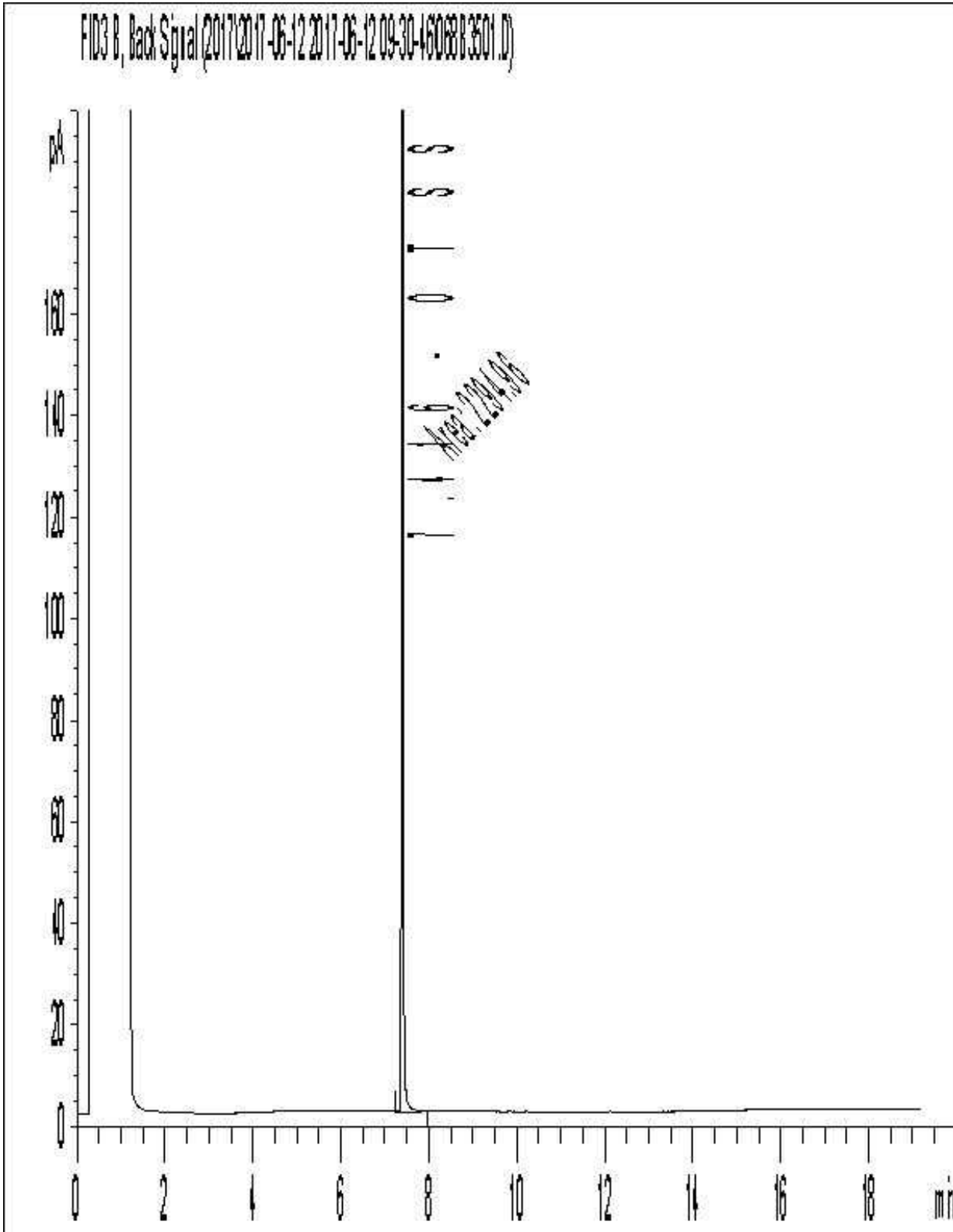
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



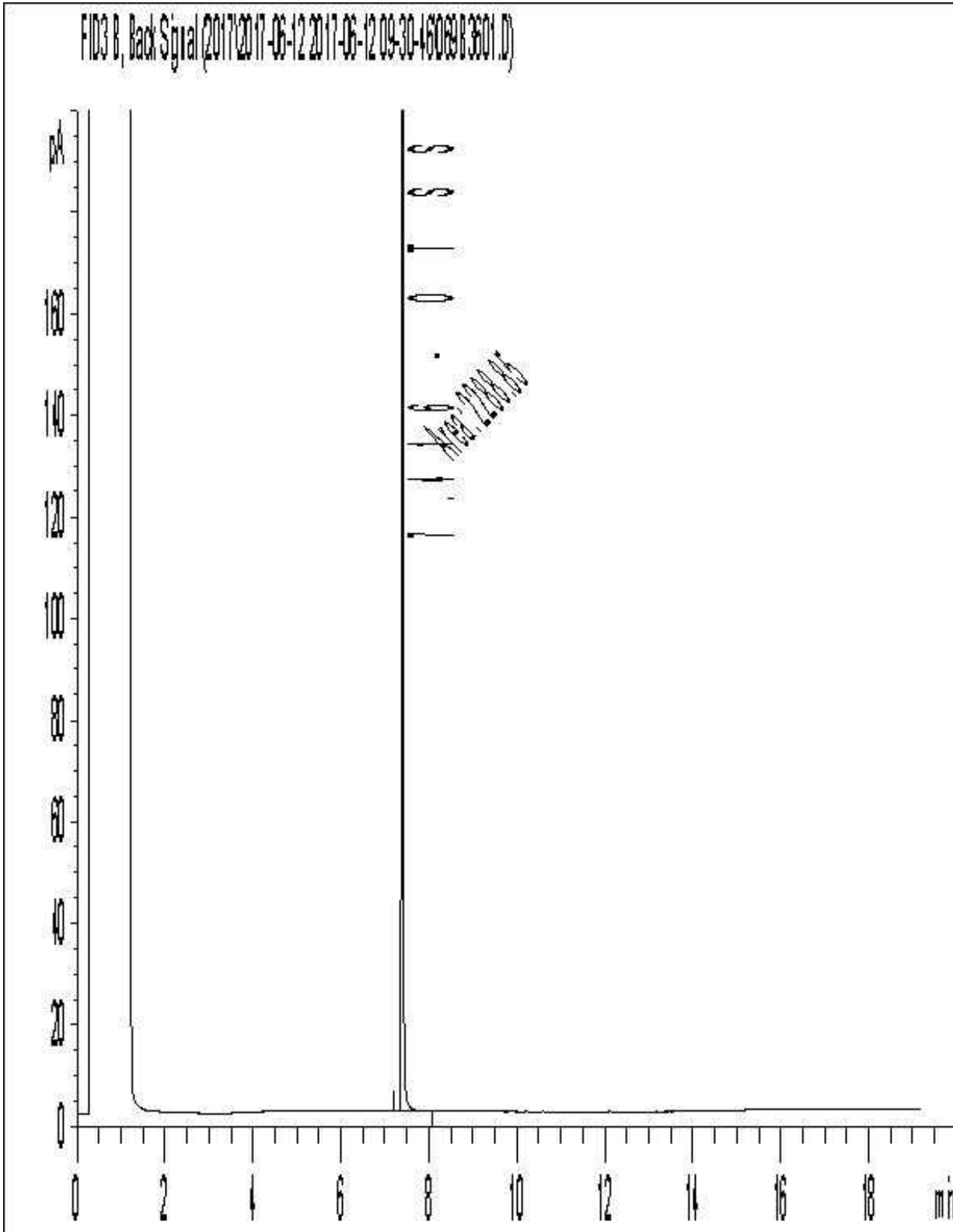
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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



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Petroleum Hydrocarbons F2-F4 in Water Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.



Soil

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/27

Report #: R4560104

Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B4733

Received: 2017/06/02, 18:00

Sample Matrix: Soil
Samples Received: 9

Analyses	Quantity	Date		Laboratory Method	Reference
		Extracted	Analyzed		
Methylnaphthalene Sum	9	N/A	2017/06/06	CAM SOP-00301	EPA 8270D m
Petroleum Hydro. CCME F1 & BTEX in Soil (2)	9	N/A	2017/06/07	OTT SOP-00002	CCME CWS
Petroleum Hydrocarbons F2-F4 in Soil (3)	7	2017/06/06	2017/06/06	OTT SOP-00001	CCME CWS
Petroleum Hydrocarbons F2-F4 in Soil (3)	2	2017/06/06	2017/06/07	OTT SOP-00001	CCME CWS
Moisture	9	N/A	2017/06/07	CAM SOP-00445	McKeague 2nd ed 1978
PAH Compounds in Soil by GC/MS (SIM)	9	2017/06/06	2017/06/08	OTT SOP-00011	EPA 8270D m
Polychlorinated Biphenyl in Soil (1)	1	2017/06/07	2017/06/07	CAM SOP-00309	EPA 8082A m
Polychlorinated Biphenyl in Soil (1)	8	2017/06/07	2017/06/08	CAM SOP-00309	EPA 8082A m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1666131
Your C.O.C. #: 612931-01-01

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/27

Report #: R4560104

Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B7B4733

Received: 2017/06/02, 18:00

- (1) This test was performed by Maxxam Analytics Mississauga
- (2) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.
- (3) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following "Alberta Environment's Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003". Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Alison Cameron, Project Manager

Email: ACameron@maxxam.ca

Phone# (613) 274-0573

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

O.REG 153 PAHS (SOIL)

Maxxam ID		EMP369	EMP370	EMP371	EMP372	EMP372	EMP373		
Sampling Date		2017/05/30	2017/05/30	2017/05/30	2017/05/30	2017/05/30	2017/05/31		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 407-B	SA 406-B	SA 411-B	SA 405-B	SA 405-B Lab-Dup	SA 379-B	RDL	QC Batch

Calculated Parameters

Methylnaphthalene, 2-(1-)	ug/g	<0.014	<0.014	0.041	<0.014		<0.014	0.014	5013637
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Polyaromatic Hydrocarbons

Acenaphthene	ug/g	<0.0050	<0.0050	0.064	<0.0050	<0.0050	0.038	0.0050	5014763
Acenaphthylene	ug/g	<0.0050	<0.0050	0.050	<0.0050	<0.0050	<0.0050	0.0050	5014763
Anthracene	ug/g	<0.0050	<0.0050	0.26	<0.0050	<0.0050	0.052	0.0050	5014763
Benzo(a)anthracene	ug/g	<0.0050	<0.0050	0.85	0.0096	0.015	0.28	0.0050	5014763
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	0.67	0.0080	0.014	0.25	0.0050	5014763
Benzo(b/j)fluoranthene	ug/g	<0.0050	<0.0050	0.96	0.012	0.018	0.38	0.0050	5014763
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	0.42	0.0080	0.012	0.18	0.0050	5014763
Benzo(k)fluoranthene	ug/g	<0.0050	<0.0050	0.37	<0.0050	0.0079	0.14	0.0050	5014763
Chrysene	ug/g	<0.0050	<0.0050	0.70	0.0080	0.013	0.25	0.0050	5014763
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	0.12	<0.0050	<0.0050	0.053	0.0050	5014763
Fluoranthene	ug/g	<0.0050	<0.0050	2.1	0.017	0.029 (1)	0.65	0.0050	5014763
Fluorene	ug/g	<0.0050	<0.0050	0.15	<0.0050	<0.0050	0.034	0.0050	5014763
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	0.49	0.0085	0.0089	0.21	0.0050	5014763
1-Methylnaphthalene	ug/g	<0.0050	<0.0050	0.020	<0.0050	<0.0050	<0.0050	0.0050	5014763
2-Methylnaphthalene	ug/g	<0.0050	<0.0050	0.021	<0.0050	<0.0050	<0.0050	0.0050	5014763
Naphthalene	ug/g	<0.0050	<0.0050	0.068	<0.0050	<0.0050	<0.0050	0.0050	5014763
Phenanthrene	ug/g	<0.0050	<0.0050	1.3	0.0075	0.013	0.34	0.0050	5014763
Pyrene	ug/g	<0.0050	<0.0050	1.5	0.013	0.021	0.46	0.0050	5014763

Surrogate Recovery (%)

D10-Anthracene	%	84	86	83	82	81	82		5014763
D14-Terphenyl (FS)	%	85	84	91	87	86	85		5014763
D8-Acenaphthylene	%	73	79	71	71	72	73		5014763

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

O.REG 153 PAHS (SOIL)

Maxxam ID		EMP374	EMP375	EMP376	EMP377		
Sampling Date		2017/05/31	2017/05/31	2017/06/01	2017/06/01		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 382-B	DEBRI BY RIVER	SA 417-B	DUP 417-B	RDL	QC Batch
Calculated Parameters							
Methylnaphthalene, 2-(1-)	ug/g	0.047	<0.014	<0.014	<0.014	0.014	5013637
Polyaromatic Hydrocarbons							
Acenaphthene	ug/g	0.0059	0.011	<0.0050	<0.0050	0.0050	5014763
Acenaphthylene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5014763
Anthracene	ug/g	<0.0050	0.043	0.0069	0.0079	0.0050	5014763
Benzo(a)anthracene	ug/g	<0.0050	0.33	0.043	0.045	0.0050	5014763
Benzo(a)pyrene	ug/g	<0.0050	0.23	0.041	0.040	0.0050	5014763
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.49	0.059	0.059	0.0050	5014763
Benzo(g,h,i)perylene	ug/g	0.0063	0.13	0.032	0.031	0.0050	5014763
Benzo(k)fluoranthene	ug/g	<0.0050	0.17	0.022	0.022	0.0050	5014763
Chrysene	ug/g	<0.0050	0.27	0.037	0.040	0.0050	5014763
Dibenz(a,h)anthracene	ug/g	<0.0050	0.039	0.0084	0.0084	0.0050	5014763
Fluoranthene	ug/g	<0.0050	0.58	0.088	0.097	0.0050	5014763
Fluorene	ug/g	<0.0050	0.011	<0.0050	<0.0050	0.0050	5014763
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.16	0.032	0.034	0.0050	5014763
1-Methylnaphthalene	ug/g	0.021	<0.0050	<0.0050	<0.0050	0.0050	5014763
2-Methylnaphthalene	ug/g	0.026	<0.0050	<0.0050	<0.0050	0.0050	5014763
Naphthalene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5014763
Phenanthrene	ug/g	0.0077	0.091	0.039	0.044	0.0050	5014763
Pyrene	ug/g	<0.0050	0.46	0.067	0.072	0.0050	5014763
Surrogate Recovery (%)							
D10-Anthracene	%	85	80	83	80		5014763
D14-Terphenyl (FS)	%	88	85	86	85		5014763
D8-Acenaphthylene	%	67	67	76	73		5014763
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

O.REG 153 PCBS (SOIL)

Maxxam ID		EMP369	EMP370	EMP371	EMP372	EMP373	EMP373		
Sampling Date		2017/05/30	2017/05/30	2017/05/30	2017/05/30	2017/05/31	2017/05/31		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 407-B	SA 406-B	SA 411-B	SA 405-B	SA 379-B	SA 379-B Lab-Dup	RDL	QC Batch
PCBs									
Aroclor 1242	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Aroclor 1248	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Aroclor 1254	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Aroclor 1260	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Total PCB	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Surrogate Recovery (%)									
Decachlorobiphenyl	%	81	91	82	83	87	87		5017203
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

Maxxam ID		EMP374	EMP375	EMP376	EMP377		
Sampling Date		2017/05/31	2017/05/31	2017/06/01	2017/06/01		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 382-B	DEBRI BY RIVER	SA 417-B	DUP 417-B	RDL	QC Batch
PCBs							
Aroclor 1242	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Aroclor 1248	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	5017203
Aroclor 1254	ug/g	<0.010	0.25	<0.010	<0.010	0.010	5017203
Aroclor 1260	ug/g	<0.010	0.014	<0.010	<0.010	0.010	5017203
Total PCB	ug/g	<0.010	0.27	<0.010	<0.010	0.010	5017203
Surrogate Recovery (%)							
Decachlorobiphenyl	%	86	95	85	82		5017203
RDL = Reportable Detection Limit QC Batch = Quality Control Batch							

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		EMP369	EMP369	EMP370	EMP370	EMP371	EMP372		
Sampling Date		2017/05/30	2017/05/30	2017/05/30	2017/05/30	2017/05/30	2017/05/30		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 407-B	SA 407-B Lab-Dup	SA 406-B	SA 406-B Lab-Dup	SA 411-B	SA 405-B	RDL	QC Batch

Inorganics

Moisture	%	5.3		4.6	5.2	3.8	13	0.2	5014765
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BTEX & F1 Hydrocarbons

Benzene	ug/g	<0.02	<0.02	<0.02		<0.02	<0.02	0.02	5016657
Toluene	ug/g	<0.02	<0.02	<0.02		<0.02	<0.02	0.02	5016657
Ethylbenzene	ug/g	<0.02	<0.02	<0.02		<0.02	<0.02	0.02	5016657
o-Xylene	ug/g	<0.02	<0.02	<0.02		<0.02	<0.02	0.02	5016657
p+m-Xylene	ug/g	<0.04	<0.04	<0.04		<0.04	<0.04	0.04	5016657
Total Xylenes	ug/g	<0.04	<0.04	<0.04		<0.04	<0.04	0.04	5016657
F1 (C6-C10)	ug/g	<10	<10	<10		<10	<10	10	5016657
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10		<10	<10	10	5016657

F2-F4 Hydrocarbons

F2 (C10-C16 Hydrocarbons)	ug/g	<10	<10	<10		<10	<10	10	5015075
F3 (C16-C34 Hydrocarbons)	ug/g	73	<50	<50		56	<50	50	5015075
F4 (C34-C50 Hydrocarbons)	ug/g	1200	390 (1)	<50		<50	150	50	5015075
Reached Baseline at C50	ug/g	No	No	Yes		Yes	No		5015075

Surrogate Recovery (%)

1,4-Difluorobenzene	%	92	102	94		90	89		5016657
4-Bromofluorobenzene	%	102	113	138		105	132		5016657
D10-Ethylbenzene	%	110	112	115		112	110		5016657
D4-1,2-Dichloroethane	%	123	117	123		118	115		5016657
o-Terphenyl	%	96	95	92		92	100		5015075

RDL = Reportable Detection Limit
 QC Batch = Quality Control Batch
 Lab-Dup = Laboratory Initiated Duplicate
 (1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		EMP373	EMP374	EMP375	EMP376	EMP377		
Sampling Date		2017/05/31	2017/05/31	2017/05/31	2017/06/01	2017/06/01		
COC Number		612931-01-01	612931-01-01	612931-01-01	612931-01-01	612931-01-01		
	UNITS	SA 379-B	SA 382-B	DEBRI BY RIVER	SA 417-B	DUP 417-B	RDL	QC Batch
Inorganics								
Moisture	%	5.2	4.8	19	10	9.0	0.2	5014765
BTEX & F1 Hydrocarbons								
Benzene	ug/g	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5016657
Toluene	ug/g	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5016657
Ethylbenzene	ug/g	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5016657
o-Xylene	ug/g	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	5016657
p+m-Xylene	ug/g	<0.04	<0.04	<0.04	<0.04	<0.04	0.04	5016657
Total Xylenes	ug/g	<0.04	<0.04	<0.04	<0.04	<0.04	0.04	5016657
F1 (C6-C10)	ug/g	<10	<10	<10	<10	<10	10	5016657
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	<10	<10	10	5016657
F2-F4 Hydrocarbons								
F2 (C10-C16 Hydrocarbons)	ug/g	<10	17	<10	<10	<10	10	5015075
F3 (C16-C34 Hydrocarbons)	ug/g	<50	58	<50	<50	<50	50	5015075
F4 (C34-C50 Hydrocarbons)	ug/g	<50	860	<50	<50	<50	50	5015075
Reached Baseline at C50	ug/g	Yes	No	Yes	Yes	Yes		5015075
Surrogate Recovery (%)								
1,4-Difluorobenzene	%	89	93	92	86	88		5016657
4-Bromofluorobenzene	%	95	100	136	129	113		5016657
D10-Ethylbenzene	%	116	114	119	122	121		5016657
D4-1,2-Dichloroethane	%	117	125	125	115	122		5016657
o-Terphenyl	%	98	100	101	99	101		5015075
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

TEST SUMMARY

Maxxam ID: EMP369
Sample ID: SA 407-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/07	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

Maxxam ID: EMP369 Dup
Sample ID: SA 407-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/07	Liliana Gaburici

Maxxam ID: EMP370
Sample ID: SA 406-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

Maxxam ID: EMP370 Dup
Sample ID: SA 406-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi

Maxxam ID: EMP371
Sample ID: SA 411-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

TEST SUMMARY

Maxxam ID: EMP372
Sample ID: SA 405-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

Maxxam ID: EMP372 Dup
Sample ID: SA 405-B
Matrix: Soil

Collected: 2017/05/30
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi

Maxxam ID: EMP373
Sample ID: SA 379-B
Matrix: Soil

Collected: 2017/05/31
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/07	Li Peng

Maxxam ID: EMP373 Dup
Sample ID: SA 379-B
Matrix: Soil

Collected: 2017/05/31
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/07	Li Peng

Maxxam ID: EMP374
Sample ID: SA 382-B
Matrix: Soil

Collected: 2017/05/31
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/07	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

TEST SUMMARY

Maxxam ID: EMP375
Sample ID: DEBRI BY RIVER
Matrix: Soil

Collected: 2017/05/31
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

Maxxam ID: EMP376
Sample ID: SA 417-B
Matrix: Soil

Collected: 2017/06/01
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

Maxxam ID: EMP377
Sample ID: DUP 417-B
Matrix: Soil

Collected: 2017/06/01
Shipped:
Received: 2017/06/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5013637	N/A	2017/06/06	Paul Rubinato
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	5016657	N/A	2017/06/07	Lyndsey Hart
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5015075	2017/06/06	2017/06/06	Liliana Gaburici
Moisture	BAL	5014765	N/A	2017/06/07	Arezoo Habibagahi
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5014763	2017/06/06	2017/06/08	Arezoo Habibagahi
Polychlorinated Biphenyl in Soil	GC/ECD	5017203	2017/06/07	2017/06/08	Li Peng

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	8.0°C
Package 2	8.0°C

Revised Report (2017/06/12): Equis facility code included.

Revised Report (2013/06/27): Client sample IDs changed as per client request.

Sample EMP369 [SA 407-B] : F24 Analysis: Duplicate results exceeded RPD acceptance criteria for flagged analytes. This is likely due to sample heterogeneity.

Sample EMP372 [SA 405-B] : PAH Analysis: Duplicate results exceeded RPD acceptance criteria for flagged analytes. This is likely due to sample heterogeneity.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5014763	D10-Anthracene	2017/06/08	84	50 - 130	87	50 - 130	90	%		
5014763	D14-Terphenyl (FS)	2017/06/08	89	50 - 130	91	50 - 130	86	%		
5014763	D8-Acenaphthylene	2017/06/08	74	50 - 130	79	50 - 130	80	%		
5015075	o-Terphenyl	2017/06/06	93	30 - 130	102	30 - 130	101	%		
5016657	1,4-Difluorobenzene	2017/06/07	85	60 - 140	93	60 - 140	88	%		
5016657	4-Bromofluorobenzene	2017/06/07	107	60 - 140	110	60 - 140	106	%		
5016657	D10-Ethylbenzene	2017/06/07	116	30 - 130	122	30 - 130	119	%		
5016657	D4-1,2-Dichloroethane	2017/06/07	111	60 - 140	120	60 - 140	118	%		
5017203	Decachlorobiphenyl	2017/06/07	91	60 - 130	85	60 - 130	92	%		
5014763	1-Methylnaphthalene	2017/06/08	81	50 - 130	82	50 - 130	<0.0050	ug/g	NC	40
5014763	2-Methylnaphthalene	2017/06/08	82	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40
5014763	Acenaphthene	2017/06/08	80	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40
5014763	Acenaphthylene	2017/06/08	70	50 - 130	71	50 - 130	<0.0050	ug/g	NC	40
5014763	Anthracene	2017/06/08	73	50 - 130	73	50 - 130	<0.0050	ug/g	NC	40
5014763	Benzo(a)anthracene	2017/06/08	85	50 - 130	85	50 - 130	<0.0050	ug/g	NC	40
5014763	Benzo(a)pyrene	2017/06/08	74	50 - 130	76	50 - 130	<0.0050	ug/g	NC	40
5014763	Benzo(b,j)fluoranthene	2017/06/08	80	50 - 130	81	50 - 130	<0.0050	ug/g	NC	40
5014763	Benzo(g,h,i)perylene	2017/06/08	75	50 - 130	79	50 - 130	<0.0050	ug/g	36	40
5014763	Benzo(k)fluoranthene	2017/06/08	81	50 - 130	81	50 - 130	<0.0050	ug/g	NC	40
5014763	Chrysene	2017/06/08	74	50 - 130	75	50 - 130	<0.0050	ug/g	NC	40
5014763	Dibenz(a,h)anthracene	2017/06/08	53	50 - 130	56	50 - 130	<0.0050	ug/g	NC	40
5014763	Fluoranthene	2017/06/08	82	50 - 130	79	50 - 130	<0.0050	ug/g	51 (1)	40
5014763	Fluorene	2017/06/08	86	50 - 130	90	50 - 130	<0.0050	ug/g	NC	40
5014763	Indeno(1,2,3-cd)pyrene	2017/06/08	76	50 - 130	82	50 - 130	<0.0050	ug/g	4.6	40
5014763	Naphthalene	2017/06/08	71	50 - 130	73	50 - 130	<0.0050	ug/g	NC	40
5014763	Phenanthrene	2017/06/08	75	50 - 130	74	50 - 130	<0.0050	ug/g	NC	40
5014763	Pyrene	2017/06/08	78	50 - 130	76	50 - 130	<0.0050	ug/g	NC	40
5014765	Moisture	2017/06/07							12	50
5015075	F2 (C10-C16 Hydrocarbons)	2017/06/07	108	50 - 130	106	80 - 120	<10	ug/g	NC	50
5015075	F3 (C16-C34 Hydrocarbons)	2017/06/07	108	50 - 130	106	80 - 120	<50	ug/g	38	50
5015075	F4 (C34-C50 Hydrocarbons)	2017/06/07	108	50 - 130	106	80 - 120	<50	ug/g	103 (1)	50

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5016657	Benzene	2017/06/07	88	60 - 140	89	60 - 140	<0.02	ug/g	NC	50
5016657	Ethylbenzene	2017/06/07	91	60 - 140	91	60 - 140	<0.02	ug/g	NC	50
5016657	F1 (C6-C10) - BTEX	2017/06/07					<10	ug/g	NC	50
5016657	F1 (C6-C10)	2017/06/07	90	60 - 140	106	80 - 120	<10	ug/g	NC	50
5016657	o-Xylene	2017/06/07	94	60 - 140	98	60 - 140	<0.02	ug/g	NC	50
5016657	p+m-Xylene	2017/06/07	99	60 - 140	100	60 - 140	<0.04	ug/g	NC	50
5016657	Toluene	2017/06/07	97	60 - 140	99	60 - 140	<0.02	ug/g	NC	50
5016657	Total Xylenes	2017/06/07					<0.04	ug/g	NC	50
5017203	Aroclor 1242	2017/06/07					<0.010	ug/g	NC	50
5017203	Aroclor 1248	2017/06/07					<0.010	ug/g	NC	50
5017203	Aroclor 1254	2017/06/07					<0.010	ug/g	NC	50
5017203	Aroclor 1260	2017/06/07	82	60 - 130	86	60 - 130	<0.010	ug/g	NC	50
5017203	Total PCB	2017/06/07	82	60 - 130	86	60 - 130	<0.010	ug/g	NC	50

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.



Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

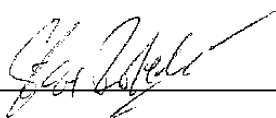
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist



Paul Rubinato, Analyst, Maxxam Analytics



Steve Roberts, Ottawa Lab Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CHAIN OF CUSTODY RECORD

Page 1 of 1

Maxxam Analytics International Corporation o/a Maxxam Analytics
 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L6 Tel: (905) 817-5700 Toll-free: 800-583-6266 Fax: (905) 817-5777 www.maxxam.ca

REPORT TO: Alex Wood
 Attention: Alex Wood
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 Fax: (613) 592-9601 x
 Email: AP_CustomerService@golder.com

Company Name: #14090 Golder Associates Ltd
 Accounts Payable
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 Fax: (613) 592-9601 x
 Email: AP_CustomerService@golder.com

PROJECT INFORMATION:
 Quotation #: B66107
 P.O. #: 1666131
 Project Name:
 Site #:
 Sampled By: alex_wood@golder.com

LABORATORY USE ONLY:
 Maxxam Job #:
 Bottle Order #:
 Project Manager:
 Alison Cameron

ANALYSIS REQUESTED (PLEASE BE SPECIFIC):
 PHC Rg 153
 P4H Rg 153
 O Reg 153 PAHs (Water)
 O Reg 153 Petroleum Hydrocarbons (Water)
 Metals / Hg / Cr VI
 Field Filtered (please circle):

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Res/Park Medium/Fine Sanitary Sewer Bylaw
 Ind/Comm Course Reg 558 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWOO Other

Turnaround Time (TAT) Required:
 Regular (Standard) TAT: (will be applied if Rush TAT is not specified)
 Standard TAT = 5-7 Working days for most tests.
 Please note: Standard TAT for certain tests such as BOD and Dissolved Solids are > 5 days - contact your Project Manager for details.
 Job Specific Rush TAT (if applies to entire submission):
 Date Required: _____ Time Required: _____
 Rush Confirmation Number: _____ (call job for #)

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle)	Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons (Water)	O Reg 153 PAHs (Water)	ANALYSIS REQUESTED (PLEASE BE SPECIFIC)	Quotation #	PROJECT INFORMATION	Maxxam Job #	Bottle Order #
1	SA 407-B	May 30		GW S					PHC Rg 153	B66107	B66107	612931	
2	SA 406-B	May 30		GW S					P4H Rg 153	1666131			
3	SA 411-B	May 30		GW S									
4	SA 405-B	May 30		GW S									
5	SA 374-B	May 31		GW S									
6	SA 382-B	"		GW S									
7	Debris by river	"		GW S									
8	SA 417-A	June 1		GW S									
9				GW									
10				GW									

02-Jun-17 18:00
 Alison Cameron
 B7B4733

RECEIVED BY: (Signature/Print) MARIANA DAVILA
 Date: (YY/MM/DD) 06/16/02
 Time Sensitive: not submitted
 Laboratory Use Only: Temperature (°C) on Receipt: 7.4, 8.1, 8.9
 Custody Seal Present: Yes
 No

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

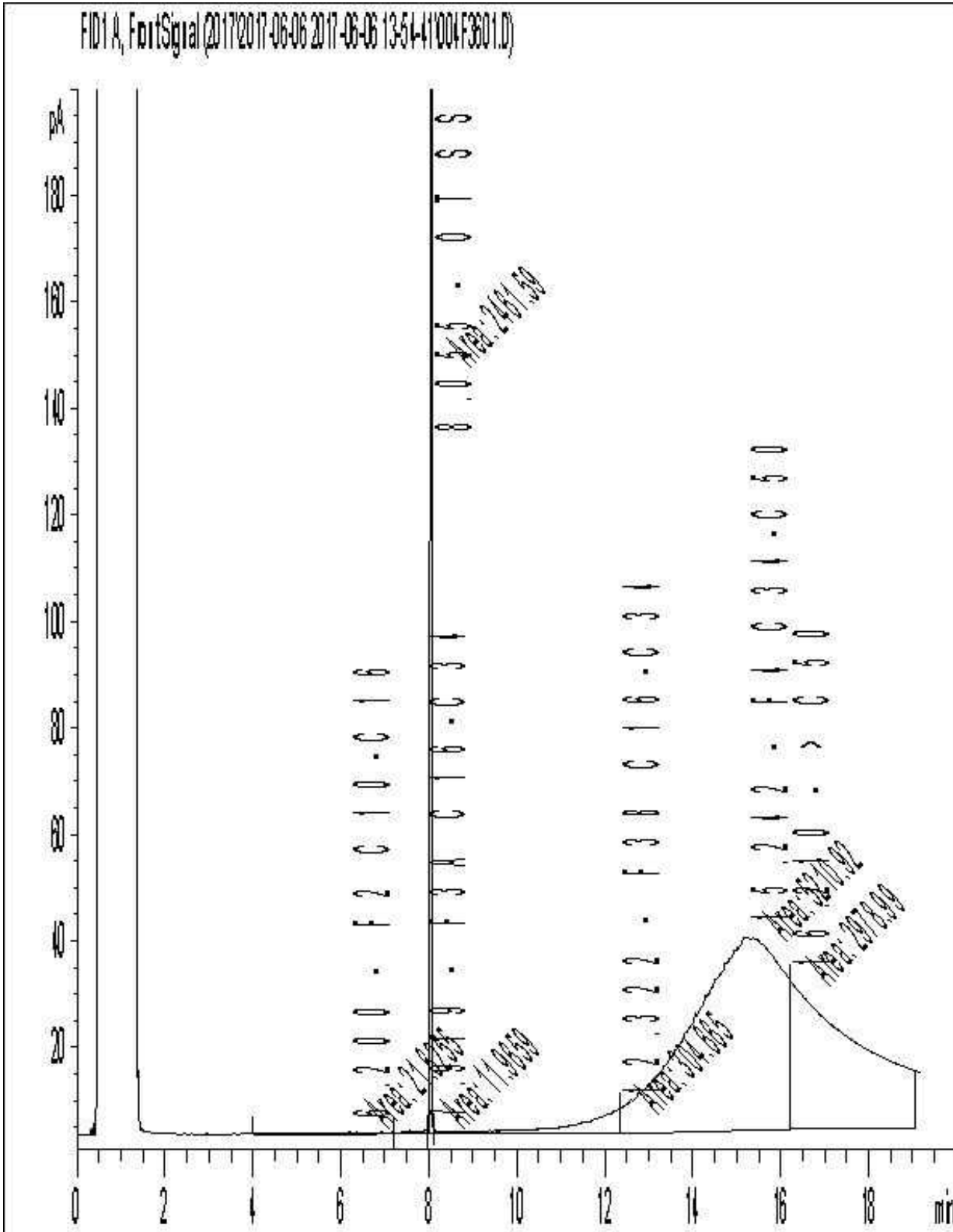
UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENTS IS AN ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD AND INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGING INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

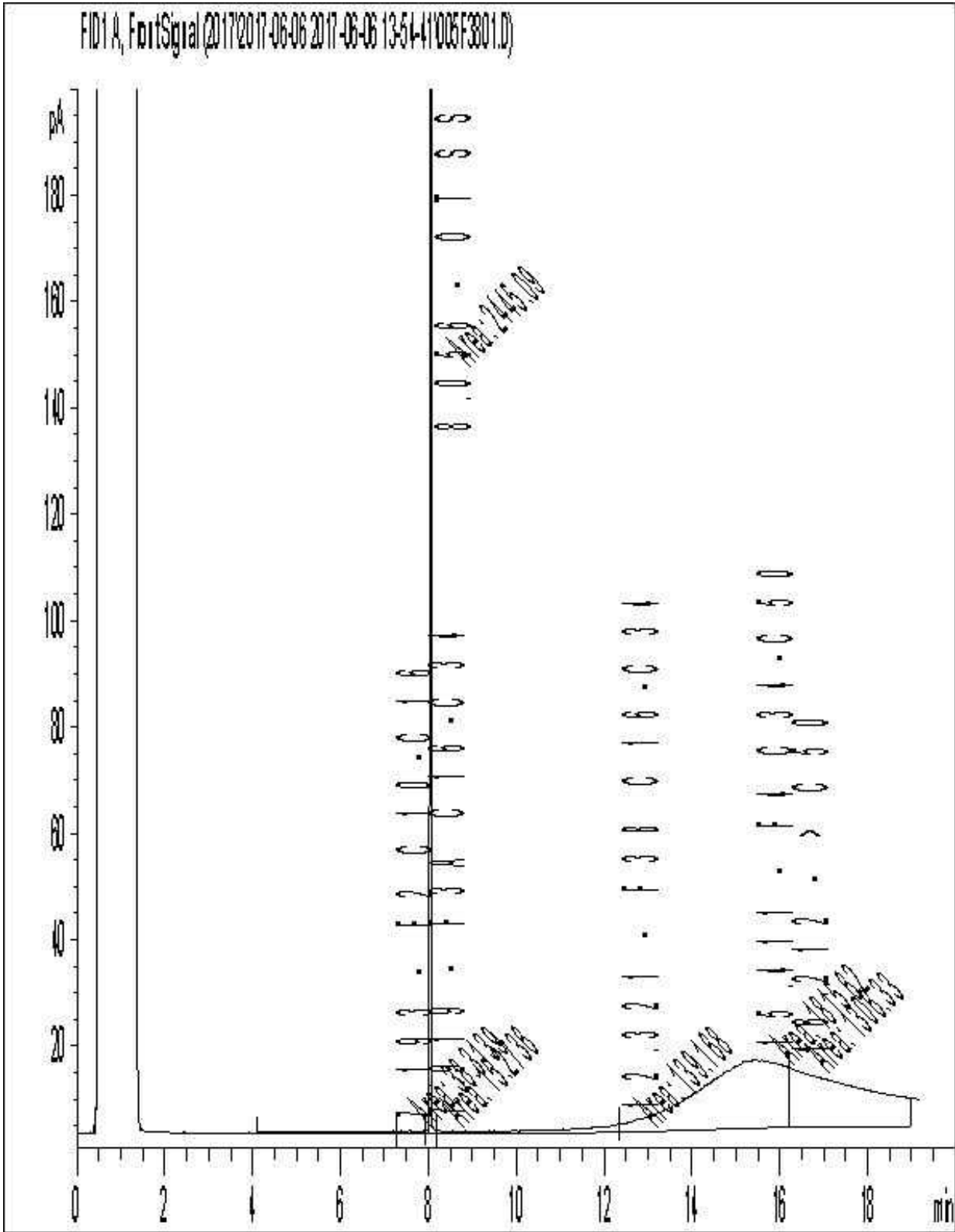
Maxxam Analytics International Corporation o/a Maxxam Analytics

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



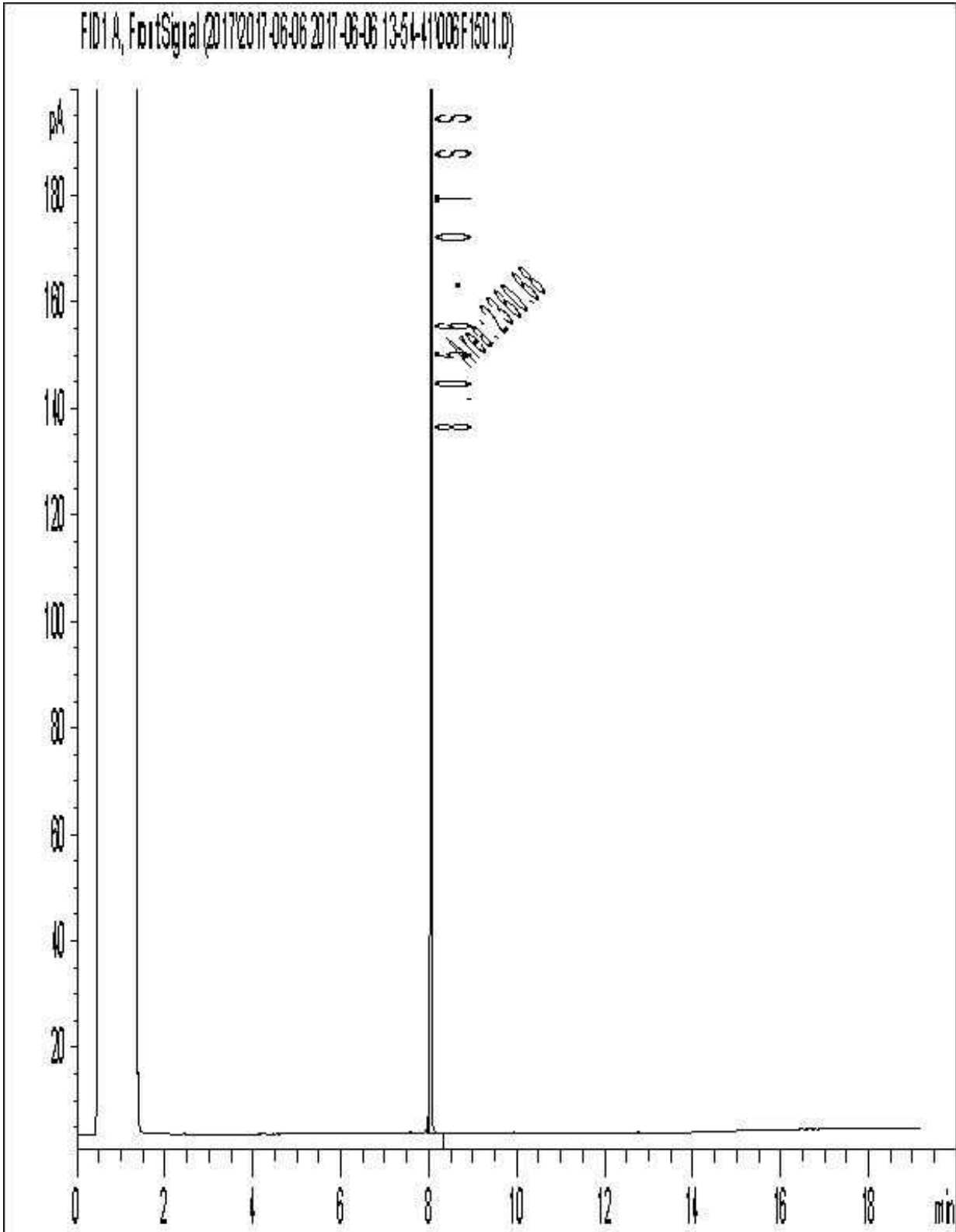
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



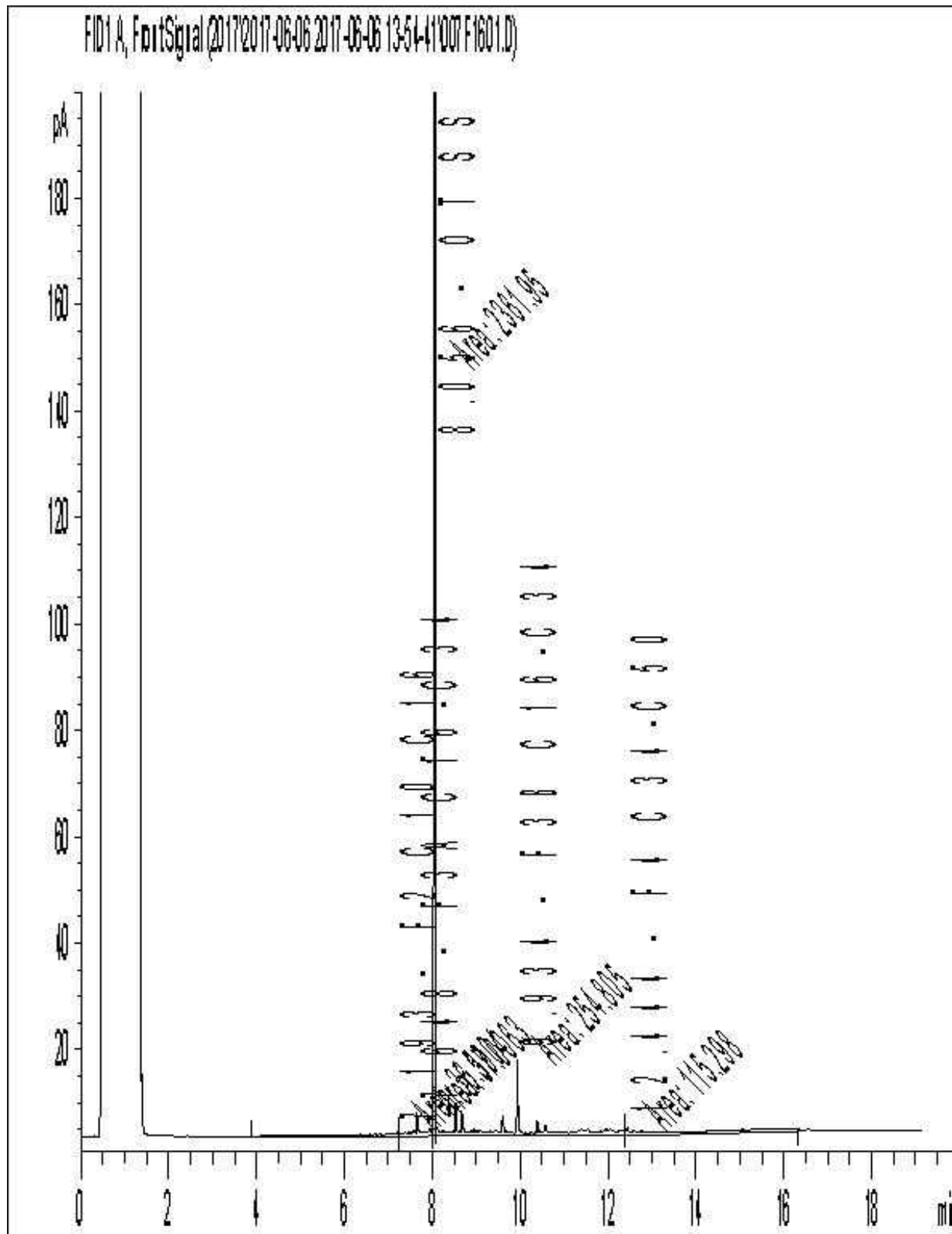
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



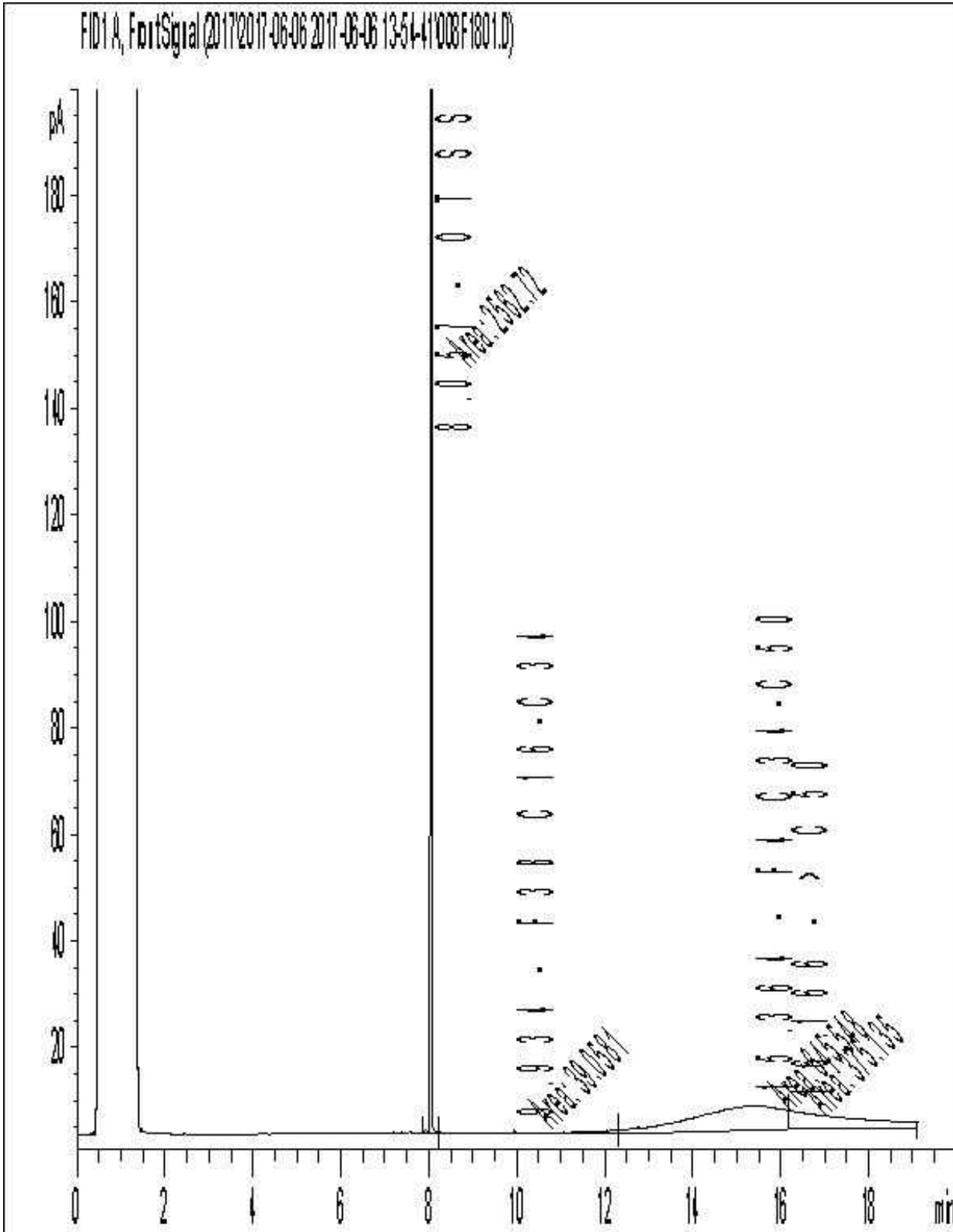
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



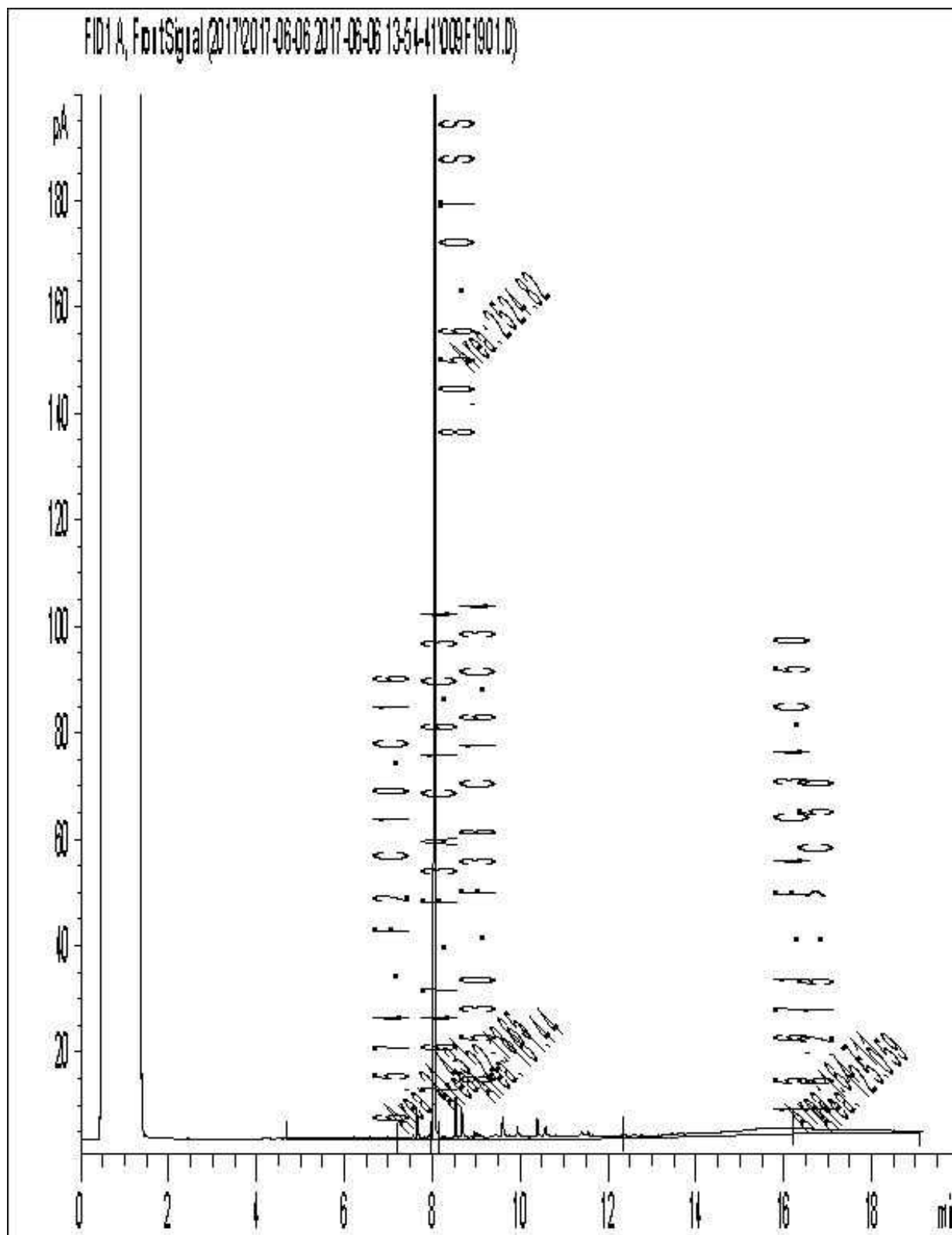
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



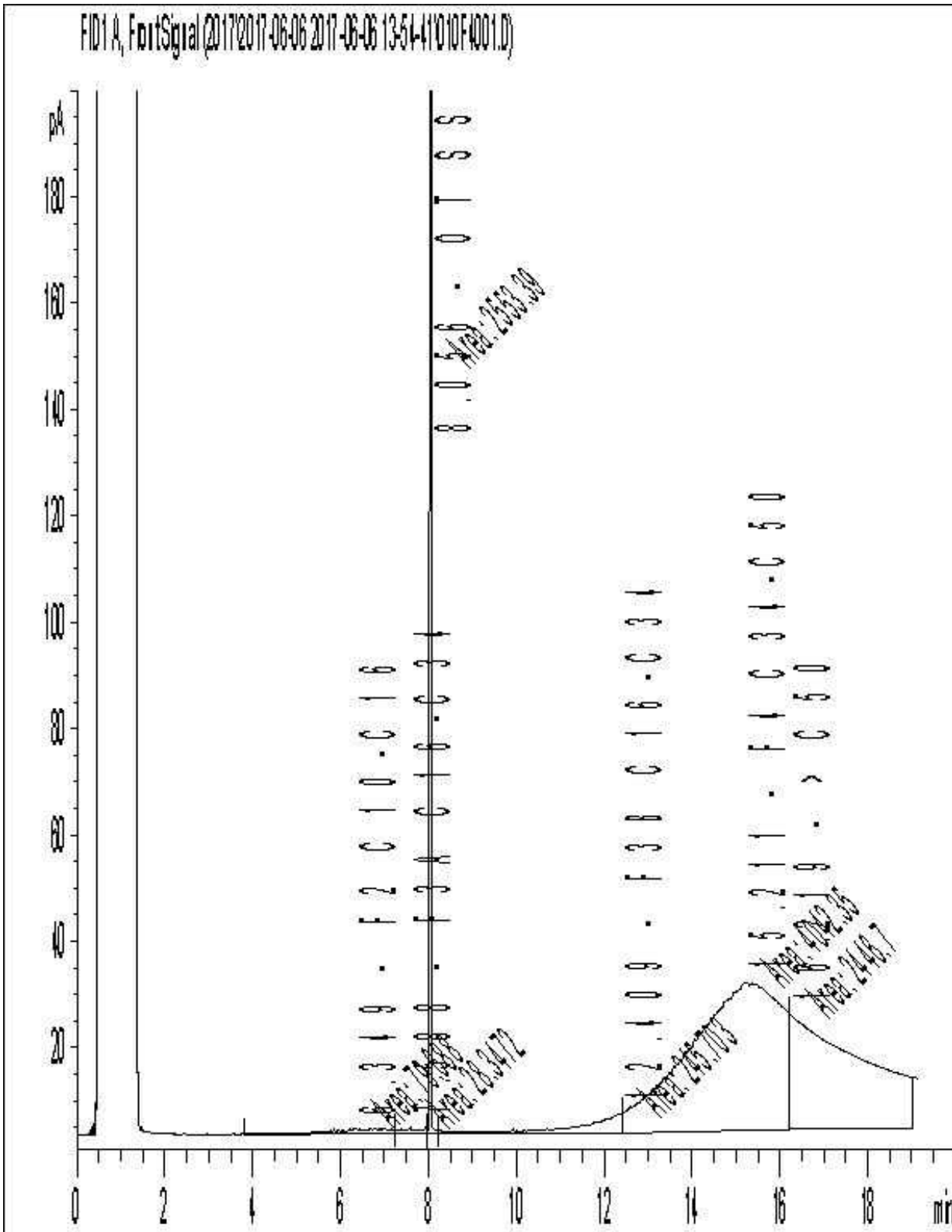
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



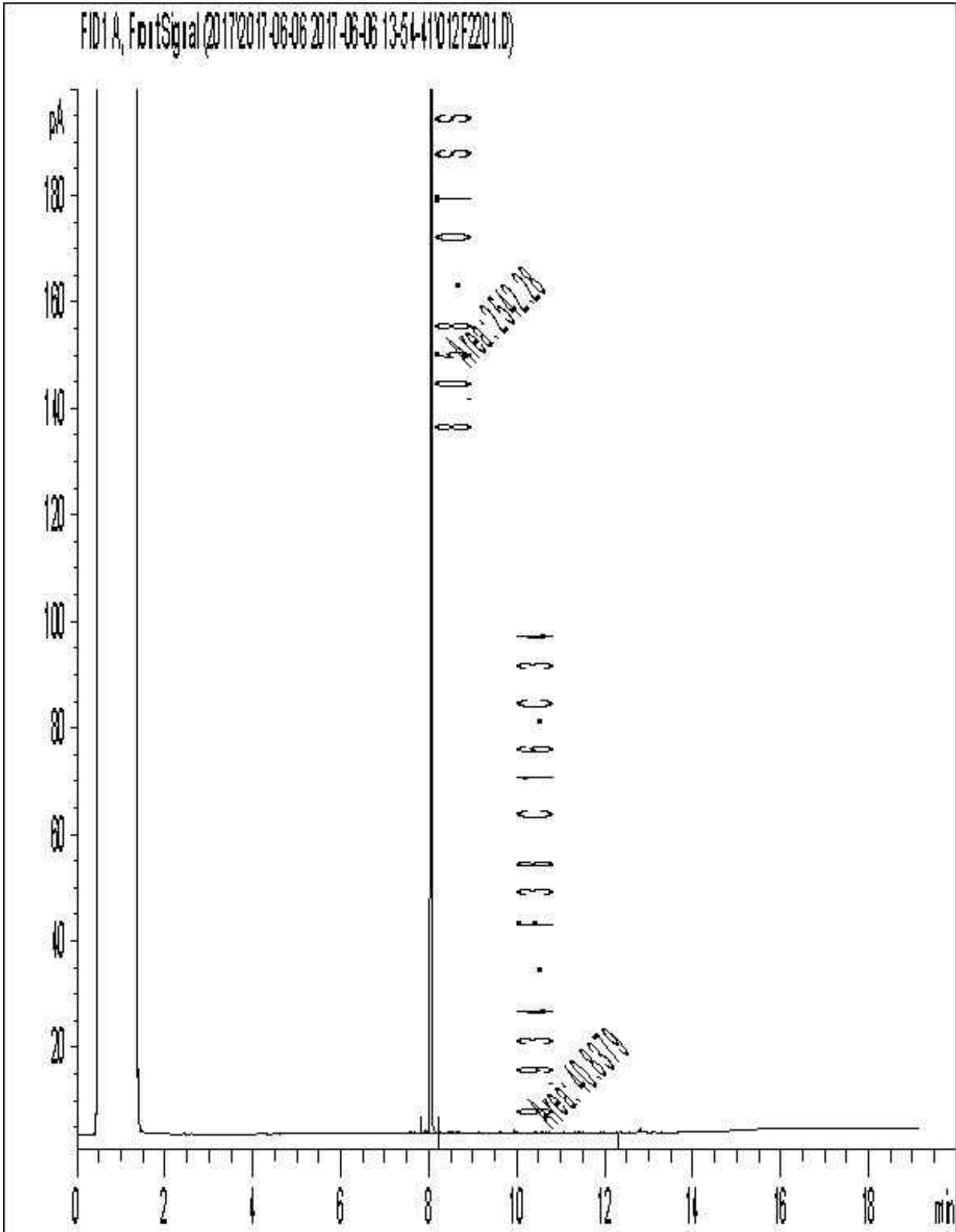
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



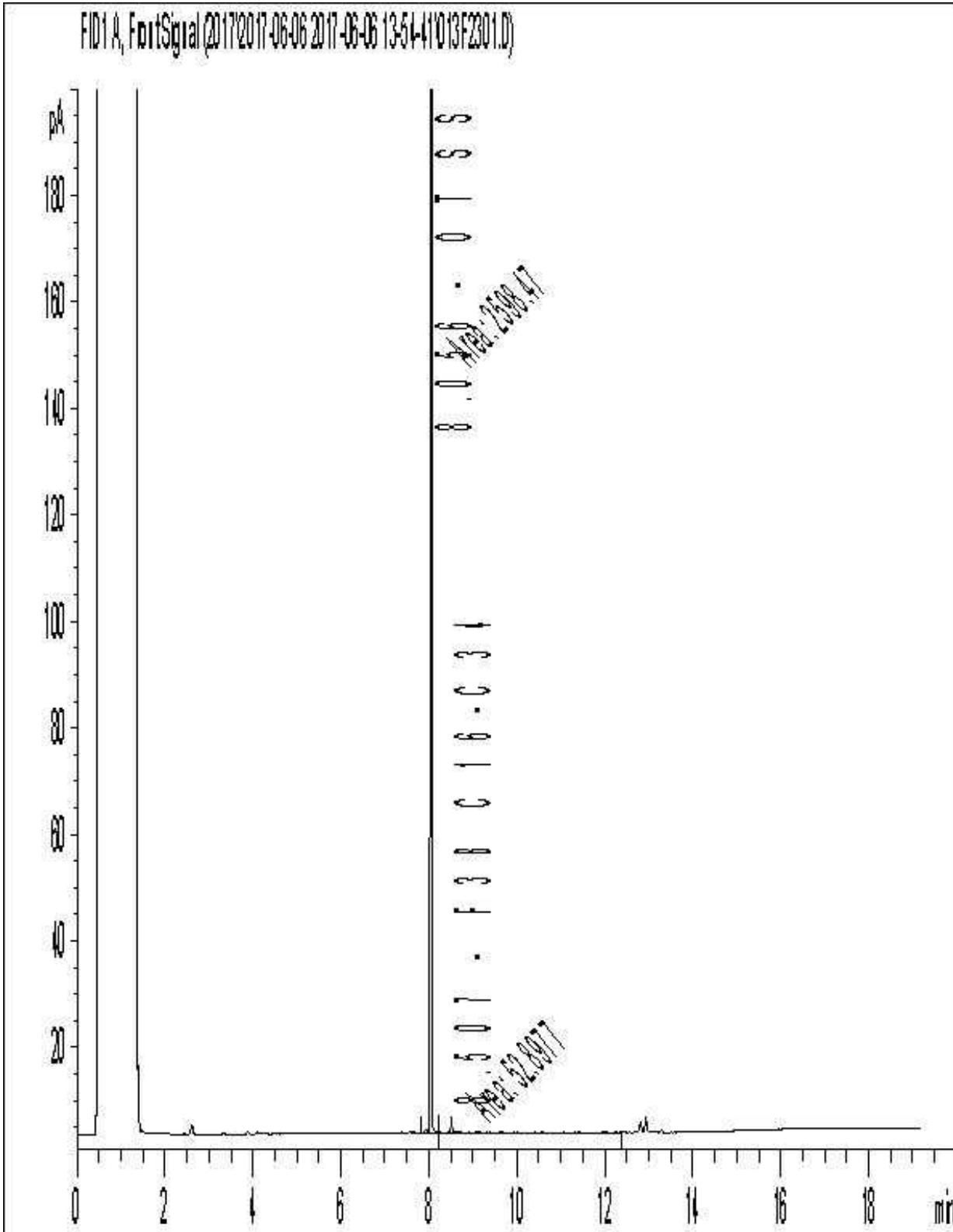
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/20

Report #: R4550878

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7B9452

Received: 2017/06/08, 13:30

Sample Matrix: Soil
Samples Received: 25

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Methylnaphthalene Sum (1)	2	N/A	2017/06/15	CAM SOP-00301	EPA 8270D m
Methylnaphthalene Sum (1)	3	N/A	2017/06/16	CAM SOP-00301	EPA 8270D m
Methylnaphthalene Sum (1)	20	N/A	2017/06/20	CAM SOP-00301	EPA 8270D m
Hexavalent Chromium in Soil by IC (1, 2)	17	2017/06/12	2017/06/14	CAM SOP-00436	EPA 3060/7199 m
Petroleum Hydrocarbons F2-F4 in Soil (1, 3)	25	2017/06/13	2017/06/14	CAM SOP-00316	CCME CWS m
F4G (CCME Hydrocarbons Gravimetric) (1)	1	2017/06/15	2017/06/15	CAM SOP-00316	CCME PHC-CWS m
Strong Acid Leachable Metals by ICPMS (1)	5	2017/06/13	2017/06/14	CAM SOP-00447	EPA 6020B m
Strong Acid Leachable Metals by ICPMS (1)	12	2017/06/13	2017/06/15	CAM SOP-00447	EPA 6020B m
PAH Compounds by GC/MS (SIM) (1, 4)	3	2017/06/14	2017/06/16	CAM SOP - 00318	EPA 8270 m
Polychlorinated Biphenyl in Solids (1, 5)	3	2017/06/13	2017/06/14	CAM SOP-00309	EPA 8082 m
Moisture (1)	25	N/A	2017/06/13	CAM SOP-00445	Carter 2nd ed 51.2 m
PAH Compounds in Soil by GC/MS (SIM) (1)	2	2017/06/13	2017/06/14	CAM SOP-00318	EPA 8270D m
PAH Compounds in Soil by GC/MS (SIM) (1)	18	2017/06/13	2017/06/16	CAM SOP-00318	EPA 8270D m
PAH Compounds in Soil by GC/MS (SIM) (1)	2	2017/06/13	2017/06/19	CAM SOP-00318	EPA 8270D m
Polychlorinated Biphenyl in Soil (1)	14	2017/06/13	2017/06/13	CAM SOP-00309	EPA 8082A m
Polychlorinated Biphenyl in Soil (1)	8	2017/06/13	2017/06/14	CAM SOP-00309	EPA 8082A m
Volatile Organic Compounds and F1 PHCs (1)	25	N/A	2017/06/14	CAM SOP-00230	EPA 8260 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope

Your Project #: 1666131
Your C.O.C. #: 614495-04-01

Attention: Alex Wood

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/06/20
Report #: R4550878
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7B9452

Received: 2017/06/08, 13:30

dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Analytics Mississauga

(2) Soils are reported on a dry weight basis unless otherwise specified.

(3) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following "Alberta Environment's Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003". Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

(4) Sample(s) analyzed using methodologies that have not been subjected to Maxxam's standard validation process for the submitted matrix and is not an Accredited method. Analysis performed with client consent, however results should be viewed with discretion

(5) Analysis was conducted according to Maxxam method CAM SOP-00309 and modified where applicable based on the sample matrix. This test is not Standards Council of Canada accredited for this matrix.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Alison Cameron, Project Manager

Email: ACameron@maxxam.ca

Phone# (613) 274-0573

=====
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL892	ENL892	ENL893	ENL894	ENL895	ENL896		
Sampling Date		2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	SA-313	SA-313 Lab-Dup	SA-312	SA-202	SA-215	DUP-312	RDL	QC Batch

Volatile Organics									
Benzene	ug/g	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	0.0060	5025980
Ethylbenzene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025980
Toluene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	5025980
p+m-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	5025980
o-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	5025980
Total Xylenes	ug/g	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	5025980
F1 (C6-C10)	ug/g	<10	<10	<10	<10	<10	<10	10	5025980
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	<10	<10	<10	10	5025980
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/g	<10		<10	<10	<10	<10	10	5025960
F3 (C16-C34 Hydrocarbons)	ug/g	<50		<50	<50	<50	<50	50	5025960
F4 (C34-C50 Hydrocarbons)	ug/g	<50		<50	<50	<50	<50	50	5025960
Reached Baseline at C50	ug/g	Yes		Yes	Yes	Yes	Yes		5025960
Surrogate Recovery (%)									
o-Terphenyl	%	100		100	94	96	100		5025960
4-Bromofluorobenzene	%	94	90	91	91	90	91		5025980
D10-o-Xylene	%	93	92	82	98	86	80		5025980
D4-1,2-Dichloroethane	%	101	100	101	99	102	99		5025980
D8-Toluene	%	102	101	101	102	100	101		5025980
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									
Lab-Dup = Laboratory Initiated Duplicate									

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL897	ENL898	ENL899		ENL900		ENL901		
Sampling Date		2017/06/06 12:00	2017/06/06 12:00	2017/06/07 12:00		2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01		614495-04-01		614495-04-01		
	UNITS	SA-281	SA-154	J-1	RDL	J-1-B	RDL	J-2	RDL	QC Batch

Volatile Organics										
Benzene	ug/g	<0.0060	<0.0060	<0.0060	0.0060	<0.0060	0.0060	<0.012	0.012	5025980
Ethylbenzene	ug/g	<0.010	<0.010	<0.010	0.010	<0.010	0.010	<0.020	0.020	5025980
Toluene	ug/g	<0.020	<0.020	<0.020	0.020	<0.020	0.020	<0.040	0.040	5025980
p+m-Xylene	ug/g	<0.020	<0.020	<0.020	0.020	<0.020	0.020	<0.040	0.040	5025980
o-Xylene	ug/g	<0.020	<0.020	<0.020	0.020	<0.020	0.020	<0.040	0.040	5025980
Total Xylenes	ug/g	<0.020	<0.020	<0.020	0.020	<0.020	0.020	<0.040	0.040	5025980
F1 (C6-C10)	ug/g	<10	<10	<10	10	660 (1)	200	<20	20	5025980
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	10	660	200	<20	20	5025980

F2-F4 Hydrocarbons										
F2 (C10-C16 Hydrocarbons)	ug/g	11	<10	<10	10	<10	10	12	10	5025960
F3 (C16-C34 Hydrocarbons)	ug/g	58	<50	<50	50	<50	50	100	50	5025960
F4 (C34-C50 Hydrocarbons)	ug/g	<50	110	<50	50	<50	50	67	50	5025960
Reached Baseline at C50	ug/g	Yes	No	Yes		Yes		No		5025960

Surrogate Recovery (%)										
o-Terphenyl	%	99	96	100		95		95		5025960
4-Bromofluorobenzene	%	90	90	94		94		92		5025980
D10-o-Xylene	%	85	82	79		79		80		5025980
D4-1,2-Dichloroethane	%	102	101	101		101		100		5025980
D8-Toluene	%	101	101	101		100		100		5025980

RDL = Reportable Detection Limit
 QC Batch = Quality Control Batch
 (1) Positive result was mainly contributed by single peak.

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL902	ENL903	ENL904	ENL905		ENL906		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01		614495-04-01		
	UNITS	J-2-B	J-3	J-4	J-5	RDL	J-6	RDL	QC Batch
Volatile Organics									
Benzene	ug/g	<0.0060	<0.0060	<0.0060	<0.0060	0.0060	<0.012	0.012	5025980
Ethylbenzene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	<0.020	0.020	5025980
Toluene	ug/g	<0.020	<0.020	<0.020	<0.020	0.020	<0.040	0.040	5025980
p+m-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	0.020	0.047	0.040	5025980
o-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020	0.020	0.044	0.040	5025980
Total Xylenes	ug/g	<0.020	<0.020	<0.020	<0.020	0.020	0.090	0.040	5025980
F1 (C6-C10)	ug/g	<10	<10	<10	<10	10	<20	20	5025980
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	<10	10	<20	20	5025980
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/g	<10	<10	<10	<10	10	640	300	5025960
F3 (C16-C34 Hydrocarbons)	ug/g	<50	<50	<50	<50	50	11000	1500	5025960
F4 (C34-C50 Hydrocarbons)	ug/g	<50	<50	<50	<50	50	47000	1500	5025960
Reached Baseline at C50	ug/g	Yes	Yes	Yes	Yes		No		5025960
Surrogate Recovery (%)									
o-Terphenyl	%	92	101	98	95		83		5025960
4-Bromofluorobenzene	%	90	93	90	90		89		5025980
D10-o-Xylene	%	86	81	82	96		99		5025980
D4-1,2-Dichloroethane	%	101	102	102	101		101		5025980
D8-Toluene	%	101	101	101	101		101		5025980
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL907	ENL908	ENL909	ENL910	ENL910		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-7	J-8	J-9	J-10	J-10 Lab-Dup	RDL	QC Batch

Volatile Organics								
Benzene	ug/g	<0.0060	<0.0060	<0.0060	<0.0060		0.0060	5025980
Ethylbenzene	ug/g	<0.010	<0.010	<0.010	<0.010		0.010	5025980
Toluene	ug/g	<0.020	<0.020	<0.020	<0.020		0.020	5025980
p+m-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020		0.020	5025980
o-Xylene	ug/g	<0.020	<0.020	<0.020	<0.020		0.020	5025980
Total Xylenes	ug/g	<0.020	<0.020	<0.020	<0.020		0.020	5025980
F1 (C6-C10)	ug/g	<10	<10	<10	<10		10	5025980
F1 (C6-C10) - BTEX	ug/g	<10	<10	<10	<10		10	5025980

F2-F4 Hydrocarbons								
F2 (C10-C16 Hydrocarbons)	ug/g	<10	<10	<10	<10	<10	10	5025960
F3 (C16-C34 Hydrocarbons)	ug/g	<50	<50	<50	<50	<50	50	5025960
F4 (C34-C50 Hydrocarbons)	ug/g	<50	<50	<50	<50	<50	50	5025960
Reached Baseline at C50	ug/g	Yes	Yes	Yes	Yes	Yes		5025960

Surrogate Recovery (%)								
o-Terphenyl	%	98	100	101	101	103		5025960
4-Bromofluorobenzene	%	90	90	90	90			5025980
D10-o-Xylene	%	84	96	85	84			5025980
D4-1,2-Dichloroethane	%	103	106	103	102			5025980
D8-Toluene	%	101	100	101	100			5025980

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL911		ENL912	ENL913	ENL913	ENL914		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-11	QC Batch	J-12	J-13	J-13 Lab-Dup	DUP-J-4	RDL	QC Batch
Volatile Organics									
Benzene	ug/g	<0.0060	5027788	<0.0060	<0.0060	<0.0060	<0.0060	0.0060	5027788
Ethylbenzene	ug/g	<0.010	5027788	<0.010	<0.010	<0.010	<0.010	0.010	5027788
Toluene	ug/g	<0.020	5027788	<0.020	<0.020	<0.020	<0.020	0.020	5027788
p+m-Xylene	ug/g	<0.020	5027788	<0.020	<0.020	<0.020	<0.020	0.020	5027788
o-Xylene	ug/g	<0.020	5027788	<0.020	<0.020	<0.020	<0.020	0.020	5027788
Total Xylenes	ug/g	<0.020	5027788	<0.020	<0.020	<0.020	<0.020	0.020	5027788
F1 (C6-C10)	ug/g	<10	5027788	<10	<10	<10	<10	10	5027788
F1 (C6-C10) - BTEX	ug/g	<10	5027788	<10	<10	<10	<10	10	5027788
F2-F4 Hydrocarbons									
F2 (C10-C16 Hydrocarbons)	ug/g	<10	5025960	<10	<10		<10	10	5026199
F3 (C16-C34 Hydrocarbons)	ug/g	<50	5025960	<50	<50		<50	50	5026199
F4 (C34-C50 Hydrocarbons)	ug/g	<50	5025960	<50	<50		<50	50	5026199
Reached Baseline at C50	ug/g	Yes	5025960	Yes	Yes		Yes		5026199
Surrogate Recovery (%)									
o-Terphenyl	%	94	5025960	90	86		84		5026199
4-Bromofluorobenzene	%	93	5027788	93	95	94	93		5027788
D10-o-Xylene	%	78	5027788	78	86	82	77		5027788
D4-1,2-Dichloroethane	%	100	5027788	99	98	95	99		5027788
D8-Toluene	%	97	5027788	97	96	98	98		5027788
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

CCME PETROLEUM HYDROCARBONS SOIL (SOIL)

Maxxam ID		ENL915		ENL916		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01		
	UNITS	SA-192-A	QC Batch	J-6B	RDL	QC Batch
Volatile Organics						
Benzene	ug/g	<0.0060	5027788	<0.0060	0.0060	5025980
Ethylbenzene	ug/g	<0.010	5027788	<0.010	0.010	5025980
Toluene	ug/g	<0.020	5027788	<0.020	0.020	5025980
p+m-Xylene	ug/g	<0.020	5027788	<0.020	0.020	5025980
o-Xylene	ug/g	<0.020	5027788	<0.020	0.020	5025980
Total Xylenes	ug/g	<0.020	5027788	<0.020	0.020	5025980
F1 (C6-C10)	ug/g	<10	5027788	<10	10	5025980
F1 (C6-C10) - BTEX	ug/g	<10	5027788	<10	10	5025980
F2-F4 Hydrocarbons						
F2 (C10-C16 Hydrocarbons)	ug/g	<10	5026199	<10	10	5026199
F3 (C16-C34 Hydrocarbons)	ug/g	<50	5026199	<50	50	5026199
F4 (C34-C50 Hydrocarbons)	ug/g	<50	5026199	180	50	5026199
Reached Baseline at C50	ug/g	Yes	5026199	No		5026199
Surrogate Recovery (%)						
o-Terphenyl	%	84	5026199	84		5026199
4-Bromofluorobenzene	%	95	5027788	91		5025980
D10-o-Xylene	%	89	5027788	82		5025980
D4-1,2-Dichloroethane	%	99	5027788	103		5025980
D8-Toluene	%	99	5027788	100		5025980
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL892	ENL893		ENL894	ENL895	ENL896		
Sampling Date		2017/06/06 12:00	2017/06/06 12:00		2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00		
COC Number		614495-04-01	614495-04-01		614495-04-01	614495-04-01	614495-04-01		
	UNITS	SA-313	SA-312	QC Batch	SA-202	SA-215	DUP-312	RDL	QC Batch
Inorganics									
Moisture	%	18	12	5025234	4.8	7.4	13	1.0	5025234
Calculated Parameters									
Methylnaphthalene, 2-(1-)	ug/g	0.020	<0.0071	5022533	<0.0071	<0.0071	<0.0071	0.0071	5022771
Polyaromatic Hydrocarbons									
Acenaphthene	ug/g	<0.0050	0.023	5026061	<0.0050	<0.0050	0.024	0.0050	5026061
Acenaphthylene	ug/g	0.025	<0.0050	5026061	<0.0050	<0.0050	<0.0050	0.0050	5026061
Anthracene	ug/g	0.0064	0.051	5026061	0.0055	<0.0050	0.059	0.0050	5026061
Benzo(a)anthracene	ug/g	0.0077	0.15	5026061	0.073	<0.0050	0.19	0.0050	5026061
Benzo(a)pyrene	ug/g	0.0069	0.12	5026061	0.094	<0.0050	0.15	0.0050	5026061
Benzo(b/j)fluoranthene	ug/g	0.0093	0.15	5026061	0.14	<0.0050	0.18	0.0050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	0.063	5026061	0.078	<0.0050	0.077	0.0050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	0.059	5026061	0.046	<0.0050	0.063	0.0050	5026061
Chrysene	ug/g	0.0077	0.13	5026061	0.077	<0.0050	0.15	0.0050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	0.019	5026061	0.018	<0.0050	0.022	0.0050	5026061
Fluoranthene	ug/g	0.016	0.30	5026061	0.15	0.0071	0.38	0.0050	5026061
Fluorene	ug/g	<0.0050	0.017	5026061	<0.0050	<0.0050	0.018	0.0050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	0.0050	0.074	5026061	0.081	<0.0050	0.090	0.0050	5026061
1-Methylnaphthalene	ug/g	0.0085	<0.0050	5026061	<0.0050	<0.0050	<0.0050	0.0050	5026061
2-Methylnaphthalene	ug/g	0.011	<0.0050	5026061	<0.0050	<0.0050	<0.0050	0.0050	5026061
Naphthalene	ug/g	0.0082	<0.0050	5026061	<0.0050	<0.0050	<0.0050	0.0050	5026061
Phenanthrene	ug/g	0.014	0.17	5026061	0.037	<0.0050	0.19	0.0050	5026061
Pyrene	ug/g	0.015	0.23	5026061	0.13	0.0058	0.30	0.0050	5026061
Surrogate Recovery (%)									
D10-Anthracene	%	94	90	5026061	100	96	91		5026061
D14-Terphenyl (FS)	%	92	90	5026061	97	92	91		5026061
D8-Acenaphthylene	%	93	93	5026061	97	92	92		5026061
RDL = Reportable Detection Limit QC Batch = Quality Control Batch									

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL897		ENL898	ENL898			ENL899		
Sampling Date		2017/06/06 12:00		2017/06/06 12:00	2017/06/06 12:00			2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01	614495-04-01			614495-04-01		
	UNITS	SA-281	RDL	SA-154	SA-154 Lab-Dup	RDL	QC Batch	J-1	RDL	QC Batch

Inorganics

Moisture	%	26	1.0	11		1.0	5025234	9.0	1.0	5025037
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Calculated Parameters

Methylnaphthalene, 2-(1-)	ug/g	<0.0071	0.0071	<0.071		0.071	5022771	<0.0071	0.0071	5022771
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Polyaromatic Hydrocarbons

Acenaphthene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Acenaphthylene	ug/g	<0.0050	0.0050	0.065	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Anthracene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Benzo(a)anthracene	ug/g	0.0083	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Benzo(a)pyrene	ug/g	0.0076	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Benzo(b/j)fluoranthene	ug/g	0.013	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Chrysene	ug/g	0.011	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Fluoranthene	ug/g	0.021	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Fluorene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	0.0058	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
1-Methylnaphthalene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
2-Methylnaphthalene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Naphthalene	ug/g	<0.0050	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Phenanthrene	ug/g	0.015	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061
Pyrene	ug/g	0.017	0.0050	<0.050	<0.050	0.050	5026061	<0.0050	0.0050	5026061

Surrogate Recovery (%)

D10-Anthracene	%	93		96	94		5026061	102		5026061
D14-Terphenyl (FS)	%	90		87	87		5026061	95		5026061
D8-Acenaphthylene	%	94		82	83		5026061	100		5026061

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL900		ENL901	ENL902		ENL903	ENL904		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01	614495-04-01		614495-04-01	614495-04-01		
	UNITS	J-1-B	RDL	J-2	J-2-B	RDL	J-3	J-4	RDL	QC Batch
Inorganics										
Moisture	%	10	1.0	16	18	1.0	5.3	3.1	1.0	5025037
Calculated Parameters										
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	0.0071	<0.071	<0.071	0.071	<0.0071	<0.0071	0.0071	5022771
Polyaromatic Hydrocarbons										
Acenaphthene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Acenaphthylene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Anthracene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Benzo(a)anthracene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Benzo(a)pyrene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Chrysene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Fluoranthene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Fluorene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
1-Methylnaphthalene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
2-Methylnaphthalene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Naphthalene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Phenanthrene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Pyrene	ug/g	<0.0050	0.0050				<0.0050	<0.0050	0.0050	5026061
Surrogate Recovery (%)										
D10-Anthracene	%	99					100	95		5026061
D14-Terphenyl (FS)	%	93					93	92		5026061
D8-Acenaphthylene	%	95					94	90		5026061
RDL = Reportable Detection Limit QC Batch = Quality Control Batch										

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL905		ENL906			ENL907		ENL908		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00			2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01			614495-04-01		614495-04-01		
	UNITS	J-5	RDL	J-6	RDL	QC Batch	J-7	QC Batch	J-8	RDL	QC Batch
Inorganics											
Moisture	%	3.6	1.0	69	1.0	5025037	8.7	5025037	15	1.0	5025037
Calculated Parameters											
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	0.0071	<4.2	4.2	5022771	<0.0071	5022771	<0.0071	0.0071	5022771
Polyaromatic Hydrocarbons											
Acenaphthene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Acenaphthylene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Anthracene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Benzo(a)anthracene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Benzo(a)pyrene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Chrysene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Fluoranthene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Fluorene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
1-Methylnaphthalene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
2-Methylnaphthalene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Naphthalene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Phenanthrene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Pyrene	ug/g	<0.0050	0.0050			5026061	<0.0050	5026068	<0.0050	0.0050	5026061
Surrogate Recovery (%)											
D10-Anthracene	%	100				5026061	83	5026068	97		5026061
D14-Terphenyl (FS)	%	96				5026061	82	5026068	90		5026061
D8-Acenaphthylene	%	95				5026061	80	5026068	92		5026061
RDL = Reportable Detection Limit QC Batch = Quality Control Batch											

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL909		ENL910	ENL911	ENL912	ENL913		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-9	QC Batch	J-10	J-11	J-12	J-13	RDL	QC Batch
Inorganics									
Moisture	%	7.5	5025037	6.8	21	22	23	1.0	5025037
Calculated Parameters									
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	5022771	<0.0071	<0.0071	<0.0071	<0.0071	0.0071	5022771
Polyaromatic Hydrocarbons									
Acenaphthene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Acenaphthylene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Anthracene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Benzo(a)anthracene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Benzo(a)pyrene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Benzo(b/j)fluoranthene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Chrysene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Fluoranthene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Fluorene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
1-Methylnaphthalene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
2-Methylnaphthalene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Naphthalene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Phenanthrene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Pyrene	ug/g	<0.0050	5026068	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	5026061
Surrogate Recovery (%)									
D10-Anthracene	%	89	5026068	95	95	93	95		5026061
D14-Terphenyl (FS)	%	88	5026068	91	90	89	91		5026061
D8-Acenaphthylene	%	85	5026068	92	89	87	90		5026061
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									

O.REG 153 PAHS (SOIL)

Maxxam ID		ENL914	ENL915		ENL916		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01		614495-04-01		
	UNITS	DUP-J-4	SA-192-A	RDL	J-6B	RDL	QC Batch
Inorganics							
Moisture	%	3.6		1.0	10	1.0	5025037
Calculated Parameters							
Methylnaphthalene, 2-(1-)	ug/g	<0.0071	<0.0071	0.0071	<0.071	0.071	5022771
Polyaromatic Hydrocarbons							
Acenaphthene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Acenaphthylene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Anthracene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Benzo(a)anthracene	ug/g	<0.0050	0.012	0.0050	<0.050	0.050	5026061
Benzo(a)pyrene	ug/g	<0.0050	0.011	0.0050	<0.050	0.050	5026061
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.015	0.0050	<0.050	0.050	5026061
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0084	0.0050	<0.050	0.050	5026061
Benzo(k)fluoranthene	ug/g	<0.0050	0.0053	0.0050	<0.050	0.050	5026061
Chrysene	ug/g	<0.0050	0.010	0.0050	<0.050	0.050	5026061
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Fluoranthene	ug/g	<0.0050	0.021	0.0050	<0.050	0.050	5026061
Fluorene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.0082	0.0050	<0.050	0.050	5026061
1-Methylnaphthalene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
2-Methylnaphthalene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Naphthalene	ug/g	<0.0050	<0.0050	0.0050	<0.050	0.050	5026061
Phenanthrene	ug/g	<0.0050	0.0098	0.0050	<0.050	0.050	5026061
Pyrene	ug/g	<0.0050	0.018	0.0050	<0.050	0.050	5026061
Surrogate Recovery (%)							
D10-Anthracene	%	93	95		96		5026061
D14-Terphenyl (FS)	%	87	91		85		5026061
D8-Acenaphthylene	%	89	91		83		5026061
RDL = Reportable Detection Limit QC Batch = Quality Control Batch							

O.REG 153 PCBS (SOIL)

Maxxam ID		ENL892	ENL893	ENL894	ENL895	ENL896	ENL897		
Sampling Date		2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00	2017/06/06 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	SA-313	SA-312	SA-202	SA-215	DUP-312	SA-281	RDL	QC Batch

PCBs									
Aroclor 1242	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1248	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1254	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1260	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Total PCB	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Surrogate Recovery (%)									
Decachlorobiphenyl	%	83	79	82	78	89	98		5025878
RDL = Reportable Detection Limit QC Batch = Quality Control Batch									

Maxxam ID		ENL898	ENL898	ENL899	ENL900	ENL903	ENL904		
Sampling Date		2017/06/06 12:00	2017/06/06 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	SA-154	SA-154 Lab-Dup	J-1	J-1-B	J-3	J-4	RDL	QC Batch

PCBs									
Aroclor 1242	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1248	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1254	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Aroclor 1260	ug/g	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Total PCB	ug/g	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	0.010	5025878
Surrogate Recovery (%)									
Decachlorobiphenyl	%	78	72	81	86	80	85		5025878
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

O.REG 153 PCBS (SOIL)

Maxxam ID		ENL905		ENL907		ENL908		ENL909		
Sampling Date		2017/06/07 12:00		2017/06/07 12:00		2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01		614495-04-01		614495-04-01		614495-04-01		
	UNITS	J-5	QC Batch	J-7	QC Batch	J-8	QC Batch	J-9	RDL	QC Batch

PCBs										
Aroclor 1242	ug/g	<0.010	5025878	<0.010	5026031	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1248	ug/g	<0.010	5025878	<0.010	5026031	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1254	ug/g	<0.010	5025878	<0.010	5026031	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1260	ug/g	<0.010	5025878	<0.010	5026031	<0.010	5025878	<0.010	0.010	5026031
Total PCB	ug/g	<0.010	5025878	<0.010	5026031	<0.010	5025878	<0.010	0.010	5026031
Surrogate Recovery (%)										
Decachlorobiphenyl	%	87	5025878	87	5026031	78	5025878	95		5026031
RDL = Reportable Detection Limit QC Batch = Quality Control Batch										

Maxxam ID		ENL909	ENL910		ENL911	ENL912		ENL913		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01		614495-04-01	614495-04-01		614495-04-01		
	UNITS	J-9 Lab-Dup	J-10	QC Batch	J-11	J-12	QC Batch	J-13	RDL	QC Batch

PCBs										
Aroclor 1242	ug/g	<0.010	<0.010	5026031	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1248	ug/g	<0.010	<0.010	5026031	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1254	ug/g	<0.010	<0.010	5026031	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1260	ug/g	<0.010	<0.010	5026031	<0.010	<0.010	5025878	<0.010	0.010	5026031
Total PCB	ug/g	<0.010	<0.010	5026031	<0.010	<0.010	5025878	<0.010	0.010	5026031
Surrogate Recovery (%)										
Decachlorobiphenyl	%	92	87	5026031	93	90	5025878	87		5026031
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate										

O.REG 153 PCBS (SOIL)

Maxxam ID		ENL914	ENL915		ENL916		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01		614495-04-01		
	UNITS	DUP-J-4	SA-192-A	QC Batch	J-6B	RDL	QC Batch
Inorganics							
Moisture	%		8.8	5025234		1.0	5025234
PCBs							
Aroclor 1242	ug/g	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1248	ug/g	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1254	ug/g	<0.010	<0.010	5025878	<0.010	0.010	5026031
Aroclor 1260	ug/g	<0.010	<0.010	5025878	<0.010	0.010	5026031
Total PCB	ug/g	<0.010	<0.010	5025878	<0.010	0.010	5026031
Surrogate Recovery (%)							
Decachlorobiphenyl	%	82	81	5025878	76		5026031
RDL = Reportable Detection Limit QC Batch = Quality Control Batch							

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		ENL899	ENL900	ENL901	ENL902	ENL903		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-1	J-1-B	J-2	J-2-B	J-3	RDL	QC Batch
Inorganics								
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	5023883
Metals								
Acid Extractable Aluminum (Al)	ug/g	14000	12000	7100	8300	12000	50	5025666
Acid Extractable Antimony (Sb)	ug/g	0.30	<0.20	<0.20	<0.20	0.24	0.20	5025666
Acid Extractable Arsenic (As)	ug/g	2.6	2.3	1.2	<1.0	2.3	1.0	5025666
Acid Extractable Barium (Ba)	ug/g	180	60	64	130	82	0.50	5025666
Acid Extractable Beryllium (Be)	ug/g	0.32	0.36	0.24	<0.20	0.33	0.20	5025666
Acid Extractable Bismuth (Bi)	ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	5025666
Acid Extractable Boron (B)	ug/g	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	5025666
Acid Extractable Cadmium (Cd)	ug/g	0.17	0.13	<0.10	<0.10	<0.10	0.10	5025666
Acid Extractable Calcium (Ca)	ug/g	1800	1800	3600	4500	3000	50	5025666
Acid Extractable Chromium (Cr)	ug/g	33	25	19	13	26	1.0	5025666
Acid Extractable Cobalt (Co)	ug/g	9.0	7.4	5.5	6.3	8.9	0.10	5025666
Acid Extractable Copper (Cu)	ug/g	37	26	18	24	47	0.50	5025666
Acid Extractable Iron (Fe)	ug/g	30000	25000	18000	21000	22000	50	5025666
Acid Extractable Lead (Pb)	ug/g	44	30	50	21	30	1.0	5025666
Acid Extractable Magnesium (Mg)	ug/g	6600	4700	4800	6000	7100	50	5025666
Acid Extractable Manganese (Mn)	ug/g	350	290	260	280	240	1.0	5025666
Acid Extractable Molybdenum (Mo)	ug/g	1.6	0.50	<0.50	<0.50	<0.50	0.50	5025666
Acid Extractable Nickel (Ni)	ug/g	17	16	10	8.2	19	0.50	5025666
Acid Extractable Phosphorus (P)	ug/g	670	600	970	1400	1000	50	5025666
Acid Extractable Potassium (K)	ug/g	4600	1600	2400	4400	2700	200	5025666
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	5025666
Acid Extractable Silver (Ag)	ug/g	0.20	<0.20	<0.20	<0.20	<0.20	0.20	5025666
Acid Extractable Sodium (Na)	ug/g	100	84	130	140	130	50	5025666
Acid Extractable Strontium (Sr)	ug/g	8.8	9.7	11	10	9.6	1.0	5025666
Acid Extractable Thallium (Tl)	ug/g	0.27	0.16	0.14	0.19	0.21	0.050	5025666
Acid Extractable Tin (Sn)	ug/g	6.1	9.3	23	7.7	3.6	1.0	5025666
Acid Extractable Uranium (U)	ug/g	0.56	0.55	0.44	0.45	0.73	0.050	5025666
Acid Extractable Vanadium (V)	ug/g	87	43	29	40	44	5.0	5025666
Acid Extractable Zinc (Zn)	ug/g	91	67	41	52	62	5.0	5025666
Acid Extractable Mercury (Hg)	ug/g	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	5025666
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		ENL904	ENL905	ENL906	ENL907	ENL907		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-4	J-5	J-6	J-7	J-7 Lab-Dup	RDL	QC Batch

Inorganics								
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2		0.2	5023883
Metals								
Acid Extractable Aluminum (Al)	ug/g	13000	12000	7000	10000	9900	50	5025666
Acid Extractable Antimony (Sb)	ug/g	<0.20	<0.20	0.67	0.77	0.52	0.20	5025666
Acid Extractable Arsenic (As)	ug/g	1.0	1.4	15	<1.0	<1.0	1.0	5025666
Acid Extractable Barium (Ba)	ug/g	90	83	72	75	75	0.50	5025666
Acid Extractable Beryllium (Be)	ug/g	0.43	0.42	0.39	0.28	0.26	0.20	5025666
Acid Extractable Bismuth (Bi)	ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	5025666
Acid Extractable Boron (B)	ug/g	<5.0	<5.0	8.4	<5.0	<5.0	5.0	5025666
Acid Extractable Cadmium (Cd)	ug/g	0.16	<0.10	1.0	0.11	<0.10	0.10	5025666
Acid Extractable Calcium (Ca)	ug/g	2400	2300	24000	2200	2100	50	5025666
Acid Extractable Chromium (Cr)	ug/g	38	31	26	18	17	1.0	5025666
Acid Extractable Cobalt (Co)	ug/g	10	8.5	6.5	8.0	7.2	0.10	5025666
Acid Extractable Copper (Cu)	ug/g	42	44	24	25	26	0.50	5025666
Acid Extractable Iron (Fe)	ug/g	22000	21000	13000	24000	24000	50	5025666
Acid Extractable Lead (Pb)	ug/g	27	24	73	15	14	1.0	5025666
Acid Extractable Magnesium (Mg)	ug/g	8100	6900	6500	5800	5500	50	5025666
Acid Extractable Manganese (Mn)	ug/g	330	250	520	290	280	1.0	5025666
Acid Extractable Molybdenum (Mo)	ug/g	<0.50	<0.50	1.8	<0.50	<0.50	0.50	5025666
Acid Extractable Nickel (Ni)	ug/g	26	18	37	11	11	0.50	5025666
Acid Extractable Phosphorus (P)	ug/g	810	750	650	640	630	50	5025666
Acid Extractable Potassium (K)	ug/g	3000	2700	990	3100	3000	200	5025666
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	5025666
Acid Extractable Silver (Ag)	ug/g	<0.20	<0.20	0.20	<0.20	<0.20	0.20	5025666
Acid Extractable Sodium (Na)	ug/g	120	130	100	<50	<50	50	5025666
Acid Extractable Strontium (Sr)	ug/g	9.9	9.1	62	5.9	6.0	1.0	5025666
Acid Extractable Thallium (Tl)	ug/g	0.24	0.19	0.080	0.15	0.14	0.050	5025666
Acid Extractable Tin (Sn)	ug/g	<1.0	<1.0	4.3	3.6	3.0	1.0	5025666
Acid Extractable Uranium (U)	ug/g	1.0	1.0	2.3	0.67	0.76	0.050	5025666
Acid Extractable Vanadium (V)	ug/g	41	41	39	43	43	5.0	5025666
Acid Extractable Zinc (Zn)	ug/g	130	85	320	65	61	5.0	5025666
Acid Extractable Mercury (Hg)	ug/g	<0.050	<0.050	0.17	<0.050	<0.050	0.050	5025666

RDL = Reportable Detection Limit
 QC Batch = Quality Control Batch
 Lab-Dup = Laboratory Initiated Duplicate

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		ENL908	ENL909	ENL909	ENL910	ENL911		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-8	J-9	J-9 Lab-Dup	J-10	J-11	RDL	QC Batch

Inorganics								
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	5023883
Metals								
Acid Extractable Aluminum (Al)	ug/g	14000	9100		8300	9000	50	5025666
Acid Extractable Antimony (Sb)	ug/g	<0.20	<0.20		<0.20	<0.20	0.20	5025666
Acid Extractable Arsenic (As)	ug/g	1.3	<1.0		<1.0	<1.0	1.0	5025666
Acid Extractable Barium (Ba)	ug/g	75	84		76	80	0.50	5025666
Acid Extractable Beryllium (Be)	ug/g	0.40	0.28		0.27	0.43	0.20	5025666
Acid Extractable Bismuth (Bi)	ug/g	<1.0	<1.0		<1.0	<1.0	1.0	5025666
Acid Extractable Boron (B)	ug/g	<5.0	<5.0		<5.0	<5.0	5.0	5025666
Acid Extractable Cadmium (Cd)	ug/g	<0.10	<0.10		<0.10	0.11	0.10	5025666
Acid Extractable Calcium (Ca)	ug/g	3000	3400		2500	3000	50	5025666
Acid Extractable Chromium (Cr)	ug/g	28	19		17	22	1.0	5025666
Acid Extractable Cobalt (Co)	ug/g	7.8	7.3		7.1	5.6	0.10	5025666
Acid Extractable Copper (Cu)	ug/g	41	28		26	25	0.50	5025666
Acid Extractable Iron (Fe)	ug/g	24000	20000		19000	16000	50	5025666
Acid Extractable Lead (Pb)	ug/g	28	4.8		6.9	20	1.0	5025666
Acid Extractable Magnesium (Mg)	ug/g	6900	5700		5100	5900	50	5025666
Acid Extractable Manganese (Mn)	ug/g	240	290		290	190	1.0	5025666
Acid Extractable Molybdenum (Mo)	ug/g	<0.50	<0.50		<0.50	<0.50	0.50	5025666
Acid Extractable Nickel (Ni)	ug/g	18	14		12	13	0.50	5025666
Acid Extractable Phosphorus (P)	ug/g	750	850		810	620	50	5025666
Acid Extractable Potassium (K)	ug/g	2600	2600		2800	2000	200	5025666
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50		<0.50	<0.50	0.50	5025666
Acid Extractable Silver (Ag)	ug/g	<0.20	<0.20		<0.20	<0.20	0.20	5025666
Acid Extractable Sodium (Na)	ug/g	280	120		100	250	50	5025666
Acid Extractable Strontium (Sr)	ug/g	11	9.0		6.5	17	1.0	5025666
Acid Extractable Thallium (Tl)	ug/g	0.19	0.16		0.16	0.16	0.050	5025666
Acid Extractable Tin (Sn)	ug/g	1.1	<1.0		<1.0	<1.0	1.0	5025666
Acid Extractable Uranium (U)	ug/g	0.90	0.86		0.83	0.78	0.050	5025666
Acid Extractable Vanadium (V)	ug/g	50	37		35	33	5.0	5025666
Acid Extractable Zinc (Zn)	ug/g	63	51		49	52	5.0	5025666
Acid Extractable Mercury (Hg)	ug/g	<0.050	<0.050		<0.050	<0.050	0.050	5025666

RDL = Reportable Detection Limit
 QC Batch = Quality Control Batch
 Lab-Dup = Laboratory Initiated Duplicate

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		ENL912	ENL913	ENL914	ENL916		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01	614495-04-01		
	UNITS	J-12	J-13	DUP-J-4	J-6B	RDL	QC Batch
Inorganics							
Chromium (VI)	ug/g	<0.2	<0.2	<0.2	<0.2	0.2	5023883
Metals							
Acid Extractable Aluminum (Al)	ug/g	10000	12000	12000	14000	50	5025666
Acid Extractable Antimony (Sb)	ug/g	<0.20	<0.20	<0.20	<0.20	0.20	5025666
Acid Extractable Arsenic (As)	ug/g	<1.0	<1.0	1.0	3.8	1.0	5025666
Acid Extractable Barium (Ba)	ug/g	100	84	91	68	0.50	5025666
Acid Extractable Beryllium (Be)	ug/g	0.47	0.47	0.43	0.35	0.20	5025666
Acid Extractable Bismuth (Bi)	ug/g	<1.0	<1.0	<1.0	<1.0	1.0	5025666
Acid Extractable Boron (B)	ug/g	<5.0	<5.0	<5.0	<5.0	5.0	5025666
Acid Extractable Cadmium (Cd)	ug/g	<0.10	<0.10	0.12	0.11	0.10	5025666
Acid Extractable Calcium (Ca)	ug/g	3400	3100	2300	2800	50	5025666
Acid Extractable Chromium (Cr)	ug/g	26	28	29	21	1.0	5025666
Acid Extractable Cobalt (Co)	ug/g	6.5	9.6	8.7	8.1	0.10	5025666
Acid Extractable Copper (Cu)	ug/g	37	49	39	32	0.50	5025666
Acid Extractable Iron (Fe)	ug/g	21000	23000	19000	23000	50	5025666
Acid Extractable Lead (Pb)	ug/g	8.6	8.1	26	14	1.0	5025666
Acid Extractable Magnesium (Mg)	ug/g	7300	6600	6800	5200	50	5025666
Acid Extractable Manganese (Mn)	ug/g	200	230	290	210	1.0	5025666
Acid Extractable Molybdenum (Mo)	ug/g	<0.50	<0.50	<0.50	0.52	0.50	5025666
Acid Extractable Nickel (Ni)	ug/g	15	21	19	16	0.50	5025666
Acid Extractable Phosphorus (P)	ug/g	720	650	750	820	50	5025666
Acid Extractable Potassium (K)	ug/g	2700	2200	2800	2300	200	5025666
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50	<0.50	<0.50	0.50	5025666
Acid Extractable Silver (Ag)	ug/g	<0.20	<0.20	<0.20	<0.20	0.20	5025666
Acid Extractable Sodium (Na)	ug/g	290	310	120	93	50	5025666
Acid Extractable Strontium (Sr)	ug/g	17	18	9.8	9.5	1.0	5025666
Acid Extractable Thallium (Tl)	ug/g	0.18	0.16	0.19	0.15	0.050	5025666
Acid Extractable Tin (Sn)	ug/g	<1.0	<1.0	<1.0	<1.0	1.0	5025666
Acid Extractable Uranium (U)	ug/g	0.94	0.92	0.97	0.66	0.050	5025666
Acid Extractable Vanadium (V)	ug/g	41	42	38	45	5.0	5025666
Acid Extractable Zinc (Zn)	ug/g	57	57	110	99	5.0	5025666
Acid Extractable Mercury (Hg)	ug/g	<0.050	<0.050	<0.050	<0.050	0.050	5025666
RDL = Reportable Detection Limit QC Batch = Quality Control Batch							

SEMI-VOLATILE ORGANICS BY GC-MS (SOIL)

Maxxam ID		ENL901	ENL902	ENL902		ENL906		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01	614495-04-01		614495-04-01		
	UNITS	J-2	J-2-B	J-2-B Lab-Dup	RDL	J-6	RDL	QC Batch

Polyaromatic Hydrocarbons								
Acenaphthene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Acenaphthylene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Anthracene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Benzo(a)anthracene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Benzo(a)pyrene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Benzo(b/j)fluoranthene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Benzo(g,h,i)perylene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Benzo(k)fluoranthene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Chrysene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Dibenz(a,h)anthracene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Fluoranthene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Fluorene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Indeno(1,2,3-cd)pyrene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
1-Methylnaphthalene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
2-Methylnaphthalene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Naphthalene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Phenanthrene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Pyrene	ug/g	<0.05	<0.05	<0.05	0.05	<3	3	5028300
Surrogate Recovery (%)								
D10-Anthracene	%	93	97	94		126		5028300
D14-Terphenyl (FS)	%	92	97	91		110		5028300
D8-Acenaphthylene	%	92	94	93		110		5028300

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		ENL916		
Sampling Date		2017/06/07 12:00		
COC Number		614495-04-01		
	UNITS	J-6B	RDL	QC Batch
F2-F4 Hydrocarbons				
F4G-sg (Grav. Heavy Hydrocarbons)	ug/g	1500	100	5029337
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				

POLYCHLORINATED BIPHENYLS BY GC-ECD (SOIL)

Maxxam ID		ENL901	ENL902		ENL906		
Sampling Date		2017/06/07 12:00	2017/06/07 12:00		2017/06/07 12:00		
COC Number		614495-04-01	614495-04-01		614495-04-01		
	UNITS	J-2	J-2-B	RDL	J-6	RDL	QC Batch
PCBs							
Aroclor 1262	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1016	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1221	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1232	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1242	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1248	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1254	ug/g	<0.1	<0.1	0.1	0.3	0.2	5026005
Aroclor 1260	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Aroclor 1268	ug/g	<0.1	<0.1	0.1	<0.2	0.2	5026005
Total PCB	ug/g	<0.1	<0.1	0.1	0.3	0.2	5026005
Surrogate Recovery (%)							
Decachlorobiphenyl	%	80	81		100		5026005
RDL = Reportable Detection Limit							
QC Batch = Quality Control Batch							

TEST SUMMARY

Maxxam ID: ENL892
Sample ID: SA-313
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022533	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL892 Dup
Sample ID: SA-313
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL893
Sample ID: SA-312
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022533	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL894
Sample ID: SA-202
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL895
Sample ID: SA-215
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal

TEST SUMMARY

Maxxam ID: ENL895
Sample ID: SA-215
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL896
Sample ID: DUP-312
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL897
Sample ID: SA-281
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL898
Sample ID: SA-154
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/19	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL898 Dup
Sample ID: SA-154
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/19	Lingyun Feng

TEST SUMMARY

Maxxam ID: ENL898 Dup
Sample ID: SA-154
Matrix: Soil

Collected: 2017/06/06
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng

Maxxam ID: ENL899
Sample ID: J-1
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/14	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL900
Sample ID: J-1-B
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/14	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL901
Sample ID: J-2
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/16	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
PAH Compounds by GC/MS (SIM)	GC/MS	5028300	2017/06/14	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Solids	GC/ECD	5026005	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

TEST SUMMARY

Maxxam ID: ENL902
Sample ID: J-2-B
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/16	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
PAH Compounds by GC/MS (SIM)	GC/MS	5028300	2017/06/14	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Solids	GC/ECD	5026005	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL902 Dup
Sample ID: J-2-B
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds by GC/MS (SIM)	GC/MS	5028300	2017/06/14	2017/06/16	Lingyun Feng

Maxxam ID: ENL903
Sample ID: J-3
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL904
Sample ID: J-4
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/14	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

TEST SUMMARY

Maxxam ID: ENL905
Sample ID: J-5
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/14	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL906
Sample ID: J-6
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/16	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
PAH Compounds by GC/MS (SIM)	GC/MS	5028300	2017/06/14	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Solids	GC/ECD	5026005	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL907
Sample ID: J-7
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/15	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026068	2017/06/13	2017/06/14	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL907 Dup
Sample ID: J-7
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu

TEST SUMMARY

Maxxam ID: ENL908
Sample ID: J-8
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL909
Sample ID: J-9
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/15	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026068	2017/06/13	2017/06/14	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

Maxxam ID: ENL909 Dup
Sample ID: J-9
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)

Maxxam ID: ENL910
Sample ID: J-10
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

TEST SUMMARY

Maxxam ID: ENL910 Dup
Sample ID: J-10
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu

Maxxam ID: ENL911
Sample ID: J-11
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5025960	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/13	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

Maxxam ID: ENL912
Sample ID: J-12
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5026199	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/14	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

Maxxam ID: ENL913
Sample ID: J-13
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5026199	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/14	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

TEST SUMMARY

Maxxam ID: ENL913 Dup
Sample ID: J-13
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

Maxxam ID: ENL914
Sample ID: DUP-J-4
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5026199	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/14	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

Maxxam ID: ENL915
Sample ID: SA-192-A
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5026199	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
Moisture	BAL	5025234	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/16	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5025878	2017/06/13	2017/06/14	Li Peng
Volatile Organic Compounds and F1 PHCs	GC/MS	5027788	N/A	2017/06/14	James Zou

Maxxam ID: ENL916
Sample ID: J-6B
Matrix: Soil

Collected: 2017/06/07
Shipped:
Received: 2017/06/08

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	5022771	N/A	2017/06/20	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	5023883	2017/06/12	2017/06/14	Manoj Kumar Gera
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	5026199	2017/06/13	2017/06/14	Zhiyue (Frank) Zhu
F4G (CCME Hydrocarbons Gravimetric)	BAL	5029337	2017/06/15	2017/06/15	Debra Deslandes
Strong Acid Leachable Metals by ICPMS	ICP/MS	5025666	2017/06/13	2017/06/15	Daniel Teclu
Moisture	BAL	5025037	N/A	2017/06/13	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	5026061	2017/06/13	2017/06/19	Lingyun Feng
Polychlorinated Biphenyl in Soil	GC/ECD	5026031	2017/06/13	2017/06/14	Mengxiu Zheng (Marcy)
Volatile Organic Compounds and F1 PHCs	GC/MS	5025980	N/A	2017/06/14	John Wu

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	22.0°C
Package 2	11.0°C

Sample ENL898 [SA-154] : PAH analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly.

Sample ENL900 [J-1-B] : VOCF1 Analysis: Due to high concentration of terpene compounds, the sample required dilution. The detection limits were adjusted accordingly. In order to meet required regulatory criteria, results for selected compounds (obtained by a separate analysis using an appropriate low dilution) are included in the report.

Sample ENL901 [J-2] : VOCF1 Analysis: Detection limits were raised due to low weight of soil provided.

PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

Sample ENL902 [J-2-B] : PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

Sample ENL906 [J-6] : VOCF1 Analysis: Detection limits were raised due to high moisture content of soil provided.

PAH analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly.

PAH Analysis: Due to the samples matrix, a smaller than usual portion of the samples were used. Detection limits were adjusted accordingly.

Sample ENL916 [J-6B] : PAH analysis: Due to the sample matrix, sample required dilution. Detection limits were adjusted accordingly.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5025878	Decachlorobiphenyl	2017/06/13	89	60 - 130	82	60 - 130	85	%		
5025960	o-Terphenyl	2017/06/14	100	60 - 130	101	60 - 130	98	%		
5025980	4-Bromofluorobenzene	2017/06/13	100	60 - 140	94	60 - 140	91	%		
5025980	D10-o-Xylene	2017/06/13	98	60 - 130	84	60 - 130	84	%		
5025980	D4-1,2-Dichloroethane	2017/06/13	103	60 - 140	101	60 - 140	100	%		
5025980	D8-Toluene	2017/06/13	100	60 - 140	102	60 - 140	102	%		
5026005	Decachlorobiphenyl	2017/06/14	87	30 - 130	90	30 - 130	105	%		
5026031	Decachlorobiphenyl	2017/06/14	93	60 - 130	97	60 - 130	96	%		
5026061	D10-Anthracene	2017/06/16	101	50 - 130	95	50 - 130	90	%		
5026061	D14-Terphenyl (FS)	2017/06/16	94	50 - 130	94	50 - 130	91	%		
5026061	D8-Acenaphthylene	2017/06/16	90	50 - 130	87	50 - 130	85	%		
5026068	D10-Anthracene	2017/06/14	100	50 - 130	86	50 - 130	95	%		
5026068	D14-Terphenyl (FS)	2017/06/14	97	50 - 130	84	50 - 130	89	%		
5026068	D8-Acenaphthylene	2017/06/14	92	50 - 130	78	50 - 130	82	%		
5026199	o-Terphenyl	2017/06/13	84	60 - 130	85	60 - 130	85	%		
5027788	4-Bromofluorobenzene	2017/06/14	105	60 - 140	107	60 - 140	94	%		
5027788	D10-o-Xylene	2017/06/14	91	60 - 130	107	60 - 130	93	%		
5027788	D4-1,2-Dichloroethane	2017/06/14	96	60 - 140	96	60 - 140	106	%		
5027788	D8-Toluene	2017/06/14	103	60 - 140	110	60 - 140	97	%		
5028300	D10-Anthracene	2017/06/16	101	30 - 130	93	30 - 130	94	%		
5028300	D14-Terphenyl (FS)	2017/06/16	100	30 - 130	92	30 - 130	92	%		
5028300	D8-Acenaphthylene	2017/06/16	102	30 - 130	93	30 - 130	92	%		
5023883	Chromium (VI)	2017/06/14	38 (1)	75 - 125	99	80 - 120	<0.2	ug/g	NC	35
5025037	Moisture	2017/06/13							5.7	20
5025234	Moisture	2017/06/13							1.2	20
5025666	Acid Extractable Aluminum (Al)	2017/06/15	NC	75 - 125	108	80 - 120	<50	ug/g	5.7	30
5025666	Acid Extractable Antimony (Sb)	2017/06/15	90	75 - 125	105	80 - 120	<0.20	ug/g	NC	30
5025666	Acid Extractable Arsenic (As)	2017/06/15	101	75 - 125	100	80 - 120	<1.0	ug/g	NC	30
5025666	Acid Extractable Barium (Ba)	2017/06/15	NC	75 - 125	106	80 - 120	<0.50	ug/g	0.16	30
5025666	Acid Extractable Beryllium (Be)	2017/06/15	92	75 - 125	100	80 - 120	<0.20	ug/g	5.6	30
5025666	Acid Extractable Bismuth (Bi)	2017/06/15	98	75 - 125	105	80 - 120	<1.0	ug/g	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5025666	Acid Extractable Boron (B)	2017/06/15	89	75 - 125	105	80 - 120	<5.0	ug/g	NC	30
5025666	Acid Extractable Cadmium (Cd)	2017/06/15	102	75 - 125	104	80 - 120	<0.10	ug/g	6.0	30
5025666	Acid Extractable Calcium (Ca)	2017/06/15	NC	75 - 125	118	80 - 120	<50	ug/g	3.2	30
5025666	Acid Extractable Chromium (Cr)	2017/06/15	95	75 - 125	100	80 - 120	<1.0	ug/g	9.4	30
5025666	Acid Extractable Cobalt (Co)	2017/06/15	95	75 - 125	103	80 - 120	<0.10	ug/g	10	30
5025666	Acid Extractable Copper (Cu)	2017/06/15	96	75 - 125	104	80 - 120	<0.50	ug/g	3.5	30
5025666	Acid Extractable Iron (Fe)	2017/06/15	NC	75 - 125	102	80 - 120	<50	ug/g	1.7	30
5025666	Acid Extractable Lead (Pb)	2017/06/15	98	75 - 125	105	80 - 120	<1.0	ug/g	4.8	30
5025666	Acid Extractable Magnesium (Mg)	2017/06/15	NC	75 - 125	97	80 - 120	<50	ug/g	4.2	30
5025666	Acid Extractable Manganese (Mn)	2017/06/15	NC	75 - 125	100	80 - 120	<1.0	ug/g	2.7	30
5025666	Acid Extractable Mercury (Hg)	2017/06/15	101	75 - 125	103	80 - 120	<0.050	ug/g	NC	30
5025666	Acid Extractable Molybdenum (Mo)	2017/06/15	99	75 - 125	104	80 - 120	<0.50	ug/g	NC	30
5025666	Acid Extractable Nickel (Ni)	2017/06/15	102	75 - 125	104	80 - 120	<0.50	ug/g	1.1	30
5025666	Acid Extractable Phosphorus (P)	2017/06/15	NC	75 - 125	106	80 - 120	<50	ug/g	2.5	30
5025666	Acid Extractable Potassium (K)	2017/06/15	NC	75 - 125	102	80 - 120	<200	ug/g	4.5	30
5025666	Acid Extractable Selenium (Se)	2017/06/15	101	75 - 125	102	80 - 120	<0.50	ug/g	NC	30
5025666	Acid Extractable Silver (Ag)	2017/06/15	101	75 - 125	105	80 - 120	<0.20	ug/g	NC	30
5025666	Acid Extractable Sodium (Na)	2017/06/15	99	75 - 125	99	80 - 120	<50	ug/g	NC	30
5025666	Acid Extractable Strontium (Sr)	2017/06/15	100	75 - 125	103	80 - 120	<1.0	ug/g	1.4	30
5025666	Acid Extractable Thallium (Tl)	2017/06/15	98	75 - 125	105	80 - 120	<0.050	ug/g	5.8	30
5025666	Acid Extractable Tin (Sn)	2017/06/15	100	75 - 125	105	80 - 120	<1.0	ug/g	18	30
5025666	Acid Extractable Uranium (U)	2017/06/15	102	75 - 125	108	80 - 120	<0.050	ug/g	12	30
5025666	Acid Extractable Vanadium (V)	2017/06/15	NC	75 - 125	100	80 - 120	<5.0	ug/g	0.79	30
5025666	Acid Extractable Zinc (Zn)	2017/06/15	NC	75 - 125	100	80 - 120	<5.0	ug/g	5.4	30
5025878	Aroclor 1242	2017/06/13					<0.010	ug/g	NC	50
5025878	Aroclor 1248	2017/06/13					<0.010	ug/g	NC	50
5025878	Aroclor 1254	2017/06/13					<0.010	ug/g	NC	50
5025878	Aroclor 1260	2017/06/13	78	60 - 130	87	60 - 130	<0.010	ug/g	18	50
5025878	Total PCB	2017/06/13	78	60 - 130	87	60 - 130	<0.010	ug/g	18	50
5025960	F2 (C10-C16 Hydrocarbons)	2017/06/14	106	50 - 130	106	80 - 120	<10	ug/g	NC	30
5025960	F3 (C16-C34 Hydrocarbons)	2017/06/14	104	50 - 130	106	80 - 120	<50	ug/g	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5025960	F4 (C34-C50 Hydrocarbons)	2017/06/14	103	50 - 130	106	80 - 120	<50	ug/g	NC	30
5025980	Benzene	2017/06/14	110	60 - 140	98	60 - 130	<0.0060	ug/g	NC	50
5025980	Ethylbenzene	2017/06/14	107	60 - 140	92	60 - 130	<0.010	ug/g	NC	50
5025980	F1 (C6-C10) - BTEX	2017/06/14					<10	ug/g	NC	30
5025980	F1 (C6-C10)	2017/06/14	92	60 - 140	94	80 - 120	<10	ug/g	NC	30
5025980	o-Xylene	2017/06/14	107	60 - 140	91	60 - 130	<0.020	ug/g	NC	50
5025980	p+m-Xylene	2017/06/14	109	60 - 140	90	60 - 130	<0.020	ug/g	NC	50
5025980	Toluene	2017/06/14	101	60 - 140	96	60 - 130	<0.020	ug/g	NC	50
5025980	Total Xylenes	2017/06/14					<0.020	ug/g	NC	50
5026005	Aroclor 1016	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1221	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1232	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1242	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1248	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1254	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1260	2017/06/14	65	30 - 130	100	30 - 130	<0.1	ug/g	10	50
5026005	Aroclor 1262	2017/06/14					<0.1	ug/g		
5026005	Aroclor 1268	2017/06/14					<0.1	ug/g		
5026005	Total PCB	2017/06/14	65	30 - 130	100	30 - 130	<0.1	ug/g	10	50
5026031	Aroclor 1242	2017/06/14					<0.010	ug/g	NC	50
5026031	Aroclor 1248	2017/06/14					<0.010	ug/g	NC	50
5026031	Aroclor 1254	2017/06/14					<0.010	ug/g	NC	50
5026031	Aroclor 1260	2017/06/14	91	60 - 130	104	60 - 130	<0.010	ug/g	NC	50
5026031	Total PCB	2017/06/14	91	60 - 130	104	60 - 130	<0.010	ug/g	NC	50
5026061	1-Methylnaphthalene	2017/06/19	105	50 - 130	105	50 - 130	<0.0050	ug/g	NC	40
5026061	2-Methylnaphthalene	2017/06/19	88	50 - 130	97	50 - 130	<0.0050	ug/g	NC	40
5026061	Acenaphthene	2017/06/19	92	50 - 130	95	50 - 130	<0.0050	ug/g	NC	40
5026061	Acenaphthylene	2017/06/19	93	50 - 130	93	50 - 130	<0.0050	ug/g	26	40
5026061	Anthracene	2017/06/19	82	50 - 130	81	50 - 130	<0.0050	ug/g	NC	40
5026061	Benzo(a)anthracene	2017/06/19	99	50 - 130	98	50 - 130	<0.0050	ug/g	NC	40
5026061	Benzo(a)pyrene	2017/06/19	99	50 - 130	100	50 - 130	<0.0050	ug/g	NC	40

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5026061	Benzo(b,j)fluoranthene	2017/06/19	102	50 - 130	105	50 - 130	<0.0050	ug/g	NC	40
5026061	Benzo(g,h,i)perylene	2017/06/19	101	50 - 130	105	50 - 130	<0.0050	ug/g	NC	40
5026061	Benzo(k)fluoranthene	2017/06/19	100	50 - 130	103	50 - 130	<0.0050	ug/g	NC	40
5026061	Chrysene	2017/06/19	100	50 - 130	99	50 - 130	<0.0050	ug/g	NC	40
5026061	Dibenz(a,h)anthracene	2017/06/19	100	50 - 130	103	50 - 130	<0.0050	ug/g	NC	40
5026061	Fluoranthene	2017/06/19	109	50 - 130	103	50 - 130	<0.0050	ug/g	NC	40
5026061	Fluorene	2017/06/19	94	50 - 130	96	50 - 130	<0.0050	ug/g	NC	40
5026061	Indeno(1,2,3-cd)pyrene	2017/06/19	103	50 - 130	104	50 - 130	<0.0050	ug/g	NC	40
5026061	Naphthalene	2017/06/19	84	50 - 130	90	50 - 130	<0.0050	ug/g	NC	40
5026061	Phenanthrene	2017/06/19	105	50 - 130	99	50 - 130	<0.0050	ug/g	NC	40
5026061	Pyrene	2017/06/19	112	50 - 130	104	50 - 130	<0.0050	ug/g	NC	40
5026068	1-Methylnaphthalene	2017/06/14	88	50 - 130	83	50 - 130	<0.0050	ug/g	NC	40
5026068	2-Methylnaphthalene	2017/06/14	82	50 - 130	78	50 - 130	<0.0050	ug/g	NC	40
5026068	Acenaphthene	2017/06/14	95	50 - 130	87	50 - 130	<0.0050	ug/g	NC	40
5026068	Acenaphthylene	2017/06/14	92	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40
5026068	Anthracene	2017/06/14	82	50 - 130	73	50 - 130	<0.0050	ug/g	NC	40
5026068	Benzo(a)anthracene	2017/06/14	96	50 - 130	86	50 - 130	<0.0050	ug/g	NC	40
5026068	Benzo(a)pyrene	2017/06/14	98	50 - 130	90	50 - 130	<0.0050	ug/g	NC	40
5026068	Benzo(b,j)fluoranthene	2017/06/14	103	50 - 130	94	50 - 130	<0.0050	ug/g	NC	40
5026068	Benzo(g,h,i)perylene	2017/06/14	98	50 - 130	94	50 - 130	<0.0050	ug/g	NC	40
5026068	Benzo(k)fluoranthene	2017/06/14	99	50 - 130	93	50 - 130	<0.0050	ug/g	NC	40
5026068	Chrysene	2017/06/14	97	50 - 130	87	50 - 130	<0.0050	ug/g	NC	40
5026068	Dibenz(a,h)anthracene	2017/06/14	103	50 - 130	97	50 - 130	<0.0050	ug/g	NC	40
5026068	Fluoranthene	2017/06/14	103	50 - 130	92	50 - 130	<0.0050	ug/g	NC	40
5026068	Fluorene	2017/06/14	97	50 - 130	87	50 - 130	<0.0050	ug/g	NC	40
5026068	Indeno(1,2,3-cd)pyrene	2017/06/14	99	50 - 130	94	50 - 130	<0.0050	ug/g	NC	40
5026068	Naphthalene	2017/06/14	81	50 - 130	80	50 - 130	<0.0050	ug/g	6.1	40
5026068	Phenanthrene	2017/06/14	98	50 - 130	88	50 - 130	<0.0050	ug/g	NC	40
5026068	Pyrene	2017/06/14	104	50 - 130	94	50 - 130	<0.0050	ug/g	NC	40
5026199	F2 (C10-C16 Hydrocarbons)	2017/06/14	96	50 - 130	96	80 - 120	<10	ug/g	NC	30
5026199	F3 (C16-C34 Hydrocarbons)	2017/06/14	94	50 - 130	94	80 - 120	<50	ug/g	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5026199	F4 (C34-C50 Hydrocarbons)	2017/06/14	96	50 - 130	96	80 - 120	<50	ug/g	NC	30
5027788	Benzene	2017/06/14	100	60 - 140	99	60 - 130	<0.0060	ug/g	NC	50
5027788	Ethylbenzene	2017/06/14	100	60 - 140	103	60 - 130	<0.010	ug/g	NC	50
5027788	F1 (C6-C10) - BTEX	2017/06/14					<10	ug/g	NC	30
5027788	F1 (C6-C10)	2017/06/14	86	60 - 140	90	80 - 120	<10	ug/g	NC	30
5027788	o-Xylene	2017/06/14	101	60 - 140	111	60 - 130	<0.020	ug/g	NC	50
5027788	p+m-Xylene	2017/06/14	105	60 - 140	108	60 - 130	<0.020	ug/g	NC	50
5027788	Toluene	2017/06/14	96	60 - 140	103	60 - 130	<0.020	ug/g	NC	50
5027788	Total Xylenes	2017/06/14					<0.020	ug/g	NC	50
5028300	1-Methylnaphthalene	2017/06/16	121	50 - 130	118	50 - 130	<0.005	ug/g	NC	50
5028300	2-Methylnaphthalene	2017/06/16	110	50 - 130	109	50 - 130	<0.005	ug/g	NC	50
5028300	Acenaphthene	2017/06/16	103	50 - 130	96	50 - 130	<0.005	ug/g	NC	50
5028300	Acenaphthylene	2017/06/16	104	50 - 130	97	50 - 130	<0.005	ug/g	NC	50
5028300	Anthracene	2017/06/16	100	50 - 130	94	50 - 130	<0.005	ug/g	NC	50
5028300	Benzo(a)anthracene	2017/06/16	102	50 - 130	95	50 - 130	<0.005	ug/g	NC	50
5028300	Benzo(a)pyrene	2017/06/16	104	50 - 130	93	50 - 130	<0.005	ug/g	NC	50
5028300	Benzo(b,j)fluoranthene	2017/06/16	97	50 - 130	87	50 - 130	<0.005	ug/g	NC	50
5028300	Benzo(g,h,i)perylene	2017/06/16	98	50 - 130	90	50 - 130	<0.005	ug/g	NC	50
5028300	Benzo(k)fluoranthene	2017/06/16	98	50 - 130	82	50 - 130	<0.005	ug/g	NC	50
5028300	Chrysene	2017/06/16	100	50 - 130	97	50 - 130	<0.005	ug/g	NC	50
5028300	Dibenz(a,h)anthracene	2017/06/16	100	50 - 130	91	50 - 130	<0.005	ug/g	NC	50
5028300	Fluoranthene	2017/06/16	104	50 - 130	98	50 - 130	<0.005	ug/g	NC	50
5028300	Fluorene	2017/06/16	98	50 - 130	91	50 - 130	<0.005	ug/g	NC	50
5028300	Indeno(1,2,3-cd)pyrene	2017/06/16	100	50 - 130	92	50 - 130	<0.005	ug/g	NC	50
5028300	Naphthalene	2017/06/16	100	50 - 130	93	50 - 130	<0.005	ug/g	NC	50
5028300	Phenanthrene	2017/06/16	101	50 - 130	95	50 - 130	<0.005	ug/g	NC	50
5028300	Pyrene	2017/06/16	106	50 - 130	97	50 - 130	<0.005	ug/g	NC	50

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5029337	F4G-sg (Grav. Heavy Hydrocarbons)	2017/06/15	99	65 - 135	103	65 - 135	<100	ug/g	NC	50

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) The matrix spike recovery was below the lower control limit. This may be due in part to the reducing environment of the sample. The matrix spike was reanalyzed to confirm result.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Brad Newman, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Page 1 of 3

PROJECT INFORMATION:
 B70916
 1666131
 J.L. ENV-592

Company Name: Golder Associates Ltd
 Attention: Central Accounting
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x
 Fax: (613) 592-9601 x
 Email: AP-CustomerService@golder.com

Company Name: Tony Lyon
 Attention: Tony Lyon
 Address: 1666131
 Project: 1666131
 Project Name: J.L. ENV-592
 Site #: J.L. ENV-592
 Sampled By: T. Lyon

REPORT TO:
 Quotation #: B70916
 P.O. #: 1666131
 Project: 1666131
 Project Name: J.L. ENV-592
 Site #: J.L. ENV-592
 Sampled By: T. Lyon

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Table 1 Res/Park Medium/Fine dCME
 Table 2 Ind/Comm Coarse Reg 558
 Table 3 Agri/Other For RSC MISA
 Table PWOO Other

Other Regulations
 Sanitary Sewer Bylaw
 Storm Sewer Bylaw
 Municipality

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle)			Metals (including Cr VI and Hg)	Date: (YY/MM/DD)	Time	# Bts used and not submitted	Time Sensitive	Laboratory Use Only		Custody Seal Intact	Yes	No	
					Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons	O Reg 153 PAHs (Soil)						O Reg 153 PCBs (Soil)	Temperature (°C) on Receipt				Yes
SA-313	SA-313	June 17 12:00	12:00	S	✓	✓	✓	✓	17/06/08	13:30			25.22/21.13/4				44	
SA-312	SA-312				✓	✓	✓	✓	17/06/08	22:30								
SA-202	SA-202				✓	✓	✓	✓	17/06/08									
SA-215	SA-215				✓	✓	✓	✓	17/06/08									
DUP-312	DUP-312				✓	✓	✓	✓	17/06/08									
SA-281	SA-281				✓	✓	✓	✓	17/06/08									
SA-154	SA-154				✓	✓	✓	✓	17/06/08									
J-1	J-1	June 17 12:00	12:00		✓	✓	✓	✓	17/06/08									
J-1-B	J-1-B				✓	✓	✓	✓	17/06/08									
J-2	J-2				✓	✓	✓	✓	17/06/08									

RECEIVED IN OTTAWA

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)
 Regular (Standard) TAT:
 (will be applied if Rush TAT is not specified)
 Standard TAT = 5-7 Working days for most tests.
 Please note: Standard TAT for certain tests such as BOD and Chlorella/Furnas are > 5 days - contact your Project Manager for details.
 Job Specific Rush TAT (if applies to entire submission)
 Rush Confirmation Number: _____ Time Required: _____
 (call lab for #) _____
 # of Bottles: _____ Comments: _____

RECEIVED BY: (Signature/Print) Alex Wood
 Date: 17/06/08
 Time: 1:20p
 RECEIVED BY: (Signature/Print) Alison Cameron
 Date: 17/06/08
 Time: 22:30

UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.
 IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.
 ** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/MP-CONTENT/UPLOAD/LOADS/ONTARIO-COC.PDF.

White: Maxxa
 Yellow: Client

17/13/15
 15/11/12
 12/14/11

Maxxam Analytics International Corporation
 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8
 Tel: (905) 617-5700 Toll-free 800-563-6266 Fax: (905) 617-5777 www.maxxam.ca

CHAIN OF CUSTODY RECORD

Page 2 of 3

Maxxam Analytics International Corporation of Maxxam Analytics
 6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 617-5700 Toll-free: 800-565-6286 Fax: (905) 617-5777 www.maxxam.ca

INVOICE TO: Maxxam Analytics International Corporation of Maxxam Analytics
 #14090 Golder Associates Ltd
 Central Accounting
 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x AP-CustomerService@golder.com Fax: (613) 592-9601 x

REPORT TO: Maxxam Analytics International Corporation of Maxxam Analytics
 Tony Lyon
 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 x AP-CustomerService@golder.com Fax: (613) 592-9601 x

PROJECT INFORMATION: B70916
 Quotation #: 1666131
 P.O. #: 1666131
 Project Name: 30cyle
 Site #: 30cyle
 Sampled By: 30cyle

Laboratory Use Only: Maxxam Job #: 61485
 Project Manager: Alison Cameron
 COC #: C614485-03-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Table 1 Res/Park Medium/Fine CCME Sanitary Sewer Bylaw
 Table 2 Ind/Comm Coarse Reg 558 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWOO Other

Other Regulations
 CCME Sanitary Sewer Bylaw
 Reg 558 Storm Sewer Bylaw
 MISA Municipality
 PWOO Other

Turnaround Time (TAT) Required: Regular (Standard) TAT: (Will be applied if Rush TAT is not specified; Standard TAT = 5-7 Working days for most tests. Please note - Standard TAT for certain tests such as BOD and Dissolved Phosphorus are > 5 days - contact your Project Manager for details.)
 Job Specific Rush TAT (if applicant to entire submission)
 Rush Confirmation Number: _____ Time Required: _____
 (call job for #) _____
 Comments: _____

# of Batches	Field Filtered (Please circle): Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons (Soil) F-Ty-B-Ty	O Reg 153 PAHs (Soil)	O Reg 153 PCBs (Soil)	Metals (including Cr VI and Hg)	Date: (YYMMDD)	Time	# Batches used and not submitted	Time Sensitive	Laboratory Use Only	
										Temperature (°C) on Receipt	Custody Seal Present
1						2017/09/08	13:30			22.22	Intact
2											
3											
4											
5											
6											
7											
8											
9											
10											

RECEIVED BY: (Signature/Print) *Maxxam Cameron* Date: 2017/09/08 Time: 13:30

RECEIVED BY: (Signature/Print) *Alison Cameron* Date: 2017/09/08 Time: 13:30

White: Maxxam Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

17/13/15 15/11/12
 12/14/11

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** IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.COM/CONTENT/UPLOADS/ONTARIO-COC.PDF.

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CHAIN OF CUSTODY RECORD

Page 2 of 3

Maxxam Analytica International Corporation o/a Maxxam Analytics
 6740 Camrobbelle Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

INVOICE TO:
 Company Name: #14090 Golder Associates Ltd
 Attention: Central Accounting
 Address: 1931 Robertson Rd
 Ottawa ON K2H 5B7
 Tel: (613) 592-9600 X
 Fax: (613) 592-9601 X
 Email: AP-CustomerServices@golder.com

REPORT TO:
 Company Name: Tony Lyon
 Attention: Tony Lyon
 Address: Alex Wood
 Tel: Alex Wood
 Email: Tony_lyon@golder.com; tlyon@golder.com

PROJECT INFORMATION:
 Quotation #: B70916
 P.O. #: 1666131
 Project:
 Site #:
 Project Name:
 Sampled By:

Laboratory Use Only:
 Maxxam Job #:
 Bottle Order #: 614495
 Project Manager: Alison Cameron
 COC #: CNE14495-02-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
 Table 1 ResPark Medium/Fine OCHE Sanitary Sewer Bylaw
 Table 2 Ind/Comm Course Reg 558 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWOOD Other

Other Regulations
 Table 1 ResPark Medium/Fine OCHE Sanitary Sewer Bylaw
 Table 2 Ind/Comm Course Reg 558 Storm Sewer Bylaw
 Table 3 Agri/Other For RSC MISA Municipality
 Table PWOOD Other

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Metals / Hg / Cr VI
 O Reg 153 Petroleum Hydrocarbons
 O Reg 153 PCBs (Soil)
 O Reg 153 PAHs (Soil)
 Metals (including Cr VI and Hg)

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle)	Metals / Hg / Cr VI	O Reg 153 Petroleum Hydrocarbons	O Reg 153 PCBs (Soil)	O Reg 153 PAHs (Soil)	Metals (including Cr VI and Hg)	# Jars used and not submitted	Time Sensitive	Temperature (°C) on Receipt	Custody Seal Present	Yes	No
1	S-12	Jun 7/11	12:00	S							5		13.30	Intact		
2	S-13										5		20/08/08	Intact		
3	DUP-J-11										5		20/08/08	Intact		
4	SA-192-A										4		20/08/08	Intact		
5																
6																
7																
8																
9																
10																

RECEIVED BY: (Signature/Print) Alex Wood
Date: (YY/MM/DD) 17/06/08
Time 1:30p
RECEIVED BY: (Signature/Print) Maxxam
Date: (YY/MM/DD) 20/08/08
Time 2:30

LABORATORY USE ONLY
 Laboratory Use Only
 Temperature (°C) on Receipt: 13.30
 Custody Seal Present: Intact

White: Maxxa Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

17/12/15 15/11/12
 12/14/14

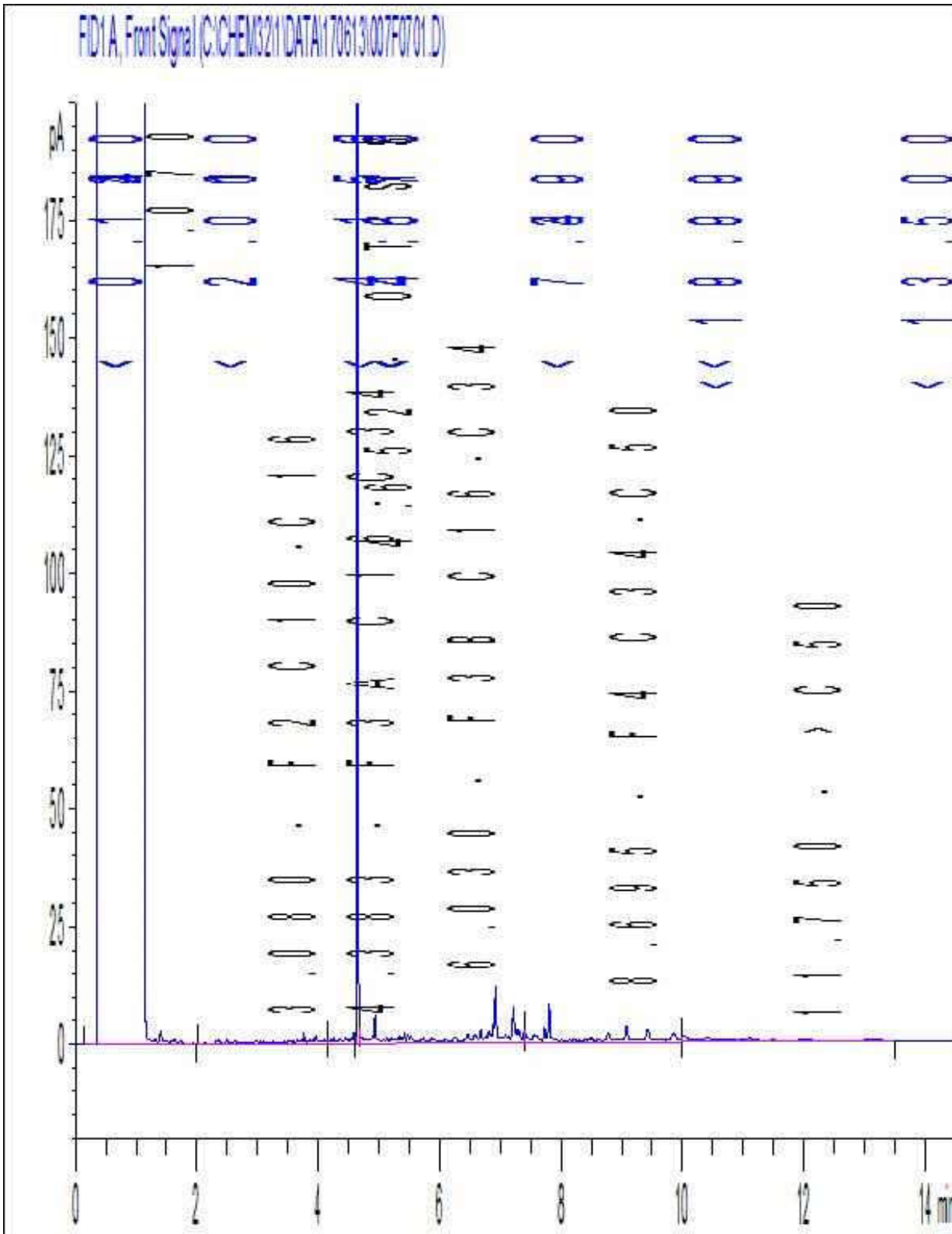
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** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CAMP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

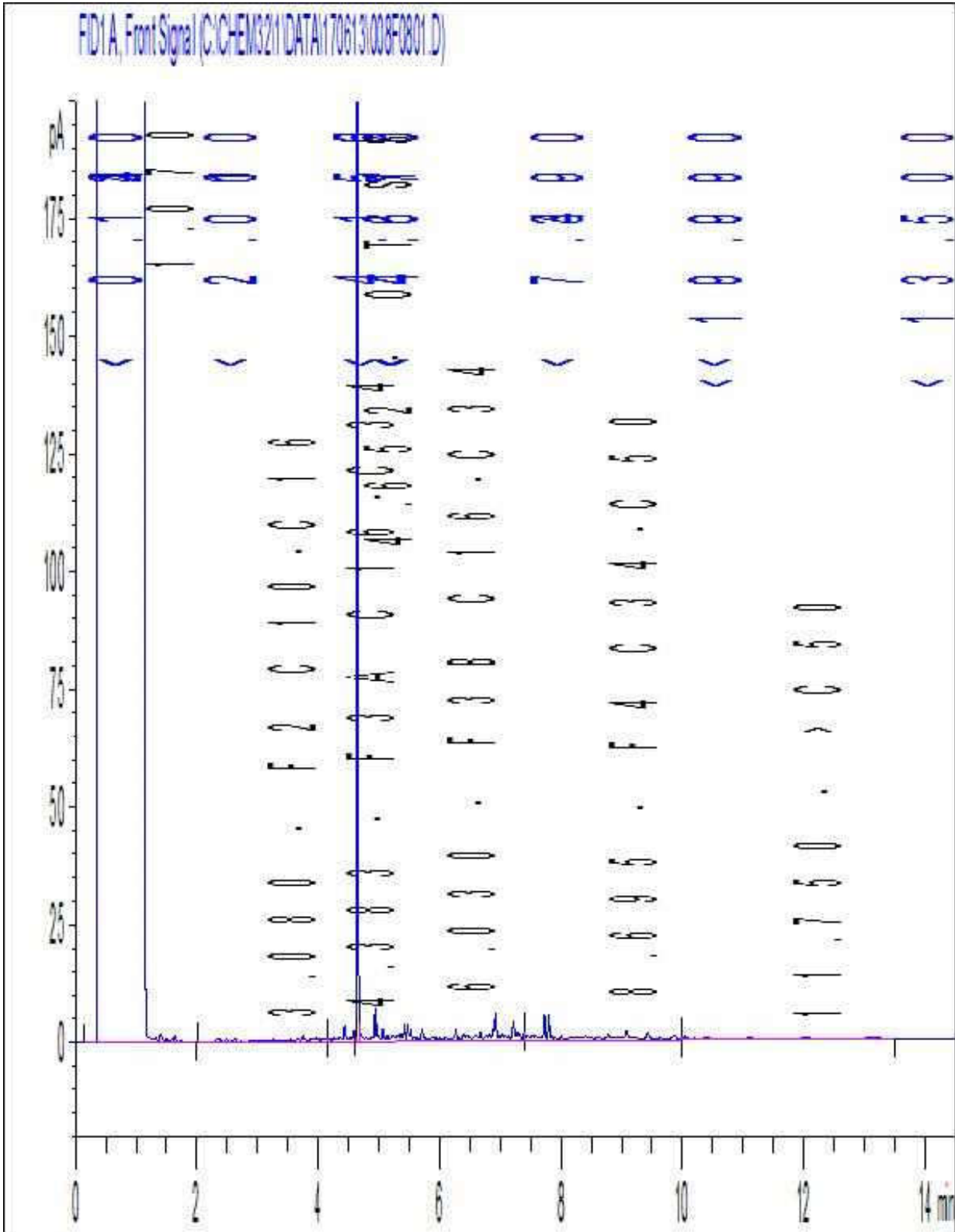
Maxxam Analytica International Corporation o/a Maxxam Analytics

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



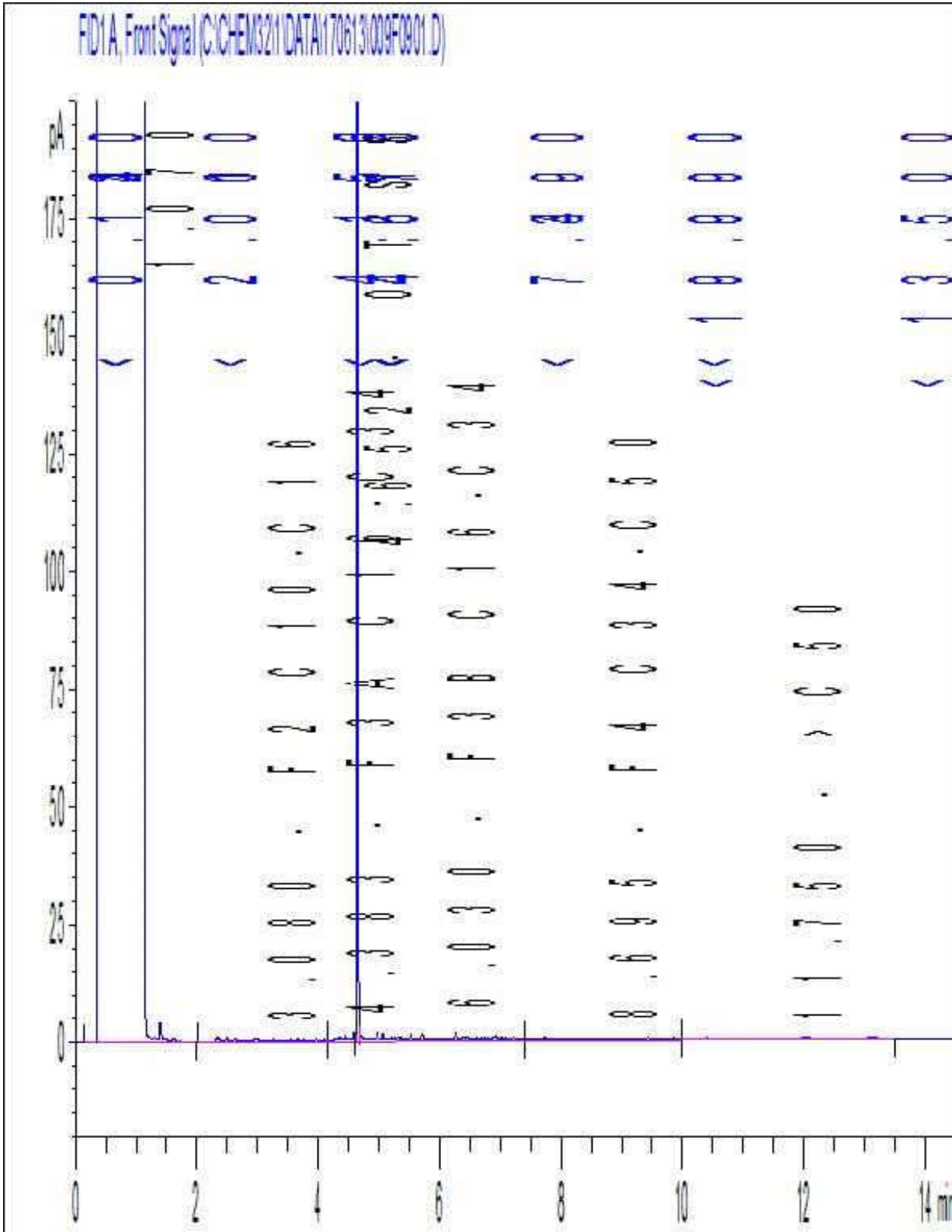
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



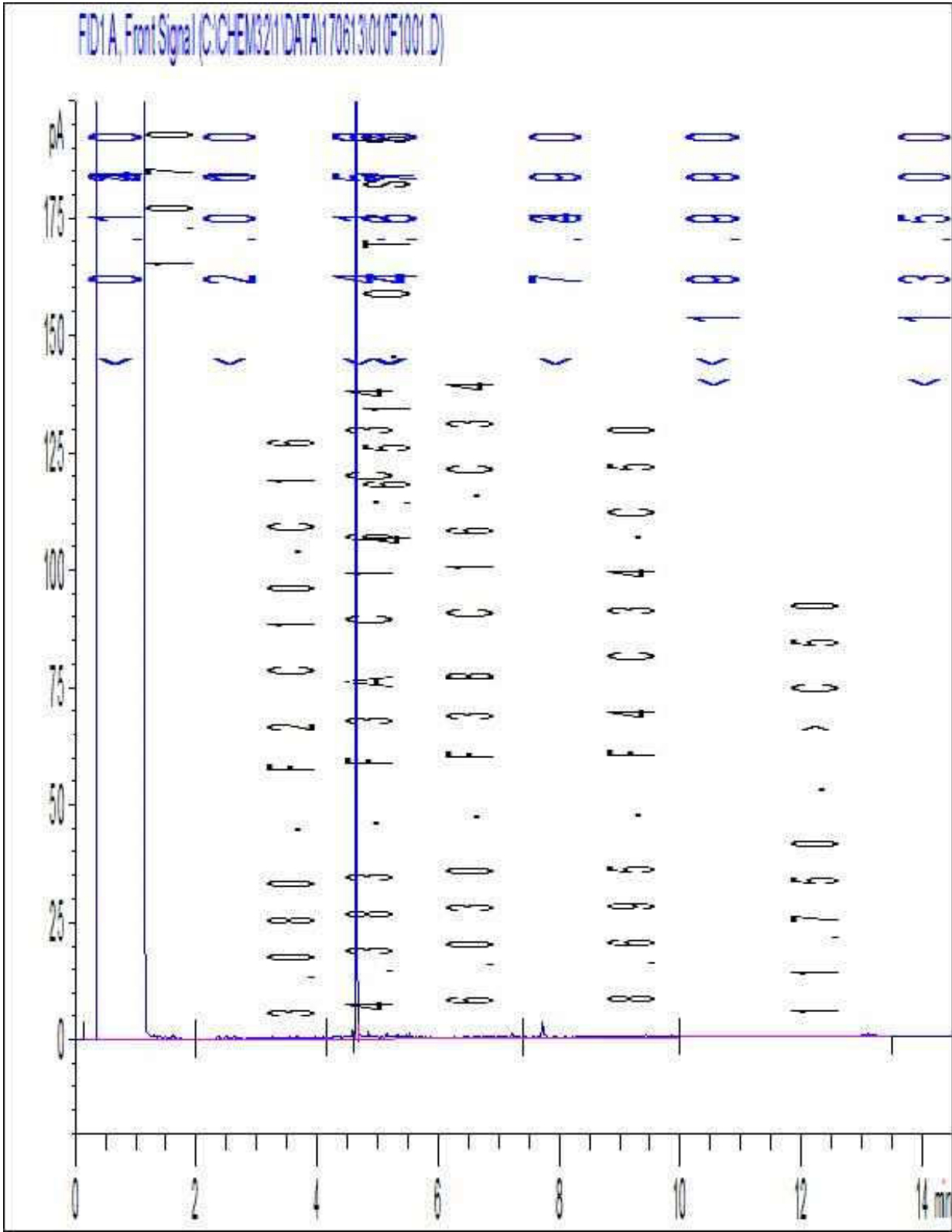
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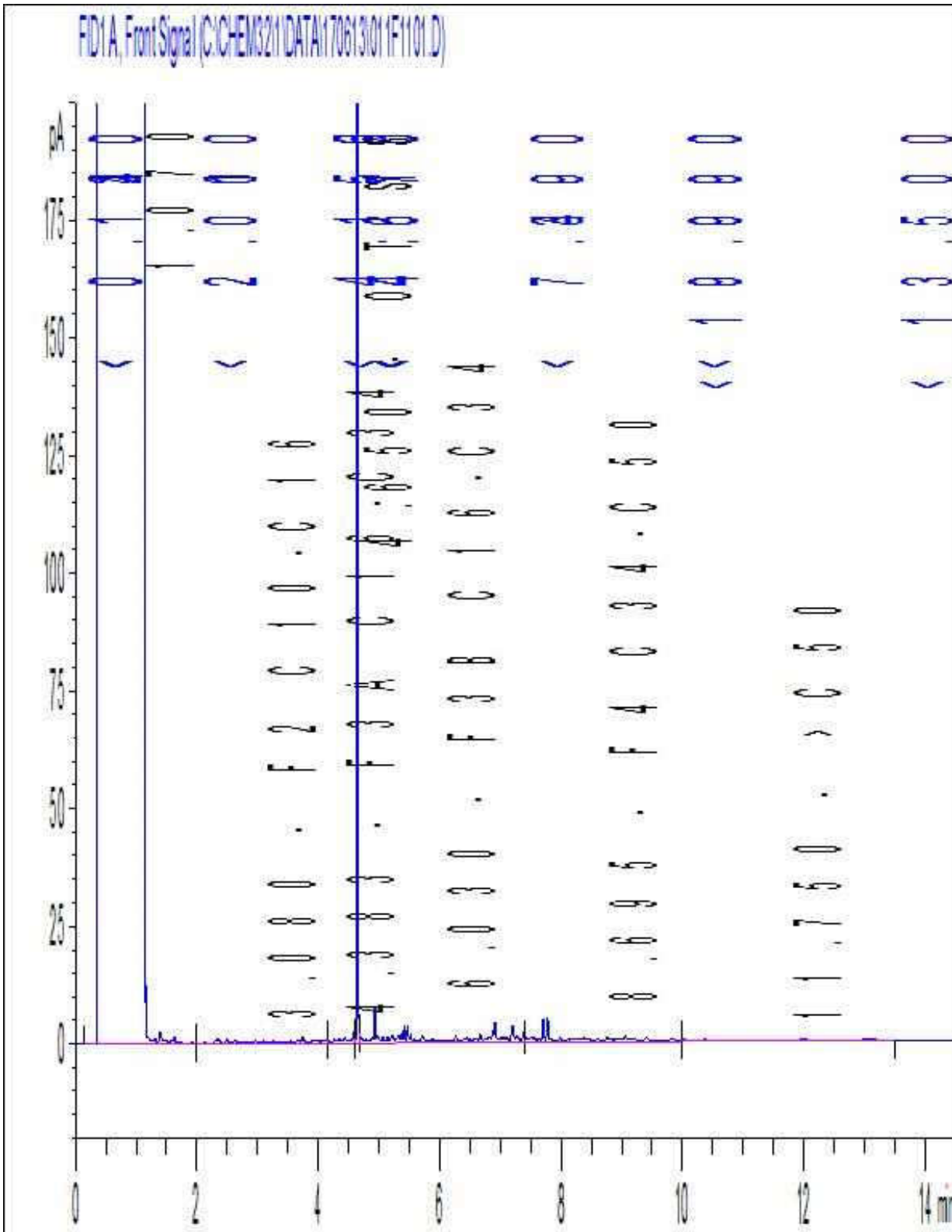
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Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



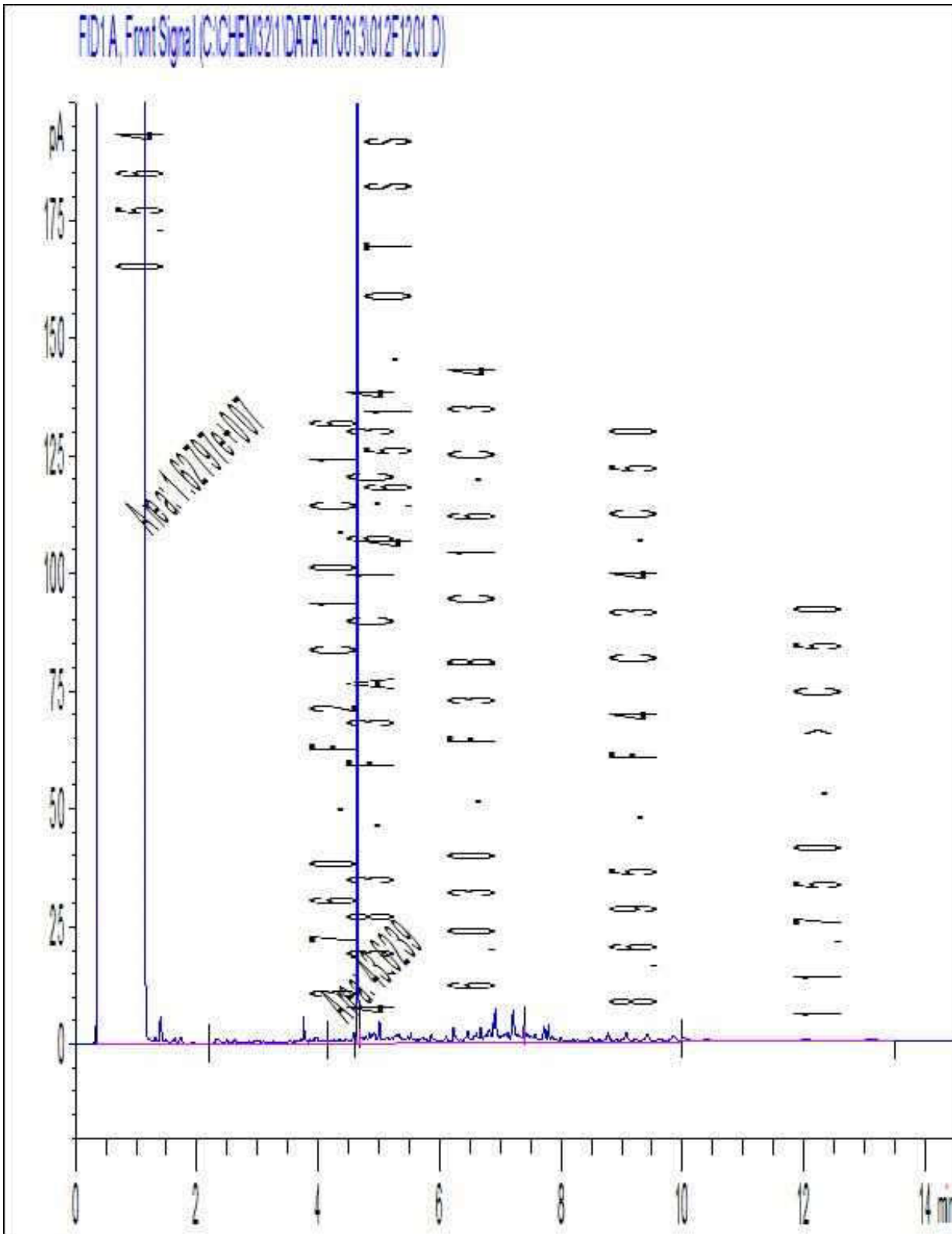
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Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



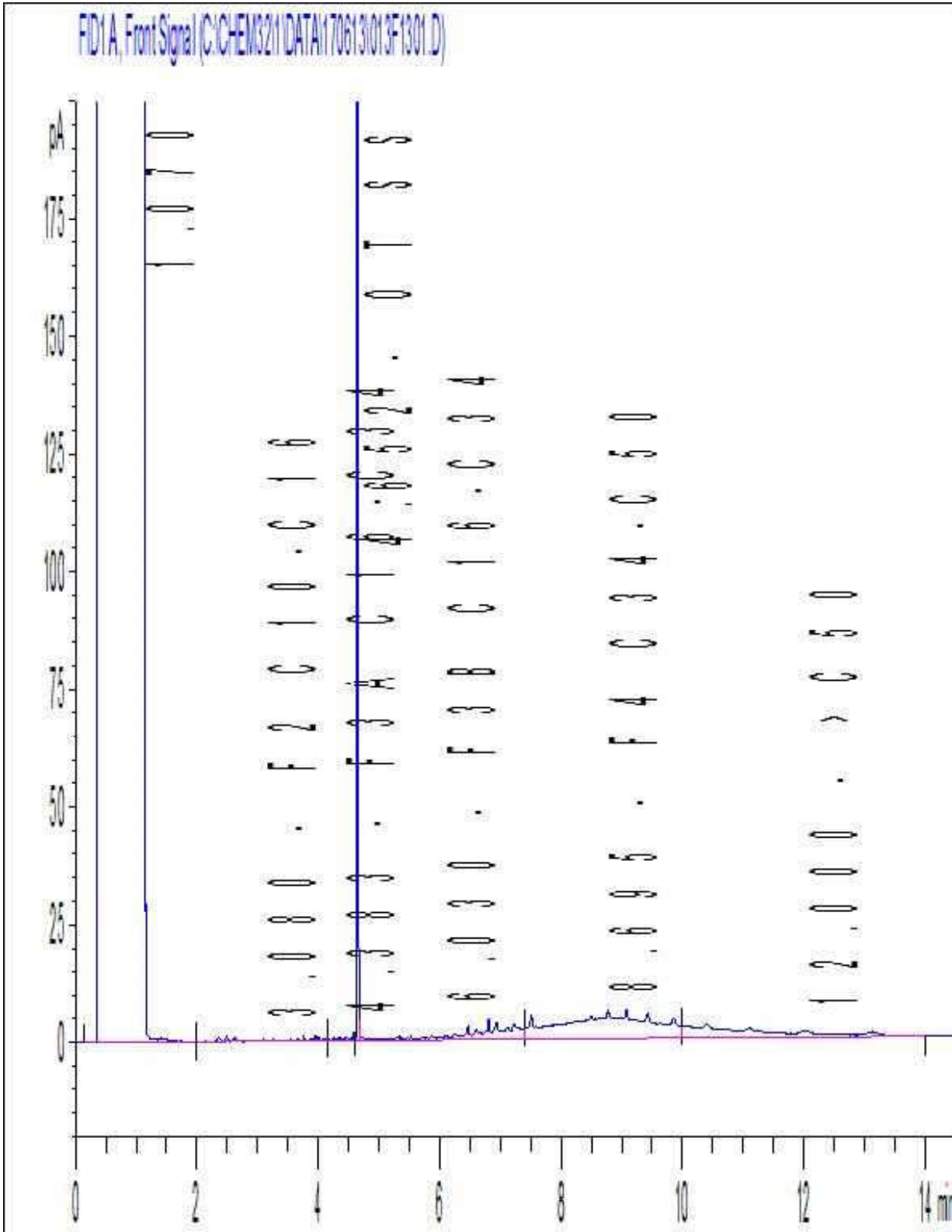
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Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



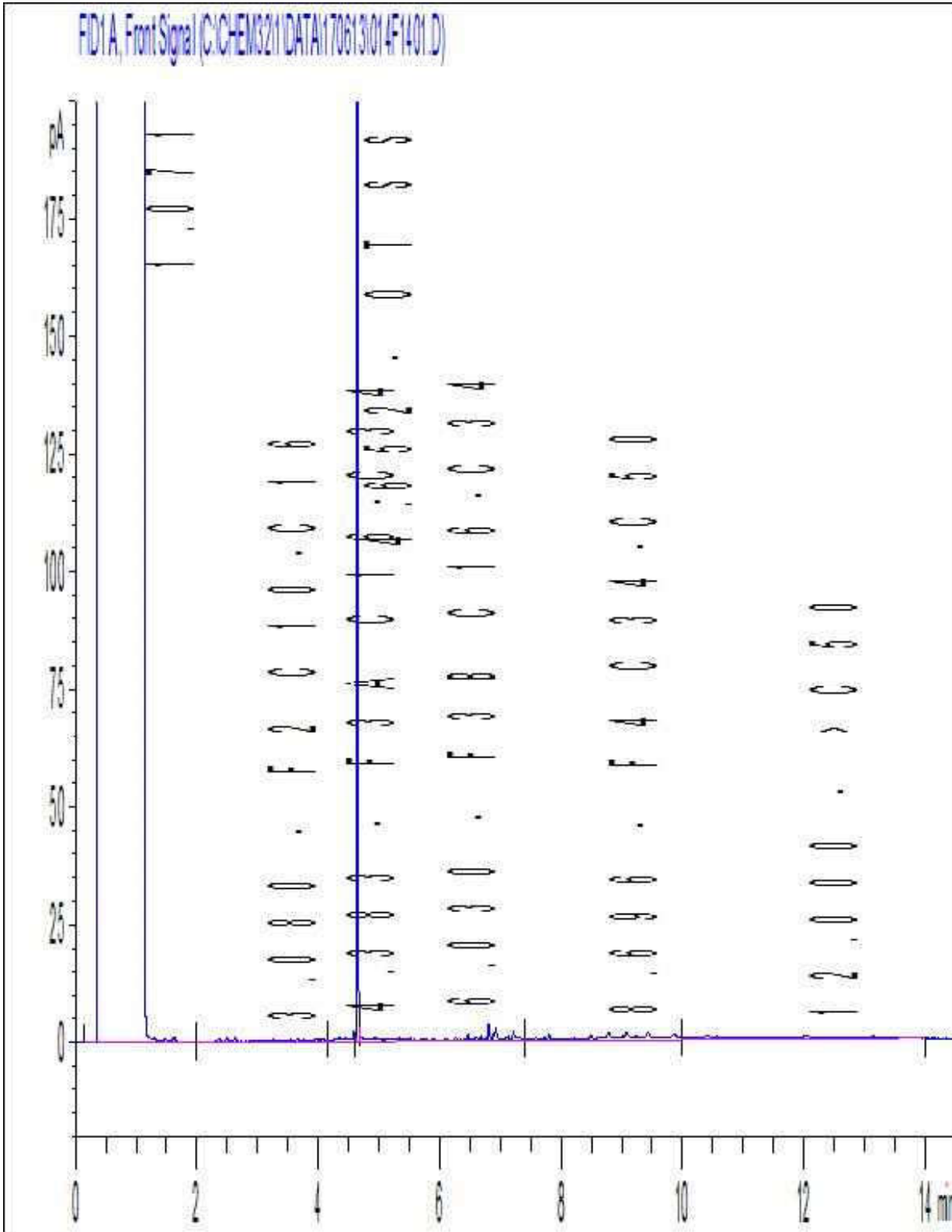
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Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



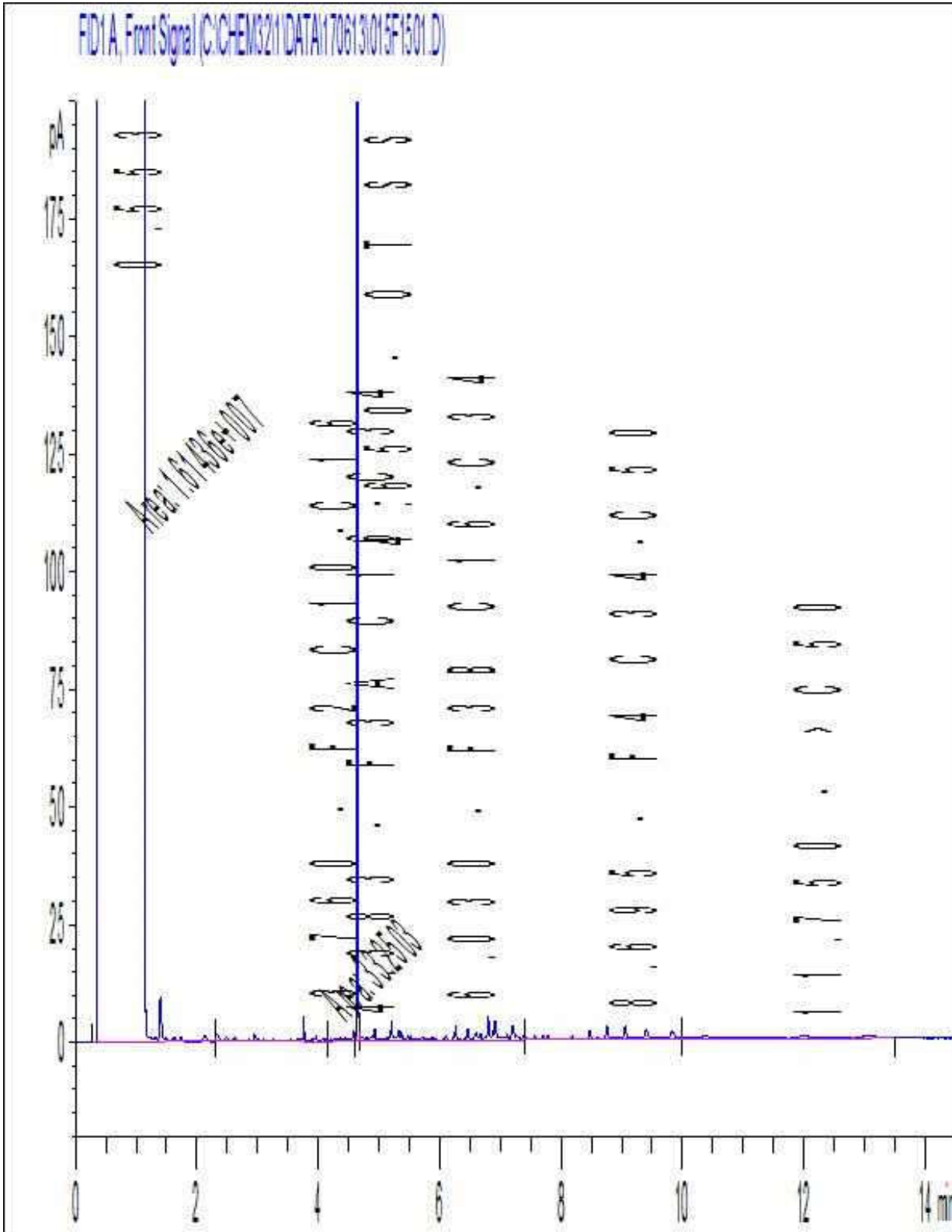
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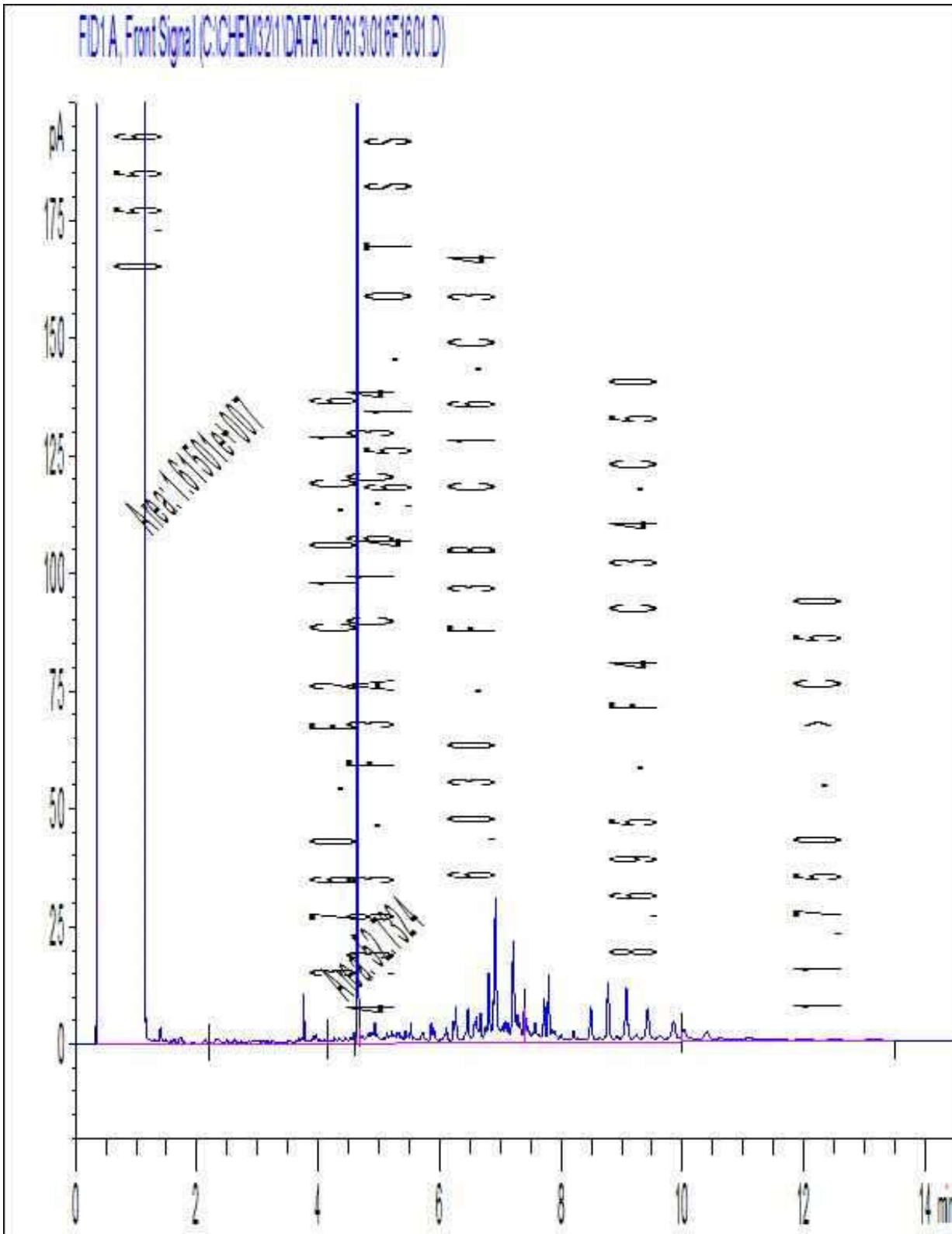
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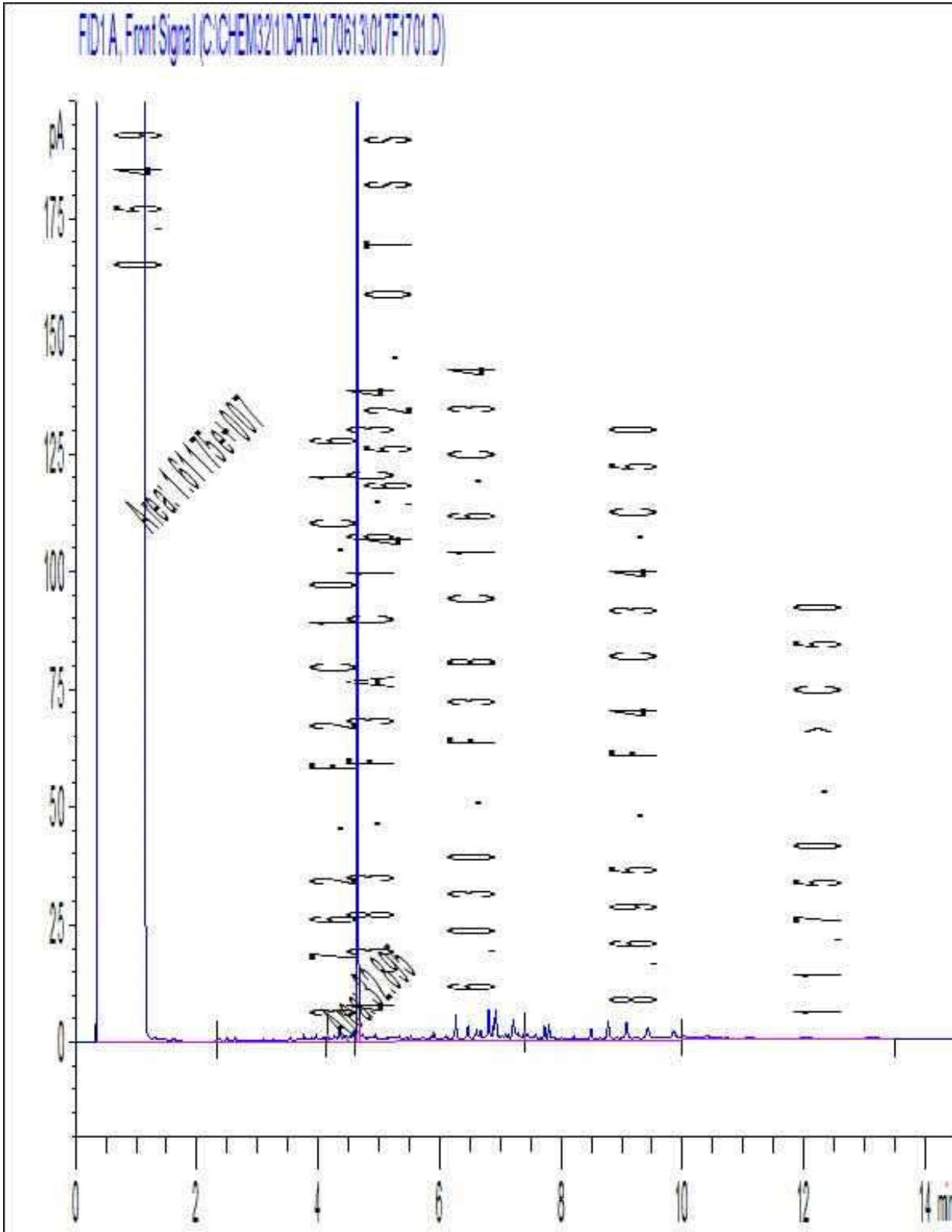
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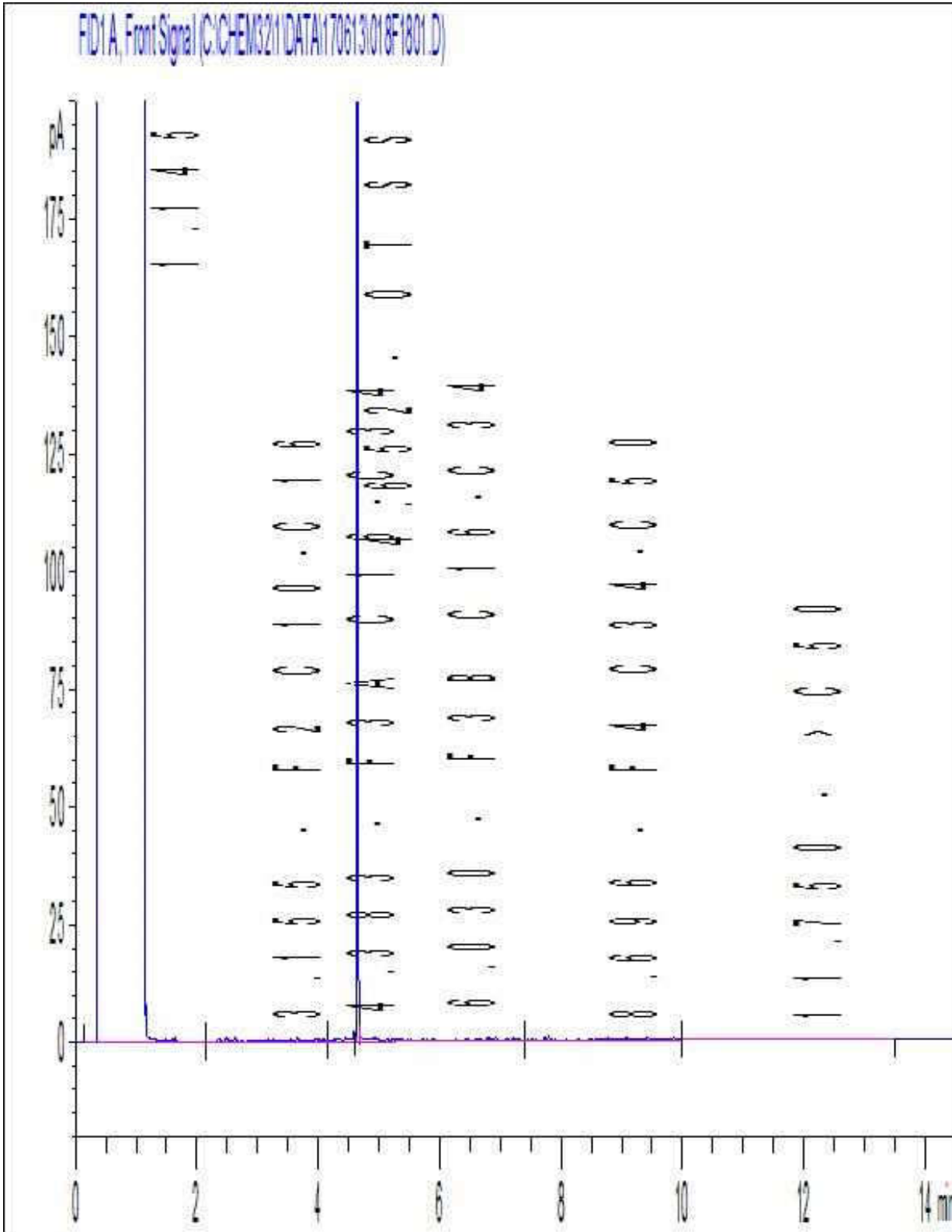
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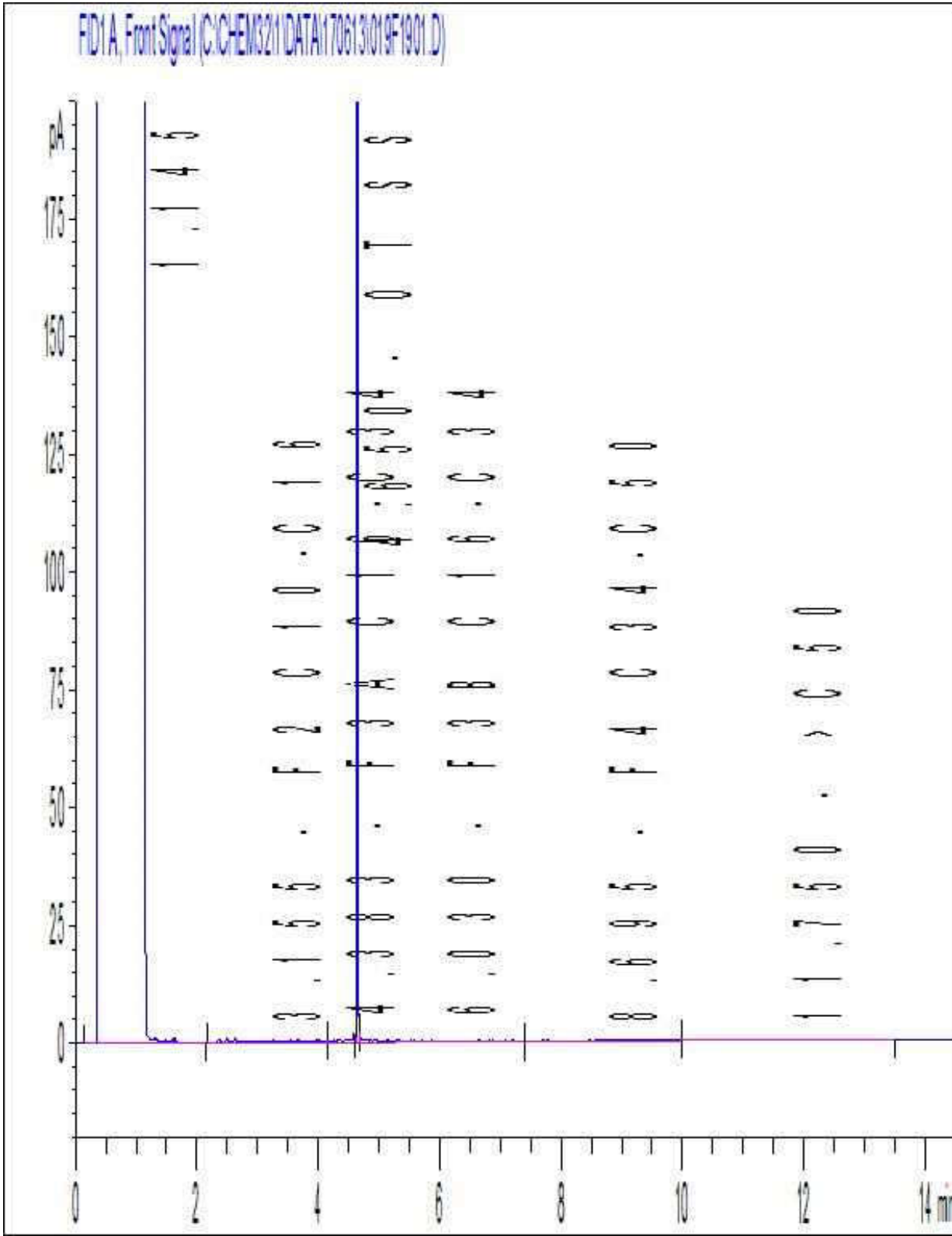
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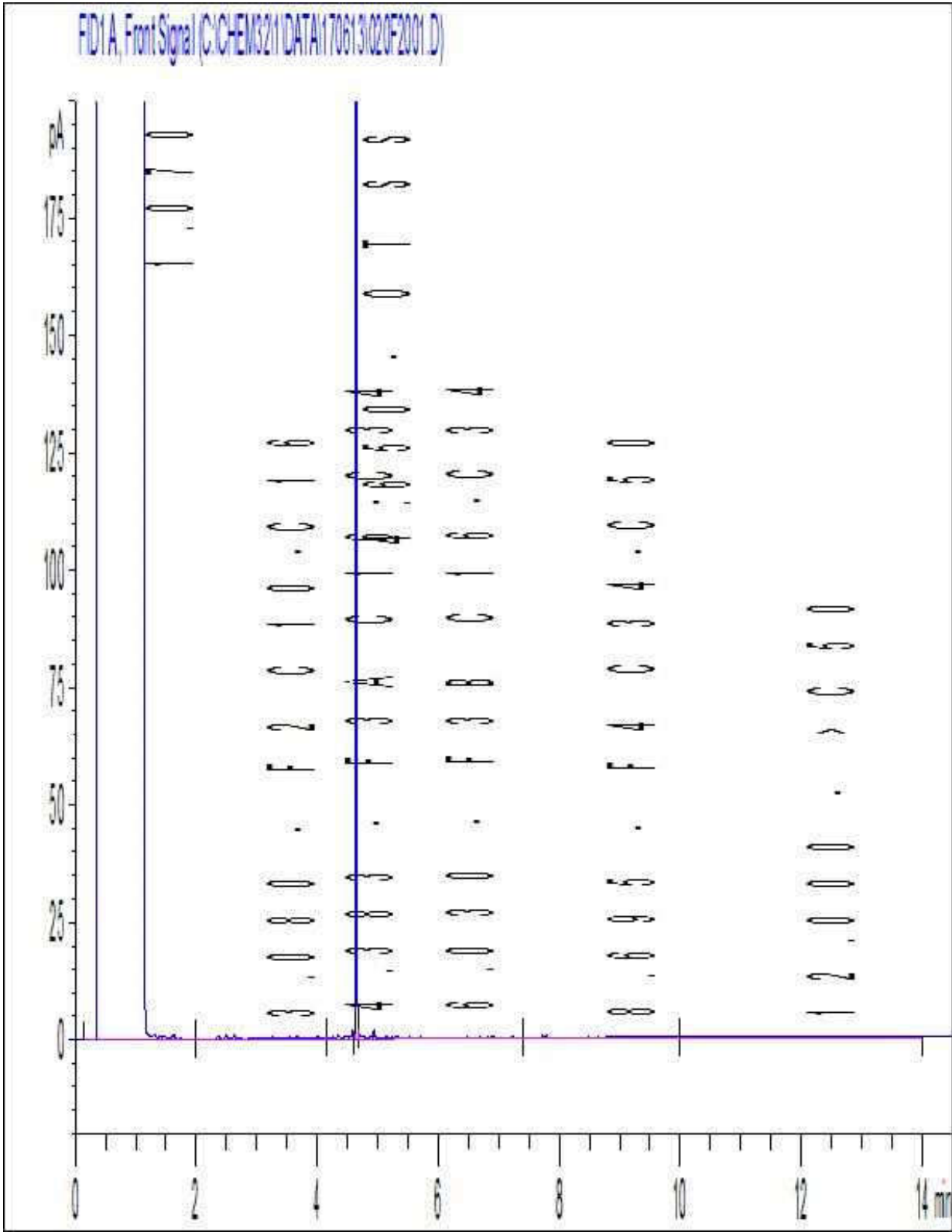
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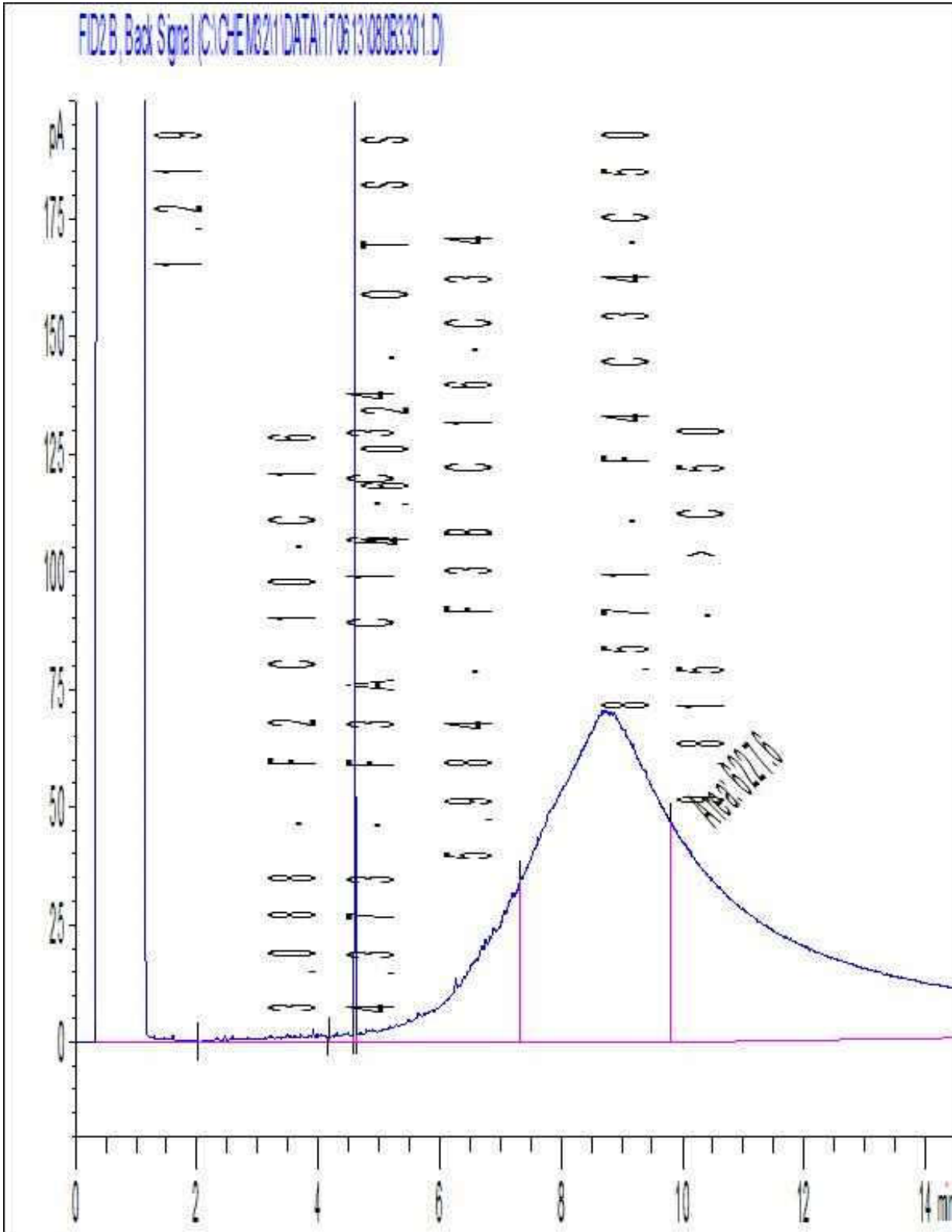
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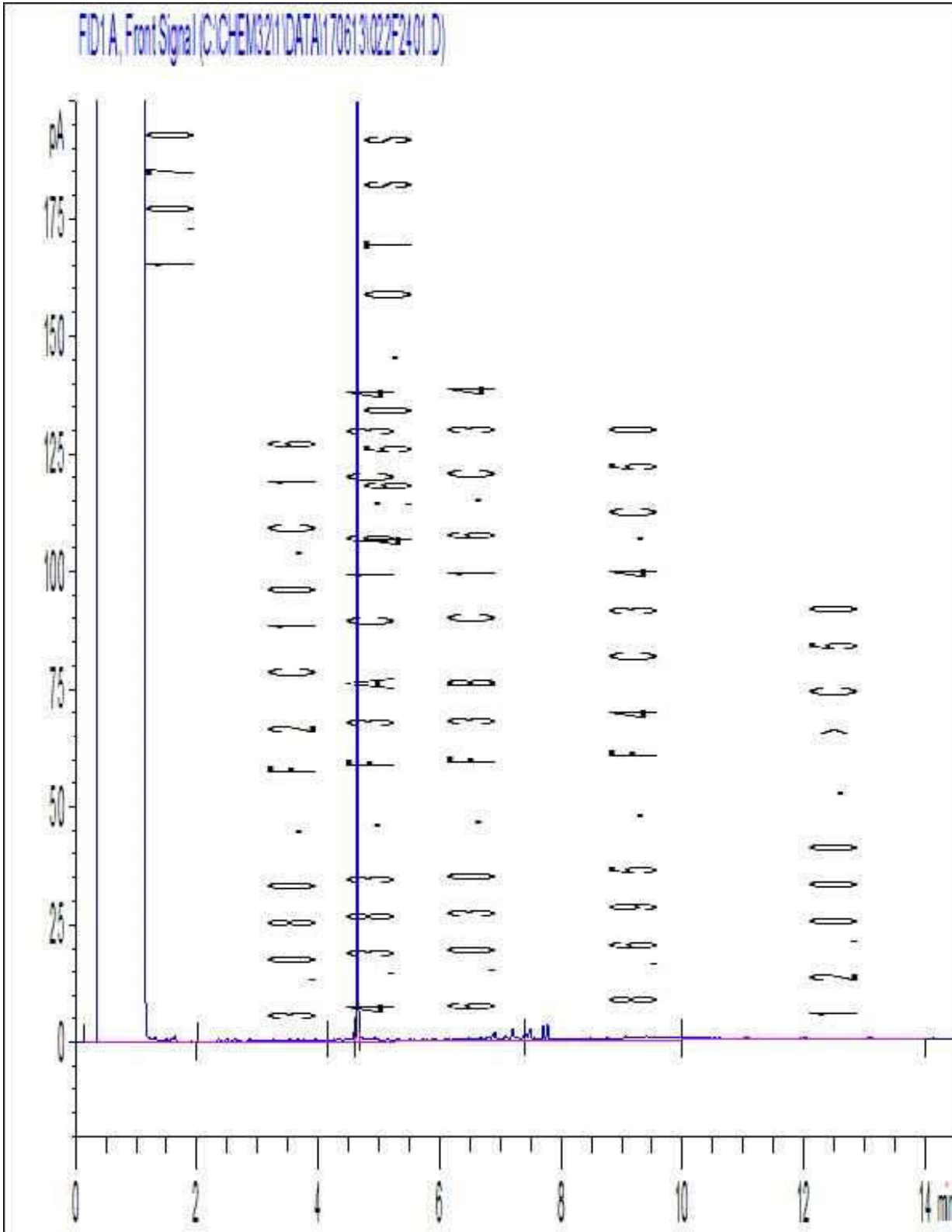
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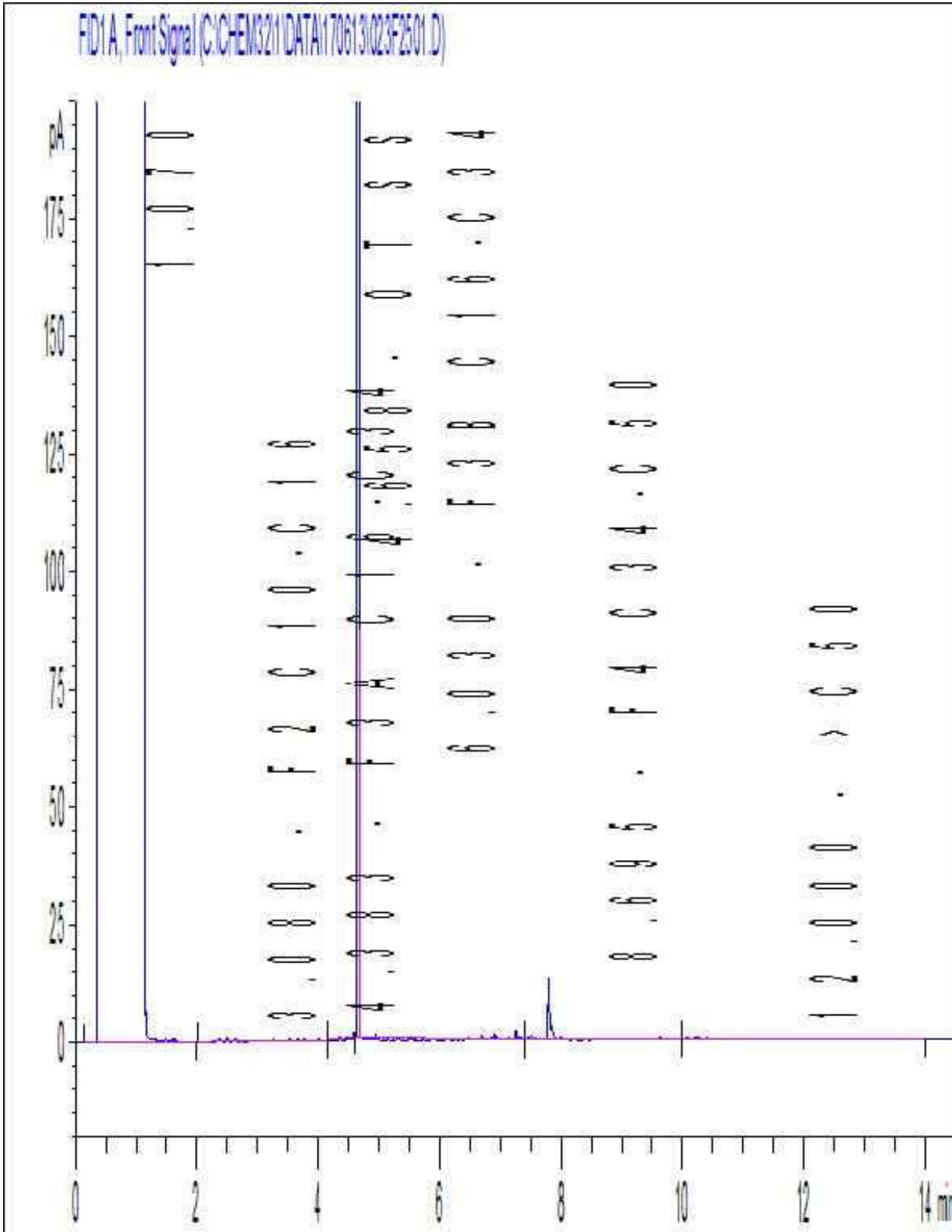
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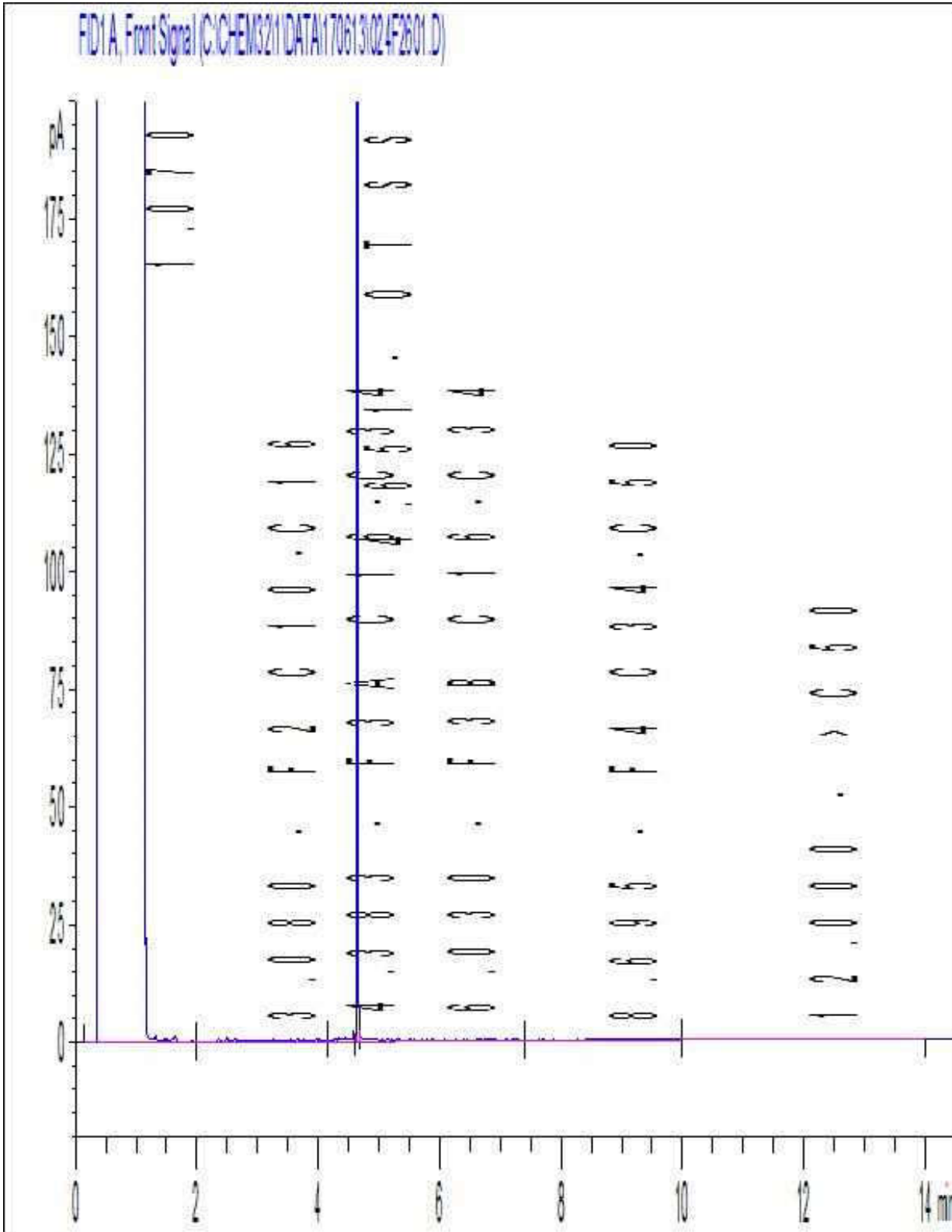
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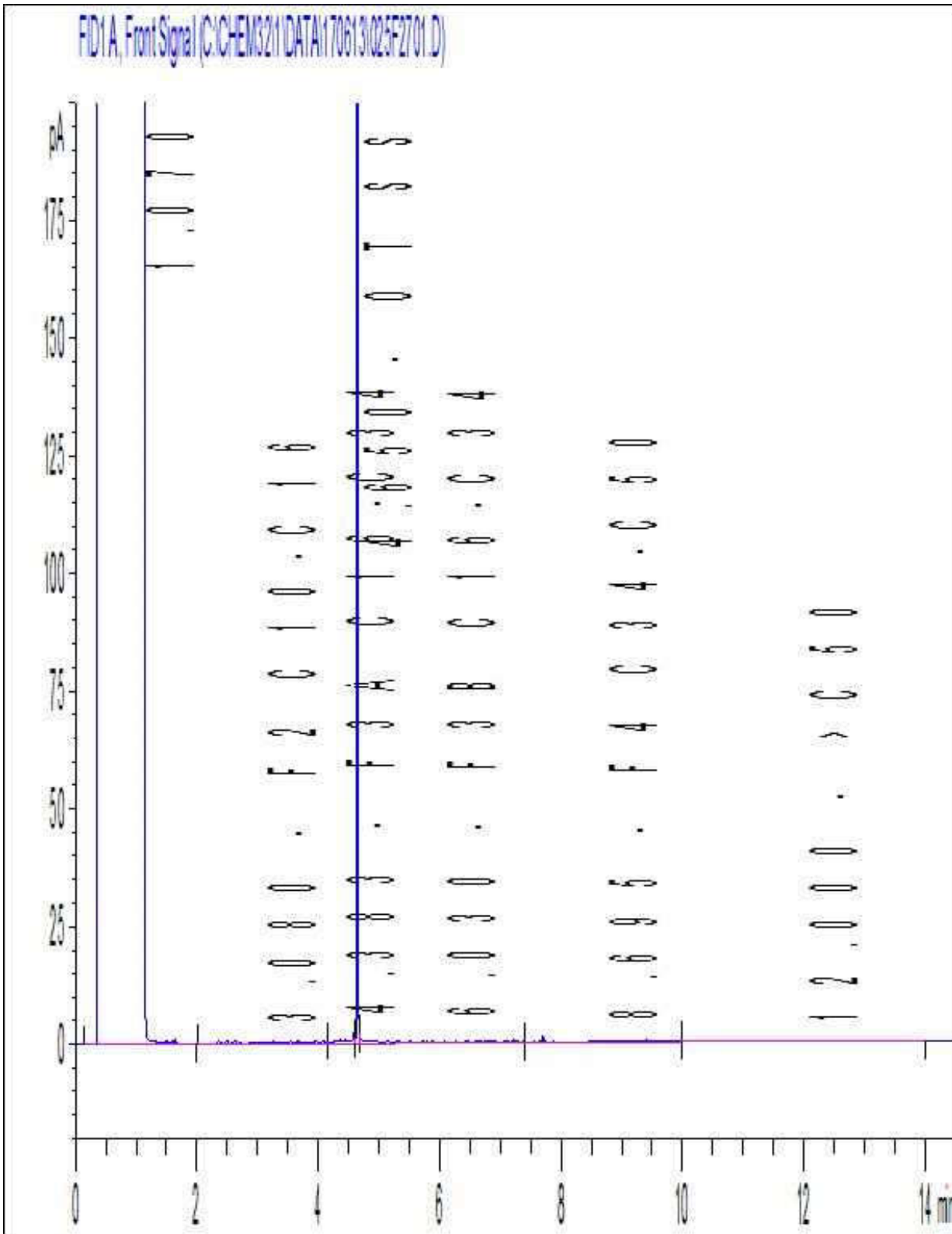
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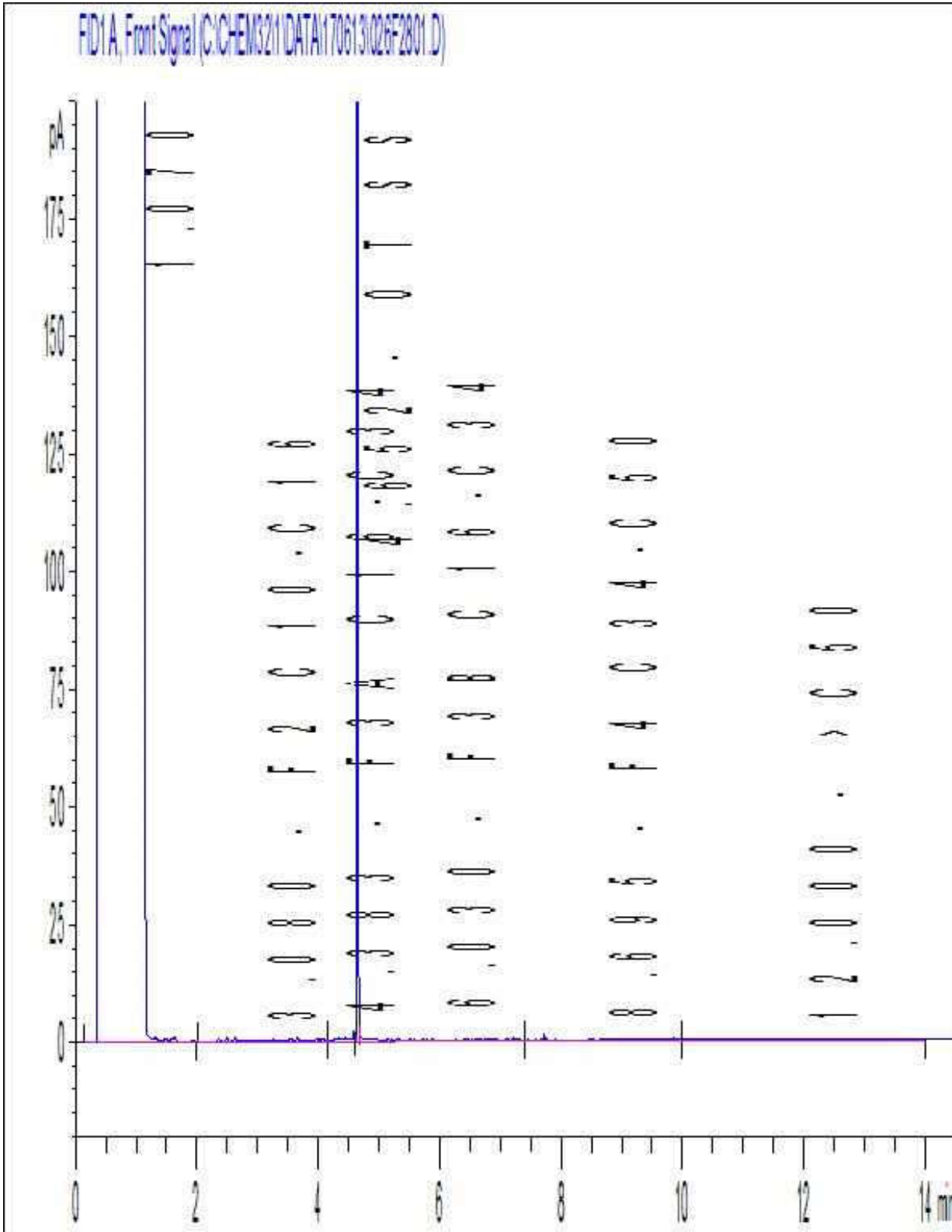
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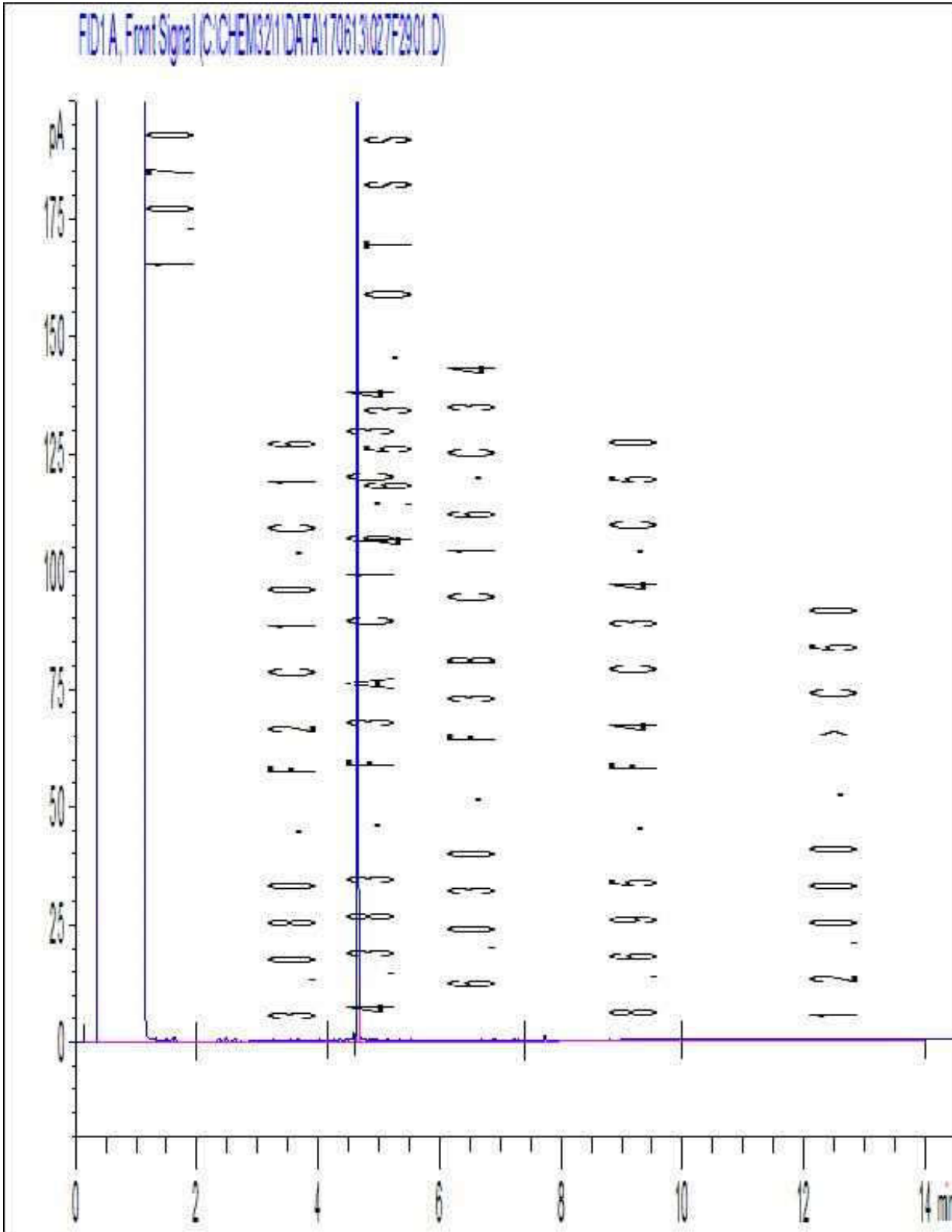
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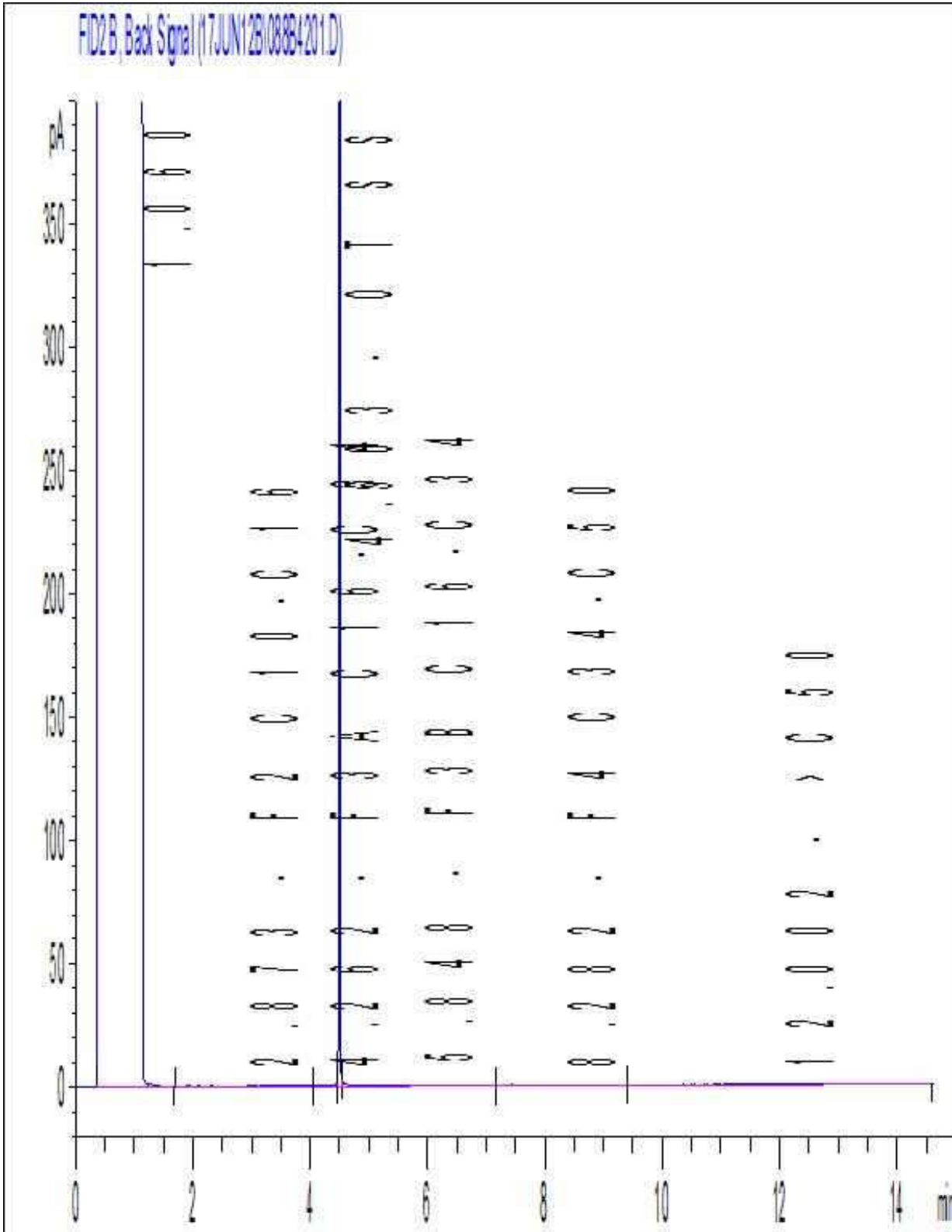
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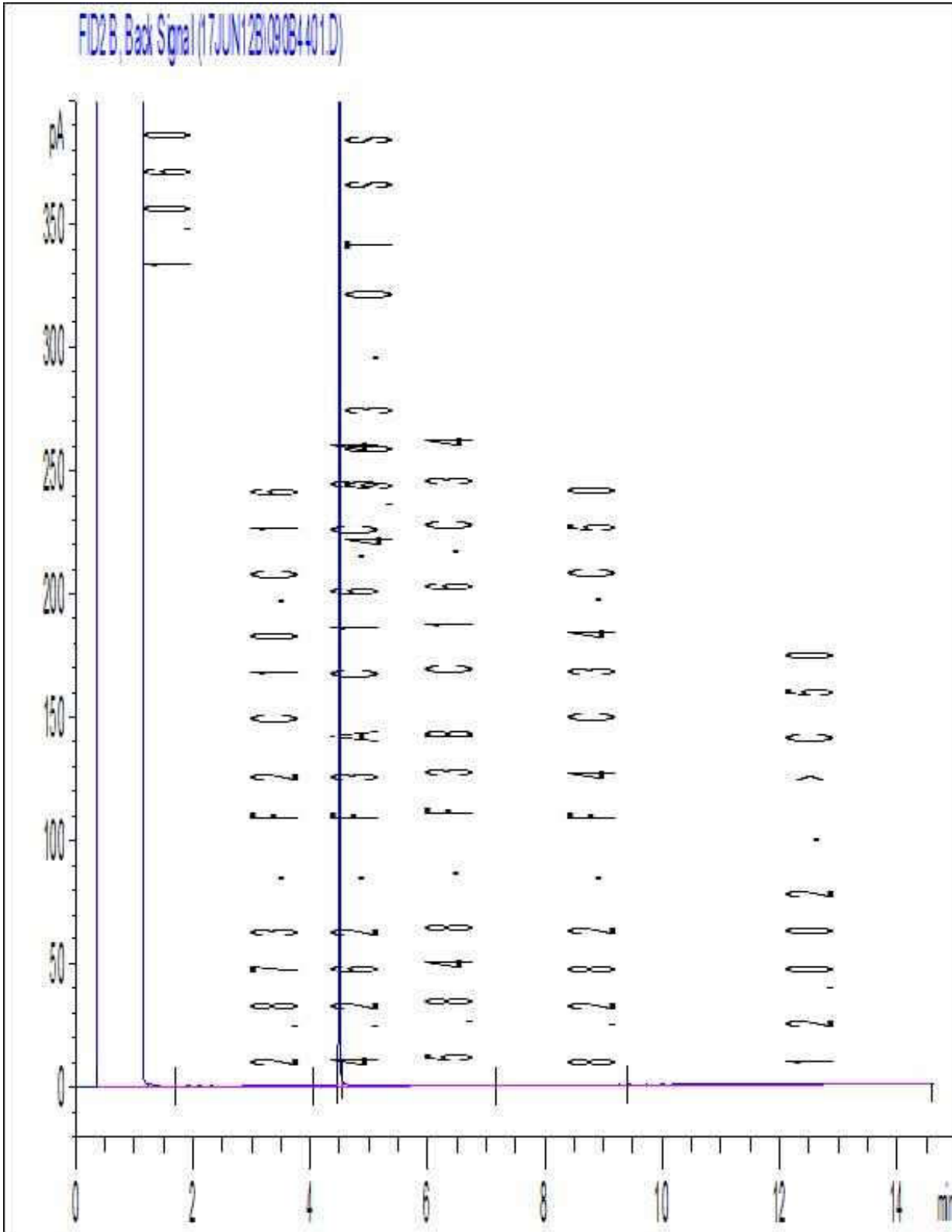
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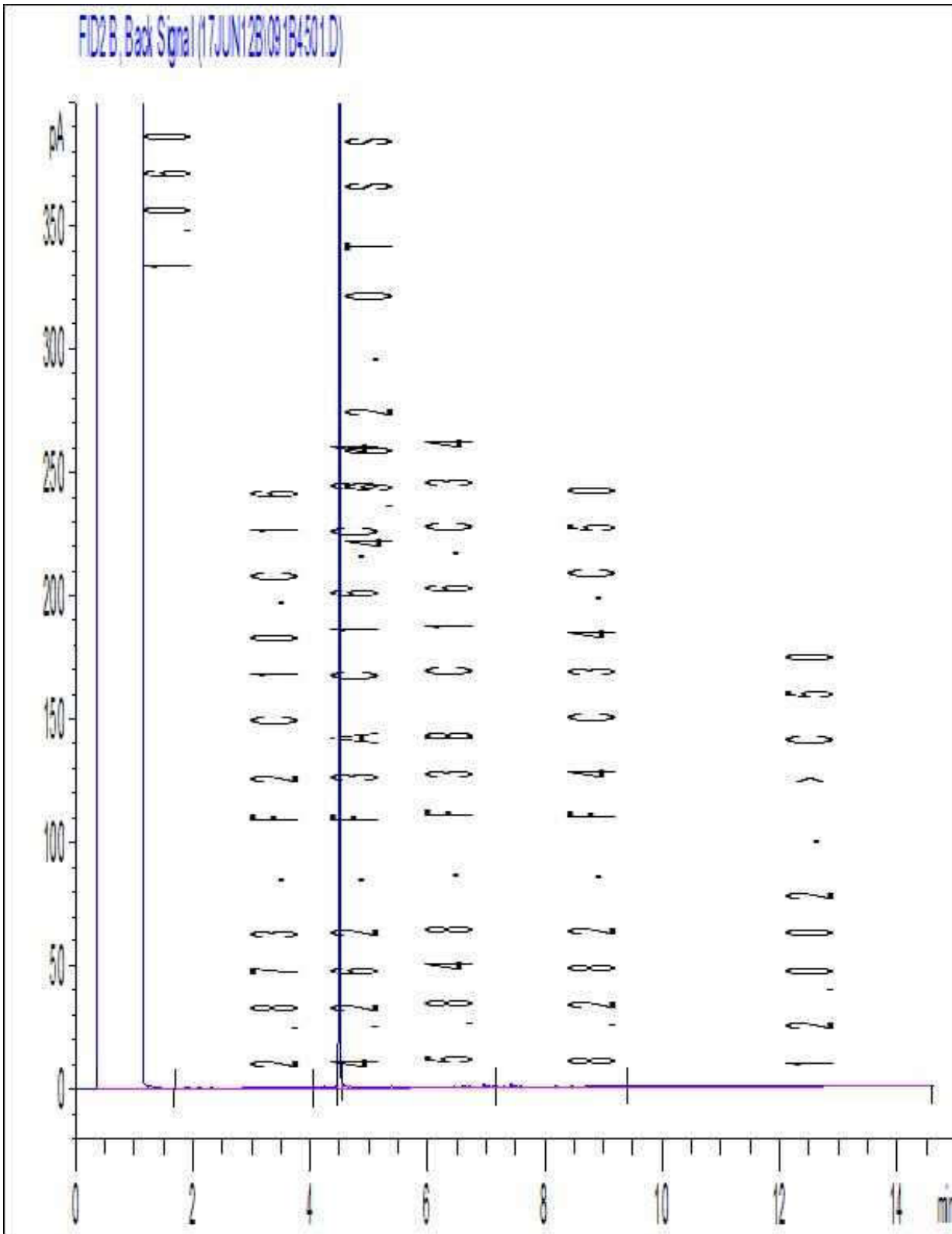
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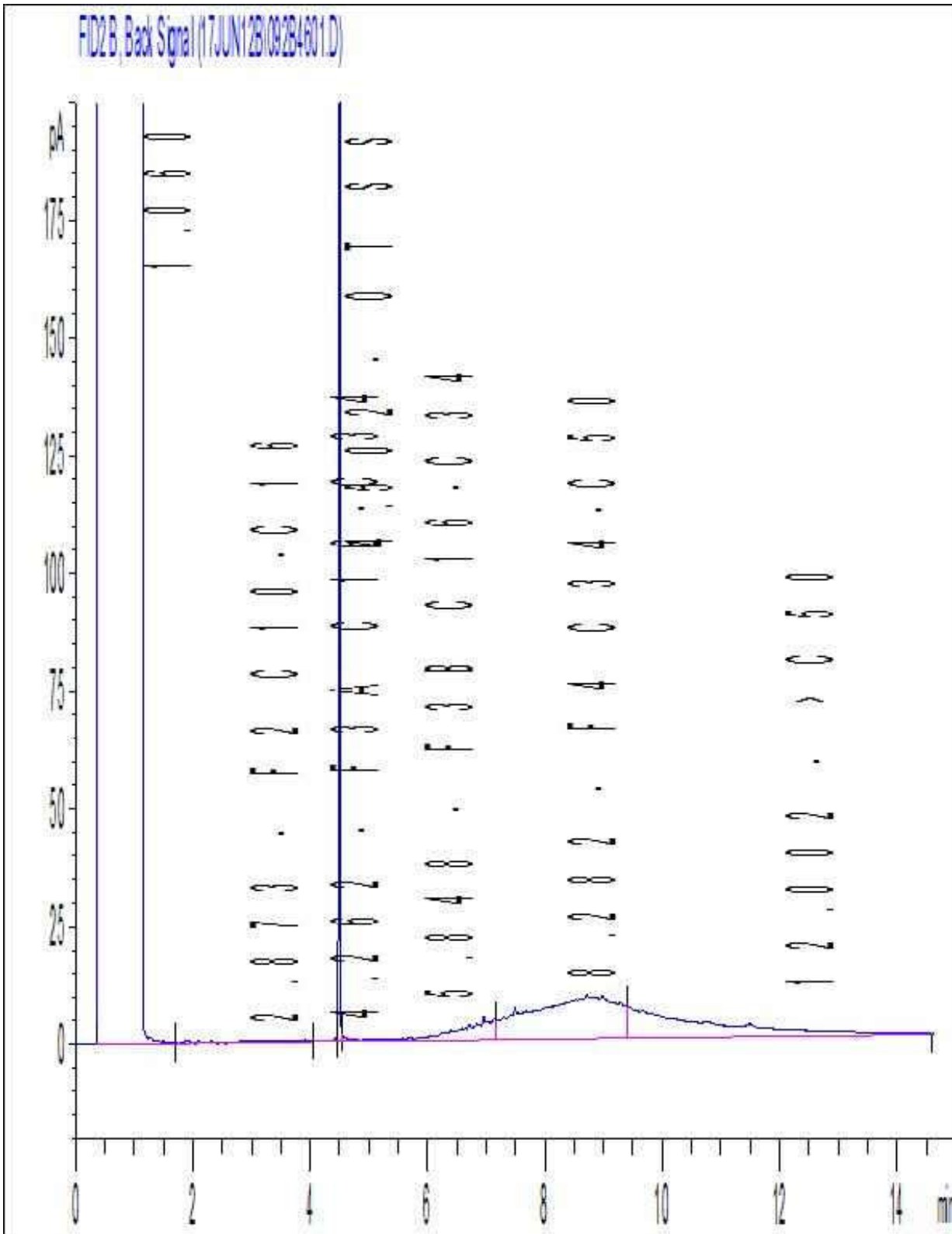
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Petroleum Hydrocarbons F2-F4 in Soil Chromatogram



Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.



Swabs

Invoice Information

Attn: Central Accounting
Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON, K2H 5B7
Email to:
ap-customerservice@golder.com

Report Information

Attn: Paul Hurst
Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON, K2H 5B7
Email to:
phurst@golder.com

Project Information

Quote #: B70916, B53122
PO/AFE#:
Project #: 1666131
Site Location: CNL NPD SITE
Sampled By: RW

Analytical Summary

A: Due On 2017/06/27 18:00

Lab ID	Client Sample ID	Sampling Date/Time	Matrix	Mercury Analysis in Swabs	
COC# na					
EPE703	SWIPE #1	2017/06/08	SWAB		A
EPE704	SWIPE #2	2017/06/08	SWAB		A
EPE705	SWIPE #3	2017/06/08	SWAB		A

Include Criteria on CofA: No

Sample Inspection Observations & Comments

of Samples Received: 3
Details: 5) C of C information incomplete
Average Temperature: Package 1: 23.0 °C

Additional Notes

- Unless special storage arrangements are made, all samples will be disposed 30 days after receipt. Additional fees may be applied for extended storage.
- Additional fees may be applied for the disposal of hazardous samples.

The contents of this report are subject to change. For up to date information, please refer to the Customer Portal.

Parameter Summary

Package/Test	Parameter	RDL *	Unit	Samples
Mercury Analysis in Swabs	Mercury (Hg)	0.01	ug	All

**RDLs are subject to change based on interferences present at the time of analysis.*

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/3

Page of

CHAIN OF CUSTODY RECORD

Turnaround Time (TAT) Required

Regular TAT (5-7 days) Most analyses
PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Rush TAT (Surcharges will be applied)
 1 Day 2 Days 3-4 Days

Date Required: _____
Rush Confirmation #: _____

LABORATORY USE ONLY
CUSTODY SEAL Y / N
Present Intact
COOLER TEMPERATURES
Y / N
COOLING MEDIA PRESENT: Y / N / D
COMMENTS
2372373

Project Information (where applicable)
Quotation #: B66106
P.O. # / A/E/R:
Project #: 1666131
Site Location: CNL NPD Site
Site #: _____
Sampled By: CNL RP Staff

Report Information (if differs from invoice)
Company Name:
Contact Name:
Address:
Phone:
Email:
Fax:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Analysis Requested	# of CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / Cr / V	BTEX / PHC Ft	PHC2 - P4	VOCs	REG 159 METALS & INORGANICS	REG 159 ICPMS METALS	REG 159 METALS (Hg, Cr, V, ICPMS Metals, HWS - B)	Mercury (Residue)	HOLD - DO NOT ANALYZE
REG 159 METALS	1								X	
REG 159 ICPMS METALS	1								X	
REG 159 METALS & INORGANICS	1								X	
REG 159 METALS	1								X	

20-Jun-17 10:53
Alison Cameron
137C8513
GR ENV-567

RECEIVED BY: (Signature/Print) _____ DATE: (YYYY/MM/DD) 20170617 TIME: (HH/MM) 10:53

RELINQUISHED BY: (Signature/Print) _____ DATE: (YYYY/MM/DD) 20170619 TIME: (HH/MM) 15:39



APPENDIX E

Ottawa River Sediment Sampling



1.0 OBJECTIVES AND SCOPE OF WORK

1.1 Objectives

The objectives of the Ottawa River Sediment Sampling task of the CNL NPD Sampling Plan were to conduct field sampling of sediment and analysis for potential CCOCs to satisfy federal and provincial environmental regulations at upgradient (CU24) and downgradient (CU25) sample locations in support of the CNL NPD Characterization Plan. Sediment samples were collected at the locations prescribed in the Characterization Plan and screened for Radiological Contaminants of Concern (ROCs) and Conventional Contaminants of Concern (CCOCs). All sediment samples were submitted for one or more selected CCOCs (reported in this Appendix) and ROCs (reported under separate cover).

1.2 Scope of Work

This report summarises the environmental investigation objectives, scope and methodology, as well as the comparison of sediment analytical results against applicable federal and provincial regulatory guidelines/standards in fulfillment of Task 8 of the CNL NPD Sampling Plan. The scope was conducted in accordance with Section 5.3 of the Characterization Plan and Golder's Standard Operating Procedures.

2.0 REGULATORY CONTEXT

2.1 Screening to Guidelines

Guidelines used to screen sediment chemistry data and to assist in classifying the magnitude of contamination (i.e., degree of contaminant hazard) in sediments at the Site were the following:

- The Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines (SQGs) for the protection of aquatic life (CCME 2011);
- The Ontario Ministry of Environment and Climate Change (MOECC)^{1,2} sediment standards for sediment in generic site conditions; and,
- The Atlantic Risk-Based Corrective Action (RBCA; 2012) sediment screening benchmark for total petroleum hydrocarbons (PHCs).

The CCME SQGs contain two sets of guidelines reflecting different levels of protection to aquatic organisms (as expressed in the guideline narratives) which are represented by the CCME interim sediment quality guideline (ISQG) and probable effects level (PEL). The ISQG is intended to represent a concentration below which adverse biological effects are expected to occur only rarely, whereas the PEL is intended to represent a concentration below which adverse effects may occasionally occur (CCME 1999).

Guidelines such as ISQG/PEL are statistically derived from arbitrarily selected percentiles of both effects and non-effects biological data that are correlated to chemical data (Chapman and Mann 1999), also called the co-occurrence method. This statistical evaluation should therefore not be assumed to imply cause and effect for the derived guideline concentrations. Moreover, because of the way these guidelines are derived, the more

¹ Formerly known as the Ontario Ministry of the Environment (OMOE).

² Specifically Table 8 Sediment Standards for all types of property use for sediment in generic site condition for use within 30 m of a water body in a potable groundwater condition (O.Reg 153 [2011]; MOECC 2011).



conservative benchmarks (e.g., ISQG) are more likely to predict effects when no effects are present (i.e., result in false positives) and thus may be overly conservative for a given protection goal.

3.0 METHODOLOGY

3.1 Field Methodology

This section of the report outlines the methods used to collect sediment samples. The field investigation was undertaken on November 30th and December 1st, 2016. The samples were collected with a standard Ponar grab sampler deployed from the non-inflatable rigid hull boat; with a target sample depth of 5 – 10 cm. The samples were collected at upgradient (CU24; SA-009 to SA-016) and downgradient (CU25; SA-001 to SA-008) locations.

At each sampling station, a minimum of three discrete grabs were collected depending on grab volume and penetration depth, to obtain the volume of sediment required for the chemistry analyses. Field staff wore nitrile gloves when sampling, and changed them between each sampling location. The grab sample locations were found using a Trimble R1 sub-metre resolution GPS. Sample depths from water surface were measured using a weighted measuring tape.

Field collection sheets each grab sampling location are included at the end of this appendix. Sample collection dates, descriptions, and depths are reported in Table E1.

Table E1: Sediment Sample Summary

Characterization Unit	Sample	Sample Collection Date	Sample Starting Depth (meters below water surface)	Sample Description
CU25	SA-001	11/30/16	5.90	Brown SILTY SAND
CU25	SA-002	11/30/16	4.10	Brown SILTY SAND
CU25	SA-003	11/30/16	4.10	Brown SILTY SAND
CU25	SA-004	11/30/16	0.61	Brown SAND
CU25	SA-005	11/30/16	0.90	Brown SAND
CU25	SA-006	11/30/16	6.50	Brown SILTY SAND
CU25	SA-007	12/01/16	4.72	Brown SILTY SAND
CU25	SA-008	12/01/16	15.90	Brown SILTY SAND
CU24	SA-009	12/01/16	5.40	Brown SILTY SAND
CU24	SA-010	11/30/16	11.10	Brown SILTY SAND
CU24	SA-011	11/30/16	2.85	Brown SILTY SAND
CU24	SA-012	11/30/16	6.20	Brown SILTY SAND, trace cobbles
CU24	SA-013	12/01/16	5.10	Dark brown SILTY SAND
CU24	SA-014	11/30/16	10.82	Brown SILTY SAND
CU24	SA-015 & Field Dup-1	11/30/16	4.60	Brown SILTY SAND
CU24	SA-016	11/30/16	4.00	Brown SILTY SAND, with organics



3.2 Laboratory Analysis

Sediment samples were submitted to Maxxam Analytics (Ottawa, ON) for chemical analysis. Maxxam is accredited by the Canadian Association for Laboratory Accreditation (CALA) for the analyses requested. The rationale for the selection of chemical analysis with regards to sample location is presented in the CNL NPD Sampling Plan. All sediment samples were submitted for analysis of PCBs, PHC F1 to F4, BTEX, PAHs, and mercury; select sediment samples were additionally submitted for total metals.

3.3 Quality Assurance / Quality Control

To assess and document that the sampling and analytical data are interpretable, meaningful, and reproducible, a quality assurance/quality control (QA/QC) program was followed. This involved using QA/QC measures in both the collection (field program) and chemical analysis (laboratory) of samples. A summary of the QA/QC program is presented below, and the results of the QA/QC program are discussed in Section 4.2.

3.3.1 Field QA/QC Procedures

Field QA/QC procedures included the following:

- Sampling methods were consistent with established Golder protocols, and provincial/federal requirements.
- Samples were collected and processed by qualified experienced personnel.
- Samples were placed in laboratory-supplied, pre-cleaned containers.
- Samples were collected in such a way to minimize the introduction of foreign material into the sample and the loss of material of interest from the sample prior to analysis.
- Sampling equipment was decontaminated between sampling events.
- Chain-of-Custody procedures were used for the shipment of samples to the laboratories.
- Duplicate samples were collected at a rate of at least 5% of the total number of sediment samples. Duplicate samples were evaluated by calculating relative percent differences (RPDs) for duplicate pair parameter concentrations and comparing these to Golder's internal data quality objectives (DQOs)³.

3.3.2 Laboratory QA/QC

The quality of the generated laboratory data was assessed using the laboratory quality control (analytical method blanks, analysis of reference material, laboratory replicate samples and laboratory spikes) and laboratory replicate samples. The analytical laboratory incorporated and reported the results of internal checks to Golder. These were used to assess the reliability, accuracy and reproducibility of the data. Reports from the laboratory were reviewed internally (i.e., by Maxxam) prior to submission to Golder.

Copies of the analytical reports and the corresponding Chain-of-Custody forms are presented in Appendix E.

³ Golder's internal DQOs are based on the BC Ministry of Environments Laboratory Manual (BC MoE 2015).



4.0 RESULTS AND DISCUSSION

4.1 Sediment Chemistry

Tabulated sediment analytical results are presented in Table E3 following the text of this appendix.

Parameters exceeding applicable criteria/guidelines are shown on Table E3 and Figure 8.

Table E2 shows the average upgradient and downgradient concentrations of parameters with at least one exceedance. Note that metals were only sampled at select locations.

Table E2: Upgradient and Downgradient Average Concentrations

Parameter	Units	Guideline/Standard			Average Upgradient Concentration (CU24)	Average Downgradient Concentration (CU25)	Percent Difference
		CCME Sediment ISQG Freshwater	CCME Sediment PEL Freshwater	REG153 (11) T8-SEDIMENT			
Metals							
Arsenic	ug/g	5.9	17	6	3.13	6.00	63%
Cadmium	ug/g	0.6	3.5	0.6	0.36	0.37	1%
Chromium	ug/g	37.3	90	26	22.00	19.88	-10%
Copper	ug/g	35.7	197	16	13.00	14.72	12%
Nickel	ug/g	--	--	16	16.00	14.76	-8%
PCBs							
Total PCBs	ug/g	0.0341	0.277	0.07	0.018	0.016	-8%
Semi-VOCs							
Acenaphthene	ug/g	0.00671	0.0889	--	0.006	0.005	-11%
Acenaphthylene	ug/g	0.00587	0.128	--	0.006	0.004	-25%
Benzo[a]anthracene	ug/g	0.0317	0.385	0.32	0.029	0.010	-95%
Benzo[a]pyrene	ug/g	0.0319	0.782	0.37	0.021	0.008	-89%
Fluoranthene	ug/g	0.111	2.355	0.75	0.062	0.028	-77%
Phenanthrene	ug/g	0.0419	0.515	0.56	0.043	0.011	-119%
Pyrene	ug/g	0.053	0.875	0.49	0.050	0.022	-76%

Note: Where concentrations were non-detect, the detection limit was used to calculate average.

4.1.1 Petroleum Hydrocarbons (PHCs)

No detections of PHCs or BTEX (benzene, toluene, ethylbenzene, and xylenes) were found at any of the sediment sampling locations.

4.1.2 Metals

Metals were analyzed in select upgradient and downgradient sediment samples in RFI 007 as part of assessing potential background concentrations. These analyses revealed that exceedances of metals were found only at downgradient sampling locations SA-001, SA-002, SA-003, and SA-008. Copper and nickel concentrations exceeded the O.Reg.153/04 Table 8 sediment standards at SA-001, SA-002, and SA-008; while chromium exceeded the standards at SA-008. Arsenic exceeded the CCME ISQG and O.Reg.153/04 Table 8 sediment standards at SA-002, SA-003, and SA-008. However, no metals concentrations exceeded the CCME PEL



guideline, which represents a concentration above which adverse effects may occasionally occur. Metals exceedances were marginally above the CCME ISQG and/or O.Reg.153/04 Table 8 standards and concentrations of all exceeding metals were similar to those upgradient (see Table B2). Given that concentrations are similar to those upstream and only marginally exceed the conservative CCME ISQG standards, it is likely that elevated metals concentrations are due to elevated background sediment levels in this reach of the Ottawa River.

4.1.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Exceedances of PAHs were found at upgradient sampling locations SA-014 (benzo(a)anthracene, benzo(a)pyrene, phenanthrene, pyrene), SA-015 (acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, phenanthrene, pyrene), and SA-016 (acenaphthene, benzo(a)anthracene, phenanthrene, pyrene); and at downgradient sampling location SA-008 (acenaphthene, pyrene). PAH exceedances were of the CCME ISQG guideline only, representing a concentration above which adverse biological effects are expected to occur only rarely. Given that exceedances are found upgradient from the CNL NPD Site, and concentrations upgradient and downgradient are similar (see Table B2), it is unlikely that the CNL NPD Site has contributed to elevated PAH levels in the Ottawa River sediment.

4.1.4 Polychlorinated Biphenyls (PCBs)

PCB exceedances for Total PCBs were found at sampling locations SA-009 (upgradient) and SA-006 (downgradient). Total PCB concentration at both locations exceeded only the CCME ISQG, indicating that adverse biological effects are expected to occur rarely due to PCBs. Given that one exceedance was found upgradient and one downgradient, and concentrations are similar between up- and downgradient sampling locations (see Table B2), it is unlikely that the CNL NPD Site has contributed to elevated PAH levels in the Ottawa River sediment.

4.2 QA/QC

The following sections present the results of the QA/QC program implemented for this investigation.

4.2.1 Field

A total of 17 sediment samples were collected, including 1 duplicate (i.e., at a rate of approximately 6% of the total samples collected), which is consistent with proposed number of duplicates. The field duplicate (Field Dup-1) was a duplicate of SA-015, taken on November 30th, 2016.

Relative percent differences (RPDs) for the duplicate sediment sample generally met Golder's internal data quality objectives (DQOs)⁴, with the following exceptions:

- The RPD for fluoranthene was 166% (DQO = 50%)
- The RPD for phenanthrene was 167% (DQO = 50%)
- The RPD for pyrene was 166% (DQO = 50%)

Sediment is a heterogeneous media (i.e. there is variability in the composition of sediment particles) therefore it is expected that RPD exceedances will be observed in the sample population. The RPD exceedances listed above are not considered to affect interpretation of the sediment chemistry results.

⁴ Golder's internal DQOs are based on the BC Ministry of Environments Laboratory Manual (BC MoE 2015).



4.2.2 Laboratory

Upon review of the laboratory COAs, it was noted that QA/QC checks (i.e., use of analysis of matrix spikes, spiked blanks and/or method blanks) were completed; that internal laboratory DQO's were met; and that the samples were submitted within the acceptable submission temperature (10°C). In some samples, detection limits of PAHs, PCBs, and or PHCs/BTEX were raised due to high moisture content.

Based on review of the sediment sample QA/QC program results, the analytical results are considered reliable for the purposes of this investigation.

5.0 CONCLUSIONS

Based on the completed scope of work and results of the CNL sediment sampling, the following summary and conclusions are provided:

- Sediment analytical results were compared to:
 - The Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines (SQGs) for the protection of aquatic life (CCME 2011);
 - The Ontario Ministry of Environment and Climate Change (MOECC)^{5,6} sediment standards for sediment in generic site conditions; and,
 - The Atlantic Risk-Based Corrective Action (RBCA; 2012) sediment screening benchmark for total petroleum hydrocarbons (PHCs).

Based on the results of the CNL sediment sampling, it can be concluded that elevated levels of select metals, PAHs, and PCBs above the applicable standards and/or guidelines were found in the sediment both upstream and downstream of the CNL NPD Site. Based on the type, magnitude and distribution of exceedances, it is unlikely that the CNL NPD Site has contributed to the elevated levels of select contaminants in the Ottawa River sediment. No further sampling is recommended at this time.

⁵ Formerly known as the Ontario Ministry of the Environment (OMOE).

⁶ Specifically Table 8 Sediment Standards for all types of property use for sediment in generic site condition for use within 30 m of a water body in a potable groundwater condition (O.Reg 153 [2011]; MOECC 2011).



6.0 REFERENCES

- Atlantic Risk-Based Corrective Action (RBCA). 2012. Ecological Screening Protocol for Petroleum Impacted Sites in Atlantic Canada. Version 3. Scientific Rationale—Scientific Rationale to support the Adoption/Development of Tier 1 Ecological Screening Levels for Soil, Surface Water, Groundwater and Sediment. July 2012.
- BC Ministry of Environment (BC MoE). 2015. *British Columbia Environmental Laboratory Manual 2015 Edition*. Environmental Monitoring, Reporting & Economics Knowledge Management Branch, and the British Columbia Environmental Laboratory Technical Advisory Committee. Dated February 2016.
- Canadian Council of Ministers of the Environment (CCME). 1999 (including updates to 2016). Soil quality guidelines for the protection of environmental and human health. Available at: <http://sts.ccme.ca/en/index.html>.
- CCME. 2011. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg. 1999; updates to 2011. Available at [<http://ceqg-rcqe.ccme.ca/>].
- Ontario Ministry of the Environment and Climate Change. (MOECC) 2016. Soil, Groundwater and Sediment Standards for Use Under Part X.V1. of the *Environmental Protection Act*. Ministry of the Environment Branch. Dated 15 April 2011. Reference No. PIBS #7382e01.
- Ontario Ministry of (OMOE). 2011. Rationale for the Development of Generic Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Dated 15 April 2011. Standards Development Branch, Ontario Ministry of the Environment. Reference No. PIBS #7386e01

Table E3: Sediment Analytical Results

Sample Depth	Parameter	Unit	CCME Sediment ISQG Freshwater ⁽¹⁾	CCME Sediment PEL Freshwater ⁽²⁾	REG153 (11) T8-SEDIMENT ⁽³⁾ or OTHER ⁽²⁾	CU25 (Downgradient)									
						SA-001 30-Nov-2016	SA-002 30-Nov-2016 ⁽⁴⁾	SA-003 30-Nov-2016	SA-004 30-Nov-2016	SA-005 30-Nov-2016	SA-006 30-Nov-2016 ⁽⁴⁾	SA-007 01-Dec-2016 ⁽⁵⁾	SA-008 01-Dec-2016 ⁽⁴⁾		
General Chemistry	Moisture, Percent	%	-	-	-	4.10	4.10	4.10	0.61	0.90	6.50	4.72	15.90		
Metals	Antimony	ug/g	-	-	- ⁽⁶⁾	40	45	42	23	25	52	47	56		
	Arsenic	ug/g	5.9	17	3.0	<0.20	<0.20	<0.20	<0.20	-	-	-	<0.20		
	Barium	ug/g	-	-	- ⁽⁶⁾	75	68	66	11	-	-	-	7.4		
	Beryllium	ug/g	-	-	- ⁽⁶⁾	0.34	0.28	0.28	<0.20	-	-	-	0.42		
	Boron	ug/g	-	-	- ⁽⁶⁾	<5.0	<5.0	<5.0	<5.0	-	-	-	<5.0		
	Cadmium	ug/g	0.8	3.5	0.6	0.38	0.67	0.34	0.13	-	-	-	0.37		
	Chromium	ug/g	37.3	90	26	24	24	20	3.4	-	-	-	28		
	Cobalt	ug/g	-	-	- ⁽⁶⁾	8.7	9.5	8.3	1.7	-	-	-	8.5		
	Copper	ug/g	35.7	197	16	20	17	14	1.6	-	-	-	21		
	Hexavalent Chromium	ug/g	-	-	- ⁽⁶⁾	<0.2	<0.2	0.3	<0.2	-	-	-	0.2		
	Lead	ug/g	35	91.3	31	7.7	13	6.6	1.1	-	-	-	8.7		
	Mercury	ug/g	0.17	0.486	0.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		
	Molybdenum	ug/g	-	-	- ⁽⁶⁾	16	17	15	2.8	-	-	-	0.67		
	Nickel	ug/g	-	-	- ⁽⁶⁾	<0.50	<0.50	<0.50	<0.50	-	-	-	<0.50		
	Selenium	ug/g	-	-	- ⁽⁶⁾	0.5	<0.20	<0.20	<0.20	-	-	-	<0.20		
	Silver	ug/g	-	-	- ⁽⁶⁾	190	180	150	72	-	-	-	190		
	Sodium	ug/g	-	-	- ⁽⁶⁾	0.12	0.16	0.13	<0.050	-	-	-	0.14		
	Thallium	ug/g	-	-	- ⁽⁶⁾	0.69	0.83	0.68	0.20	-	-	-	1.5		
	Uranium	ug/g	-	-	- ⁽⁶⁾	31	23	27	<5.0	-	-	-	29		
	Vanadium	ug/g	-	-	- ⁽⁶⁾	86	88	82	11	-	-	-	75		
	Zinc	ug/g	123	315	120	-	-	-	-	-	-	-	-		
	Polychlorinated Biphenyls (PCBs)														
	Aroclor 1242	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.020	<0.020	<0.010	<0.010	<0.020	<0.020	<0.030		
	Aroclor 1248	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.020	<0.020	<0.010	<0.010	<0.020	<0.020	<0.030		
	Aroclor 1254	ug/g	0.06 ⁽⁷⁾	0.34 ⁽⁸⁾	-	<0.020	<0.020	<0.020	<0.010	<0.010	0.054	<0.020	<0.030		
	Aroclor 1260	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.020	<0.020	<0.010	<0.010	<0.020	<0.020	<0.030		
	Polychlorinated Biphenyls	ug/g	0.0341	0.277	0.07	<0.020	<0.020	0.020	<0.010	<0.010	0.054	<0.020	<0.030		
	Petroleum Hydrocarbons														
	Benzene	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.040	<0.020	<0.020	<0.020	<0.040	<0.020	<0.040		
	Ethylbenzene	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.040	<0.020	<0.020	<0.020	<0.040	<0.020	<0.040		
	m,p-Xylenes	ug/g	-	-	- ⁽⁶⁾	<0.040	<0.080	<0.040	<0.040	<0.040	<0.080	<0.040	<0.080		
	o-Xylene	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.040	<0.020	<0.020	<0.020	<0.040	<0.020	<0.040		
	Petroleum Hydrocarbons - F1 (C6-C10)	ug/g	-	-	- ⁽⁶⁾	<10	<20	<10	<10	<10	<20	<10	<20		
	Petroleum Hydrocarbons - F1 (C6-C10)-BTX	ug/g	-	-	- ⁽⁶⁾	<10	<20	<10	<10	<10	<20	<10	<20		
	Petroleum Hydrocarbons - F2 (C10-C16)	ug/g	-	-	- ⁽⁶⁾	<10	<20	<10	<10	<10	<20	<10	<20		
	Petroleum Hydrocarbons - F3 (C16-C34)	ug/g	-	-	- ⁽⁶⁾	<50	<100	<50	<50	<50	<100	<50	<100		
	Petroleum Hydrocarbons - F4 (C34-C50)	ug/g	-	-	- ⁽⁶⁾	<50	<100	<50	<50	<50	<100	<50	<100		
	Total Petroleum Hydrocarbons	ug/g	-	-	500 ⁽²⁾	<70	<140	<70	<70	<70	<140	<70	<140		
	Toluene	ug/g	-	-	- ⁽⁶⁾	<0.020	<0.040	<0.020	<0.020	<0.020	<0.040	<0.020	<0.040		
	TPH as Gasoline	ug/g	-	-	- ⁽⁶⁾	-	-	-	-	-	-	-	-		
	TPH-Diesel	ug/g	-	-	- ⁽⁶⁾	<50	<100	<50	<50	<50	<100	<50	<100		
	Xylenes, Total	ug/g	-	-	- ⁽⁶⁾	<0.040	<0.080	<0.040	<0.040	<0.040	<0.080	<0.040	<0.080		

Table E3: Sediment Analytical Results

Parameter	Unit	CCME Sediment ISQG Freshwater ⁽¹⁾	CCME Sediment PEL Freshwater ⁽²⁾	REG153 (11) T8-SEDIMENT ⁽³⁾ or OTHER ⁽²⁾	CUZ5 (Downgradient)								
					SA-001 30-Nov-2016	SA-002 30-Nov-2016 ⁽⁴⁾	SA-003 30-Nov-2016	SA-004 30-Nov-2016	SA-005 30-Nov-2016	SA-006 30-Nov-2016 ⁽⁴⁾	SA-007 01-Dec-2016 ⁽⁵⁾	SA-008 01-Dec-2016 ⁽⁴⁾	
Polycyclic Aromatic Hydrocarbons (PAHs) (Semi-VOCs)													
1,2,3-Methylnaphthalene	ug/g	--	--	--	<0.014	<0.014	<0.014	<0.0071	<0.0071	<0.0071	<0.014	<0.014	<0.014
1-Methylnaphthalene	ug/g	--	--	-- ⁽⁶⁾	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/g	0.0202 ⁽⁶⁾	0.201 ⁽¹⁰⁾	-- ⁽⁶⁾	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.010	<0.010
Acenaphthene	ug/g	0.00671 ⁽⁶⁾	0.0889 ⁽¹⁰⁾	-- ⁽⁶⁾	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.010	0.012
Acenaphthylene	ug/g	0.00687 ⁽⁶⁾	0.128 ⁽¹⁰⁾	-- ⁽⁶⁾	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.010	<0.010
Anthracene	ug/g	0.0469 ⁽⁶⁾	0.245 ⁽¹⁰⁾	0.22	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.010	0.016
Benzo [b] fluoranthene	ug/g	--	0.385	--	0.022	0.032	0.012	<0.0050	<0.0050	0.028	0.012	0.012	0.021
Benzo [a] anthracene	ug/g	0.0317	0.782	0.37	0.014	0.017	0.011	<0.0050	<0.0050	0.016	<0.010	<0.010	0.013
Benzo [k] fluoranthene	ug/g	--	--	0.17	<0.010	0.015	<0.010	<0.0050	<0.0050	0.012	<0.010	<0.010	0.010
Chrysene	ug/g	--	--	0.24	<0.010	0.014	<0.010	<0.0050	<0.0050	0.011	<0.010	<0.010	<0.010
Dibenz [a,h] anthracene	ug/g	0.00622 ⁽⁶⁾	0.135 ⁽¹⁰⁾	0.06	<0.010	0.016	<0.010	<0.0050	<0.0050	0.016	<0.010	<0.010	0.012
Fluorene	ug/g	0.111	2.355	0.75	<0.010	0.033	<0.010	<0.0050	<0.0050	0.032	<0.010	<0.010	0.074
Fluoranthene	ug/g	0.0212 ⁽⁶⁾	0.144 ⁽¹⁰⁾	0.19	<0.010	0.016	<0.010	<0.0050	<0.0050	0.012	<0.010	<0.010	<0.010
Indeno [1,2,3-cd] pyrene	ug/g	--	--	0.2	<0.010	0.016	<0.010	<0.0050	<0.0050	0.012	<0.010	<0.010	<0.010
Naphthalene	ug/g	0.0346 ⁽⁶⁾	0.391 ⁽¹⁰⁾	-- ⁽⁶⁾	<0.010	<0.010	<0.010	<0.0050	<0.0050	0.012	<0.010	<0.010	<0.010
Phenanthrene	ug/g	0.0419	0.515	0.56	0.020	0.013	0.016	<0.0050	<0.0050	0.012	<0.010	<0.010	0.015
Pyrene	ug/g	0.053	0.875	0.49	0.031	0.029	0.018	<0.0050	<0.0050	0.026	0.013	0.013	0.056

Tables should be read in conjunction with the accompanying document.

Indicates parameter not detected above laboratory method detection limit.

< Indicates parameter detected above equipment analytical range.

> Chemical not analyzed or criteria not defined.

-- Parameter is greater than CCME Sediment ISQG Freshwater

> Parameter is greater than CCME Sediment PEL Freshwater

> Parameter is greater than REG153 (11) T8-SEDIMENT

(1) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Interim freshwater sediment quality guidelines

(2) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life - Probable effect levels - Freshwater

(3) O.Reg 153 (2011) Table 8 Standards for all types of property use for sediment in generic site condition for use within 30 m of a water body in a potable groundwater condition

(4) F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

(5) F24 Analysis : Detection limits were adjusted for high moisture content .

(6) No value derived.

(7) Provisional; adoption of lowest effect level from Ontario (Persaud et al. 1993).

(8) Provisional; 1% TOC; adoption of severe effect level of 34 ug/g TOC from Ontario (Persaud et al. 1993).

(9) Provisional; adoption of interim ISQG.

(10) Provisional; adoption of interim PEL.

(11) DL was raised due to matrix interference.

(12) Atlantic Risk-Based Corrective Action (RBCA; 2012) sediment screening benchmark for total PHC

(13) O.Reg. 153 (2011) Table 6 Standards for perland property use for shallow soil in a potable groundwater condition



Sediment

Your Project #: 1666131
 Site#: Nuclear Demonstration Property
 Your C.O.C. #: 587912-03-01, 587912-02-01

Attention:Paul Hurst

Golder Associates Ltd
 1931 Robertson Rd
 Ottawa, ON
 K2H 5B7

Report Date: 2017/09/15
 Report #: R4704761
 Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B6Q3824
Received: 2016/12/02, 16:00

Sample Matrix: Soil
 # Samples Received: 17

Analyses	Quantity	Date		Laboratory Method	Reference
		Extracted	Analyzed		
Methylnaphthalene Sum (1)	17	N/A	2016/12/09	CAM SOP-00301	EPA 8270D m
Hexavalent Chromium in Soil by IC (1, 2)	3	2017/02/07	2017/02/08	CAM SOP-00436	EPA 3060/7199 m
Hexavalent Chromium in Soil by IC (1, 2)	5	2017/02/08	2017/02/08	CAM SOP-00436	EPA 3060/7199 m
Petroleum Hydro. CCME F1 & BTEX in Soil (1, 3)	12	N/A	2016/12/06	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydro. CCME F1 & BTEX in Soil (1, 3)	5	N/A	2016/12/09	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydrocarbons F2-F4 in Soil (1, 4)	3	2016/12/08	2016/12/08	CAM SOP-00316	CCME CWS m
Petroleum Hydrocarbons F2-F4 in Soil (1, 4)	14	2016/12/08	2016/12/09	CAM SOP-00316	CCME CWS m
Mercury in Soil by CVAA (1)	17	2016/12/08	2016/12/08	CAM SOP-00453	EPA 7471B m
Strong Acid Leachable Metals by ICPMS (1)	5	2017/02/07	2017/02/07	CAM SOP-00447	EPA 6020B m
Strong Acid Leachable Metals by ICPMS (1)	3	2017/02/08	2017/02/08	CAM SOP-00447	EPA 6020B m
Moisture (1)	17	N/A	2016/12/08	CAM SOP-00445	Carter 2nd ed 51.2 m
PAH Compounds in Soil by GC/MS (SIM) (1)	17	2016/12/08	2016/12/09	CAM SOP-00318	EPA 8270D m
Polychlorinated Biphenyl in Soil (1)	17	2016/12/06	2016/12/07	CAM SOP-00309	EPA 8082A m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

Your Project #: 1666131
Site#: Nuclear Demonstration Property
Your C.O.C. #: 587912-03-01, 587912-02-01

Attention:Paul Hurst

Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
K2H 5B7

Report Date: 2017/09/15
Report #: R4704761
Version: 3 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B6Q3824

Received: 2016/12/02, 16:00

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

- (1) This test was performed by Maxxam Analytics Mississauga
- (2) Soils are reported on a dry weight basis unless otherwise specified.
- (3) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.
- (4) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following "Alberta Environment's Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003". Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Alison Cameron, Project Manager
Email: ACameron@maxxam.ca
Phone# (613) 274-0573

=====
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

O.REG 153 PAHS (SOIL)

Maxxam ID		DOK771	DOK772	DOK773	DOK774	DOK775		
Sampling Date		2016/11/30 10:00	2016/11/30 10:00	2016/11/30 10:45	2016/11/30 11:20	2016/11/30 12:00		
COC Number		587912-03-01	587912-03-01	587912-03-01	587912-03-01	587912-03-01		
	UNITS	SA-015	FIELD DUP-1	SA-012	SA-011	SA-016	RDL	QC Batch
Calculated Parameters								
Methylnaphthalene, 2-(1-)	ug/g	<0.014	<0.014	<0.014	<0.014	<0.014	0.014	4777560
Polyaromatic Hydrocarbons								
Acenaphthene	ug/g	<0.010	<0.010	<0.010	<0.010	0.012	0.010	4784065
Acenaphthylene	ug/g	0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Anthracene	ug/g	0.026	<0.010	<0.010	<0.010	0.013	0.010	4784065
Benzo(a)anthracene	ug/g	0.061	<0.010	0.014	0.027	0.045	0.010	4784065
Benzo(a)pyrene	ug/g	0.047	<0.010	0.010	0.021	0.028	0.010	4784065
Benzo(b,j)fluoranthene	ug/g	0.066	0.015	0.020	0.057	0.035	0.010	4784065
Benzo(g,h,i)perylene	ug/g	0.025	<0.010	<0.010	0.030	0.012	0.010	4784065
Benzo(k)fluoranthene	ug/g	0.020	<0.010	<0.010	0.014	0.014	0.010	4784065
Chrysene	ug/g	0.055	<0.010	0.011	0.021	0.029	0.010	4784065
Dibenz(a,h)anthracene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Fluoranthene	ug/g	0.15	0.014	0.029	0.050	0.079	0.010	4784065
Fluorene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Indeno(1,2,3-cd)pyrene	ug/g	0.028	<0.010	<0.010	0.031	0.015	0.010	4784065
1-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
2-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Naphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Phenanthrene	ug/g	0.11	<0.010	0.017	0.020	0.061	0.010	4784065
Pyrene	ug/g	0.13	0.012	0.025	0.043	0.059	0.010	4784065
Surrogate Recovery (%)								
D10-Anthracene	%	89	87	90	102	89		4784065
D14-Terphenyl (FS)	%	87	85	89	100	89		4784065
D8-Acenaphthylene	%	87	87	92	103	87		4784065
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

O.REG 153 PAHS (SOIL)

Maxxam ID		DOK776		DOK777		DOK778		DOK779		
Sampling Date		2016/11/30 12:35		2016/11/30 13:15		2016/11/30 13:30		2016/11/30 13:50		
COC Number		587912-03-01		587912-03-01		587912-03-01		587912-03-01		
	UNITS	SA-005	RDL	SA-001	RDL	SA-010	RDL	SA-014	RDL	QC Batch

Calculated Parameters

Methylnaphthalene, 2-(1-)	ug/g	<0.0071	0.0071	<0.014	0.014	<0.014	0.014	<0.014	0.014	4777560
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Polyaromatic Hydrocarbons

Acenaphthene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
Acenaphthylene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
Anthracene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	0.028	0.010	4784065
Benzo(a)anthracene	ug/g	<0.0050	0.0050	0.014	0.010	<0.050 (1)	0.050	0.047	0.010	4784065
Benzo(a)pyrene	ug/g	<0.0050	0.0050	0.014	0.010	0.022	0.010	0.033	0.010	4784065
Benzo(b/j)fluoranthene	ug/g	<0.0050	0.0050	0.022	0.010	0.037	0.010	0.054	0.010	4784065
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0050	<0.010	0.010	0.012	0.010	0.020	0.010	4784065
Benzo(k)fluoranthene	ug/g	<0.0050	0.0050	<0.010	0.010	0.011	0.010	0.016	0.010	4784065
Chrysene	ug/g	<0.0050	0.0050	0.014	0.010	0.022	0.010	0.035	0.010	4784065
Dibenz(a,h)anthracene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
Fluoranthene	ug/g	<0.0050	0.0050	0.036	0.010	0.064	0.010	0.10	0.010	4784065
Fluorene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	0.014	0.010	4784065
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.0050	<0.010	0.010	0.013	0.010	0.023	0.010	4784065
1-Methylnaphthalene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
2-Methylnaphthalene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
Naphthalene	ug/g	<0.0050	0.0050	<0.010	0.010	<0.010	0.010	<0.010	0.010	4784065
Phenanthrene	ug/g	<0.0050	0.0050	0.020	0.010	0.039	0.010	0.084	0.010	4784065
Pyrene	ug/g	<0.0050	0.0050	0.031	0.010	0.049	0.010	0.074	0.010	4784065

Surrogate Recovery (%)

D10-Anthracene	%	88		90		86		88		4784065
D14-Terphenyl (FS)	%	83		88		85		86		4784065
D8-Acenaphthylene	%	88		91		89		89		4784065

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

(1) DL was raised due to matrix interference.

O.REG 153 PAHS (SOIL)

Maxxam ID		DOK780	DOK780	DOK781		DOK782		DOK783		
Sampling Date		2016/11/30 14:10	2016/11/30 14:10	2016/11/30 14:30		2016/11/30 14:50		2016/11/30 15:10		
COC Number		587912-03-01	587912-03-01	587912-02-01		587912-02-01		587912-02-01		
	UNITS	SA-006	SA-006 Lab-Dup	SA-002	RDL	SA-004	RDL	SA-003	RDL	QC Batch

Calculated Parameters										
Methylnaphthalene, 2-(1-)	ug/g	<0.014		<0.014	0.014	<0.0071	0.0071	<0.014	0.014	4777560
Polyaromatic Hydrocarbons										
Acenaphthene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Acenaphthylene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Anthracene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Benzo(a)anthracene	ug/g	0.016	0.017	0.017	0.010	<0.0050	0.0050	0.011	0.010	4784065
Benzo(a)pyrene	ug/g	0.012	0.012	0.015	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Benzo(b,j)fluoranthene	ug/g	0.028	0.026	0.032	0.010	<0.0050	0.0050	0.012	0.010	4784065
Benzo(g,h,i)perylene	ug/g	0.011	0.010	0.014	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Benzo(k)fluoranthene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Chrysene	ug/g	0.016	0.015	0.016	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Dibenz(a,h)anthracene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Fluoranthene	ug/g	0.032	0.037	0.033	0.010	<0.0050	0.0050	0.025	0.010	4784065
Fluorene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Indeno(1,2,3-cd)pyrene	ug/g	0.012	0.011	0.016	0.010	<0.0050	0.0050	<0.010	0.010	4784065
1-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
2-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Naphthalene	ug/g	<0.010	<0.010	<0.010	0.010	<0.0050	0.0050	<0.010	0.010	4784065
Phenanthrene	ug/g	0.012	0.015	0.013	0.010	<0.0050	0.0050	0.016	0.010	4784065
Pyrene	ug/g	0.026	0.029	0.029	0.010	<0.0050	0.0050	0.018	0.010	4784065
Surrogate Recovery (%)										
D10-Anthracene	%	87	87	93		91		94		4784065
D14-Terphenyl (FS)	%	86	86	89		86		93		4784065
D8-Acenaphthylene	%	87	89	92		89		94		4784065

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 PAHS (SOIL)

Maxxam ID		DOK784	DOK785	DOK786	DOK787		
Sampling Date		2016/12/01 09:20	2016/12/01 09:40	2016/12/01 10:10	2016/12/01 10:35		
COC Number		587912-02-01	587912-02-01	587912-02-01	587912-02-01		
	UNITS	SA-013	SA-009	SA-008	SA-007	RDL	QC Batch
Calculated Parameters							
Methylnaphthalene, 2-(1-)	ug/g	<0.014	<0.014	<0.014	<0.014	0.014	4777560
Polyaromatic Hydrocarbons							
Acenaphthene	ug/g	<0.010	<0.010	0.012	<0.010	0.010	4784065
Acenaphthylene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Anthracene	ug/g	<0.010	<0.010	0.016	<0.010	0.010	4784065
Benzo(a)anthracene	ug/g	<0.010	<0.010	0.013	<0.010	0.010	4784065
Benzo(a)pyrene	ug/g	<0.010	<0.010	0.010	<0.010	0.010	4784065
Benzo(b/j)fluoranthene	ug/g	<0.010	0.014	0.021	0.012	0.010	4784065
Benzo(g,h,i)perylene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Benzo(k)fluoranthene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Chrysene	ug/g	<0.010	<0.010	0.012	<0.010	0.010	4784065
Dibenz(a,h)anthracene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Fluoranthene	ug/g	0.011	0.016	0.074	0.016	0.010	4784065
Fluorene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Indeno(1,2,3-cd)pyrene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
1-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
2-Methylnaphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Naphthalene	ug/g	<0.010	<0.010	<0.010	<0.010	0.010	4784065
Phenanthrene	ug/g	<0.010	<0.010	0.015	<0.010	0.010	4784065
Pyrene	ug/g	<0.010	0.013	0.056	0.013	0.010	4784065
Surrogate Recovery (%)							
D10-Anthracene	%	89	91	79	90		4784065
D14-Terphenyl (FS)	%	86	88	77	87		4784065
D8-Acenaphthylene	%	90	94	81	94		4784065
RDL = Reportable Detection Limit QC Batch = Quality Control Batch							

O.REG 153 PCBS (SOIL)

Maxxam ID		DOK771	DOK772	DOK773		DOK774		DOK775		
Sampling Date		2016/11/30 10:00	2016/11/30 10:00	2016/11/30 10:45		2016/11/30 11:20		2016/11/30 12:00		
COC Number		587912-03-01	587912-03-01	587912-03-01		587912-03-01		587912-03-01		
	UNITS	SA-015	FIELD DUP-1	SA-012	RDL	SA-011	RDL	SA-016	RDL	QC Batch

PCBs										
Aroclor 1242	ug/g	<0.020	<0.020	<0.020	0.020	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1248	ug/g	<0.020	<0.020	<0.020	0.020	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1254	ug/g	<0.020	<0.020	<0.020	0.020	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1260	ug/g	<0.020	<0.020	<0.020	0.020	<0.030	0.030	<0.020	0.020	4780894
Total PCB	ug/g	<0.020	<0.020	<0.020	0.020	<0.030	0.030	<0.020	0.020	4780894

Surrogate Recovery (%)										
Decachlorobiphenyl	%	93	98	84		92		94		4780894

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		DOK776		DOK777	DOK778	DOK779	DOK780		
Sampling Date		2016/11/30 12:35		2016/11/30 13:15	2016/11/30 13:30	2016/11/30 13:50	2016/11/30 14:10		
COC Number		587912-03-01		587912-03-01	587912-03-01	587912-03-01	587912-03-01		
	UNITS	SA-005	RDL	SA-001	SA-010	SA-014	SA-006	RDL	QC Batch

PCBs										
Aroclor 1242	ug/g	<0.010	0.010	<0.020	<0.020	<0.020	<0.020	0.020	4780894	
Aroclor 1248	ug/g	<0.010	0.010	<0.020	<0.020	<0.020	<0.020	0.020	4780894	
Aroclor 1254	ug/g	<0.010	0.010	<0.020	0.032	<0.020	0.054	0.020	4780894	
Aroclor 1260	ug/g	<0.010	0.010	<0.020	<0.020	<0.020	<0.020	0.020	4780894	
Total PCB	ug/g	<0.010	0.010	<0.020	0.032	<0.020	0.054	0.020	4780894	

Surrogate Recovery (%)										
Decachlorobiphenyl	%	93		74	97	100	100		4780894	

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

O.REG 153 PCBS (SOIL)

Maxxam ID		DOK781		DOK782		DOK783	DOK784	DOK785		
Sampling Date		2016/11/30 14:30		2016/11/30 14:50		2016/11/30 15:10	2016/12/01 09:20	2016/12/01 09:40		
COC Number		587912-02-01		587912-02-01		587912-02-01	587912-02-01	587912-02-01		
	UNITS	SA-002	RDL	SA-004	RDL	SA-003	SA-013	SA-009	RDL	QC Batch
PCBs										
Aroclor 1242	ug/g	<0.020	0.020	<0.010	0.010	<0.020	<0.020	<0.020	0.020	4780894
Aroclor 1248	ug/g	<0.020	0.020	<0.010	0.010	<0.020	<0.020	<0.020	0.020	4780894
Aroclor 1254	ug/g	<0.020	0.020	<0.010	0.010	0.020	<0.020	0.043	0.020	4780894
Aroclor 1260	ug/g	<0.020	0.020	<0.010	0.010	<0.020	<0.020	<0.020	0.020	4780894
Total PCB	ug/g	<0.020	0.020	<0.010	0.010	0.020	<0.020	0.043	0.020	4780894
Surrogate Recovery (%)										
Decachlorobiphenyl	%	88		94		90	101	103		4780894
RDL = Reportable Detection Limit QC Batch = Quality Control Batch										

Maxxam ID		DOK786		DOK787		
Sampling Date		2016/12/01 10:10		2016/12/01 10:35		
COC Number		587912-02-01		587912-02-01		
	UNITS	SA-008	RDL	SA-007	RDL	QC Batch
PCBs						
Aroclor 1242	ug/g	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1248	ug/g	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1254	ug/g	<0.030	0.030	<0.020	0.020	4780894
Aroclor 1260	ug/g	<0.030	0.030	<0.020	0.020	4780894
Total PCB	ug/g	<0.030	0.030	<0.020	0.020	4780894
Surrogate Recovery (%)						
Decachlorobiphenyl	%	91		86		4780894
RDL = Reportable Detection Limit QC Batch = Quality Control Batch						

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		DOK771	DOK771		DOK772		DOK773		DOK774		
Sampling Date		2016/11/30 10:00	2016/11/30 10:00		2016/11/30 10:00		2016/11/30 10:45		2016/11/30 11:20		
COC Number		587912-03-01	587912-03-01		587912-03-01		587912-03-01		587912-03-01		
	UNITS	SA-015	SA-015 Lab-Dup	RDL	FIELD DUP-1	RDL	SA-012	RDL	SA-011	RDL	QC Batch

Inorganics

Moisture	%	48		1.0	47	1.0	42	1.0	60	1.0	4783972
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BTEX & F1 Hydrocarbons

Benzene	ug/g	<0.040	<0.040	0.040	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910
Toluene	ug/g	<0.040	<0.040	0.040	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910
Ethylbenzene	ug/g	<0.040	<0.040	0.040	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910
o-Xylene	ug/g	<0.040	<0.040	0.040	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910
p+m-Xylene	ug/g	<0.080	<0.080	0.080	<0.040	0.040	<0.040	0.040	<0.080	0.080	4779910
Total Xylenes	ug/g	<0.080	<0.080	0.080	<0.040	0.040	<0.040	0.040	<0.080	0.080	4779910
F1 (C6-C10)	ug/g	<20	<20	20	<10	10	<10	10	<20	20	4779910
F1 (C6-C10) - BTEX	ug/g	<20	<20	20	<10	10	<10	10	<20	20	4779910

F2-F4 Hydrocarbons

F2 (C10-C16 Hydrocarbons)	ug/g	<20		20	<20	20	<10	10	<20	20	4784530
F3 (C16-C34 Hydrocarbons)	ug/g	<100		100	<100	100	<50	50	<100	100	4784530
F4 (C34-C50 Hydrocarbons)	ug/g	<100		100	<100	100	<50	50	<100	100	4784530
Reached Baseline at C50	ug/g	Yes			Yes		Yes		Yes		4784530
Diesel (C10-C24)	ug/g	<100		100	<100	100	<50	50	<100	100	4784530

Surrogate Recovery (%)

1,4-Difluorobenzene	%	99	100		100		97		99		4779910
4-Bromofluorobenzene	%	103	104		103		102		100		4779910
D10-Ethylbenzene	%	90	94		78		83		89		4779910
D4-1,2-Dichloroethane	%	102	103		95		105		105		4779910
o-Terphenyl	%	106			101		104		109		4784530

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		DOK775		DOK776	DOK777		DOK778	DOK778		
Sampling Date		2016/11/30 12:00		2016/11/30 12:35	2016/11/30 13:15		2016/11/30 13:30	2016/11/30 13:30		
COC Number		587912-03-01		587912-03-01	587912-03-01		587912-03-01	587912-03-01		
	UNITS	SA-016	RDL	SA-005	SA-001	RDL	SA-010	SA-010 Lab-Dup	RDL	QC Batch

Inorganics

Moisture	%	45	1.0	25	40	1.0	46	46	1.0	4783883
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BTEX & F1 Hydrocarbons

Benzene	ug/g	<0.020	0.020	<0.020	<0.020	0.020	<0.020		0.020	4779910
Toluene	ug/g	<0.020	0.020	<0.020	<0.020	0.020	<0.020		0.020	4779910
Ethylbenzene	ug/g	<0.020	0.020	<0.020	<0.020	0.020	<0.020		0.020	4779910
o-Xylene	ug/g	<0.020	0.020	<0.020	<0.020	0.020	<0.020		0.020	4779910
p+m-Xylene	ug/g	<0.040	0.040	<0.040	<0.040	0.040	<0.040		0.040	4779910
Total Xylenes	ug/g	<0.040	0.040	<0.040	<0.040	0.040	<0.040		0.040	4779910
F1 (C6-C10)	ug/g	<10	10	<10	<10	10	<10		10	4779910
F1 (C6-C10) - BTEX	ug/g	<10	10	<10	<10	10	<10		10	4779910

F2-F4 Hydrocarbons

F2 (C10-C16 Hydrocarbons)	ug/g	<20	20	<10	<10	10	<20		20	4784530
F3 (C16-C34 Hydrocarbons)	ug/g	<100	100	<50	<50	50	<100		100	4784530
F4 (C34-C50 Hydrocarbons)	ug/g	<100	100	<50	<50	50	<100		100	4784530
Reached Baseline at C50	ug/g	Yes		Yes	Yes		Yes			4784530
Diesel (C10-C24)	ug/g	<100	100	<50	<50	50	<100		100	4784530

Surrogate Recovery (%)

1,4-Difluorobenzene	%	100		98	101		100			4779910
4-Bromofluorobenzene	%	105		102	105		101			4779910
D10-Ethylbenzene	%	79		79	84		85			4779910
D4-1,2-Dichloroethane	%	104		102	99		103			4779910
o-Terphenyl	%	107		104	111		107			4784530

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		DOK779		DOK780	DOK781		DOK782	DOK783		
Sampling Date		2016/11/30 13:50		2016/11/30 14:10	2016/11/30 14:30		2016/11/30 14:50	2016/11/30 15:10		
COC Number		587912-03-01		587912-03-01	587912-02-01		587912-02-01	587912-02-01		
	UNITS	SA-014	RDL	SA-006	SA-002	RDL	SA-004	SA-003	RDL	QC Batch
Inorganics										
Moisture	%	44	1.0	52	45	1.0	23	42	1.0	4783972
BTEX & F1 Hydrocarbons										
Benzene	ug/g	<0.020	0.020	<0.040	<0.040	0.040	<0.020	<0.020	0.020	4779910
Toluene	ug/g	<0.020	0.020	<0.040	<0.040	0.040	<0.020	<0.020	0.020	4779910
Ethylbenzene	ug/g	<0.020	0.020	<0.040	<0.040	0.040	<0.020	<0.020	0.020	4779910
o-Xylene	ug/g	<0.020	0.020	<0.040	<0.040	0.040	<0.020	<0.020	0.020	4779910
p+m-Xylene	ug/g	<0.040	0.040	<0.080	<0.080	0.080	<0.040	<0.040	0.040	4779910
Total Xylenes	ug/g	<0.040	0.040	<0.080	<0.080	0.080	<0.040	<0.040	0.040	4779910
F1 (C6-C10)	ug/g	<10	10	<20	<20	20	<10	<10	10	4779910
F1 (C6-C10) - BTEX	ug/g	<10	10	<20	<20	20	<10	<10	10	4779910
F2-F4 Hydrocarbons										
F2 (C10-C16 Hydrocarbons)	ug/g	<20	20	<20	<20	20	<10	<10	10	4784530
F3 (C16-C34 Hydrocarbons)	ug/g	<100	100	<100	<100	100	<50	<50	50	4784530
F4 (C34-C50 Hydrocarbons)	ug/g	<100	100	<100	<100	100	<50	<50	50	4784530
Reached Baseline at C50	ug/g	Yes		Yes	Yes		Yes	Yes		4784530
Diesel (C10-C24)	ug/g	<100	100	<100	<100	100	<50	<50	50	4784530
Surrogate Recovery (%)										
1,4-Difluorobenzene	%	100		101	100		101	101		4779910
4-Bromofluorobenzene	%	103		103	103		103	103		4779910
D10-Ethylbenzene	%	83		77	102		79	88		4779910
D4-1,2-Dichloroethane	%	104		105	103		106	101		4779910
o-Terphenyl	%	104		101	105		103	104		4784530
RDL = Reportable Detection Limit										
QC Batch = Quality Control Batch										

O.REG 153 PETROLEUM HYDROCARBONS (SOIL)

Maxxam ID		DOK784		DOK785		DOK786			DOK787		
Sampling Date		2016/12/01 09:20		2016/12/01 09:40		2016/12/01 10:10			2016/12/01 10:35		
COC Number		587912-02-01		587912-02-01		587912-02-01			587912-02-01		
	UNITS	SA-013	RDL	SA-009	RDL	SA-008	RDL	QC Batch	SA-007	RDL	QC Batch
Inorganics											
Moisture	%	43	1.0	49	1.0	56	1.0	4783972	47	1.0	4783972
BTEX & F1 Hydrocarbons											
Benzene	ug/g	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910	<0.020	0.020	4785535
Toluene	ug/g	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910	<0.020	0.020	4785535
Ethylbenzene	ug/g	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910	<0.020	0.020	4785535
o-Xylene	ug/g	<0.020	0.020	<0.020	0.020	<0.040	0.040	4779910	<0.020	0.020	4785535
p+m-Xylene	ug/g	<0.040	0.040	<0.040	0.040	<0.080	0.080	4779910	<0.040	0.040	4785535
Total Xylenes	ug/g	<0.040	0.040	<0.040	0.040	<0.080	0.080	4779910	<0.040	0.040	4785535
F1 (C6-C10)	ug/g	<10	10	<10	10	<20	20	4779910	<10	10	4785535
F1 (C6-C10) - BTEX	ug/g	<10	10	<10	10	<20	20	4779910	<10	10	4785535
Gasoline	ug/g								<10	10	4785535
F2-F4 Hydrocarbons											
F2 (C10-C16 Hydrocarbons)	ug/g	<10	10	<20	20	<20	20	4784530	<20	20	4784530
F3 (C16-C34 Hydrocarbons)	ug/g	<50	50	<100	100	<100	100	4784530	<100	100	4784530
F4 (C34-C50 Hydrocarbons)	ug/g	<50	50	<100	100	<100	100	4784530	<100	100	4784530
Reached Baseline at C50	ug/g	Yes		Yes		Yes		4784530	Yes		4784530
Diesel (C10-C24)	ug/g	<50	50	<100	100	<100	100	4784530	<100	100	4784530
Surrogate Recovery (%)											
1,4-Difluorobenzene	%	102		101		102		4779910	104		4785535
4-Bromofluorobenzene	%	102		102		102		4779910	95		4785535
D10-Ethylbenzene	%	70		60		78		4779910	87		4785535
D4-1,2-Dichloroethane	%	99		98		99		4779910	104		4785535
o-Terphenyl	%	109		108		106		4784530	107		4784530
RDL = Reportable Detection Limit											
QC Batch = Quality Control Batch											

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		DOK771	DOK772	DOK773	DOK774	DOK775		
Sampling Date		2016/11/30 10:00	2016/11/30 10:00	2016/11/30 10:45	2016/11/30 11:20	2016/11/30 12:00		
COC Number		587912-03-01	587912-03-01	587912-03-01	587912-03-01	587912-03-01		
	UNITS	SA-015	FIELD DUP-1	SA-012	SA-011	SA-016	RDL	QC Batch
Inorganics								
Chromium (VI)	ug/g			<0.2			0.2	4855074
Metals								
Acid Extractable Mercury (Hg)	ug/g	<0.05	<0.05	<0.05	0.05	<0.05	0.05	4783794
Acid Extractable Antimony (Sb)	ug/g			<0.20			0.20	4855834
Acid Extractable Arsenic (As)	ug/g			3.5			1.0	4855834
Acid Extractable Barium (Ba)	ug/g			69			0.50	4855834
Acid Extractable Beryllium (Be)	ug/g			0.35			0.20	4855834
Acid Extractable Boron (B)	ug/g			<5.0			5.0	4855834
Acid Extractable Cadmium (Cd)	ug/g			0.53			0.10	4855834
Acid Extractable Chromium (Cr)	ug/g			23			1.0	4855834
Acid Extractable Cobalt (Co)	ug/g			7.8			0.10	4855834
Acid Extractable Copper (Cu)	ug/g			15			0.50	4855834
Acid Extractable Lead (Pb)	ug/g			8.2			1.0	4855834
Acid Extractable Molybdenum (Mo)	ug/g			<0.50			0.50	4855834
Acid Extractable Nickel (Ni)	ug/g			16			0.50	4855834
Acid Extractable Selenium (Se)	ug/g			<0.50			0.50	4855834
Acid Extractable Silver (Ag)	ug/g			<0.20			0.20	4855834
Acid Extractable Sodium (Na)	ug/g			180			50	4855834
Acid Extractable Thallium (Tl)	ug/g			0.16			0.050	4855834
Acid Extractable Uranium (U)	ug/g			1.2			0.050	4855834
Acid Extractable Vanadium (V)	ug/g			28			5.0	4855834
Acid Extractable Zinc (Zn)	ug/g			81			5.0	4855834
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		DOK776	DOK777	DOK778	DOK779	DOK780		
Sampling Date		2016/11/30 12:35	2016/11/30 13:15	2016/11/30 13:30	2016/11/30 13:50	2016/11/30 14:10		
COC Number		587912-03-01	587912-03-01	587912-03-01	587912-03-01	587912-03-01		
	UNITS	SA-005	SA-001	SA-010	SA-014	SA-006	RDL	QC Batch
Inorganics								
Chromium (VI)	ug/g		<0.2	<0.2			0.2	4855074
Metals								
Acid Extractable Mercury (Hg)	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4783794
Acid Extractable Antimony (Sb)	ug/g		<0.20	<0.20			0.20	4855834
Acid Extractable Arsenic (As)	ug/g		3.0	3.1			1.0	4855834
Acid Extractable Barium (Ba)	ug/g		75	56			0.50	4855834
Acid Extractable Beryllium (Be)	ug/g		0.34	0.31			0.20	4855834
Acid Extractable Boron (B)	ug/g		<5.0	<5.0			5.0	4855834
Acid Extractable Cadmium (Cd)	ug/g		0.38	0.31			0.10	4855834
Acid Extractable Chromium (Cr)	ug/g		24	22			1.0	4855834
Acid Extractable Cobalt (Co)	ug/g		8.7	7.3			0.10	4855834
Acid Extractable Copper (Cu)	ug/g		20	12			0.50	4855834
Acid Extractable Lead (Pb)	ug/g		7.7	7.3			1.0	4855834
Acid Extractable Molybdenum (Mo)	ug/g		<0.50	<0.50			0.50	4855834
Acid Extractable Nickel (Ni)	ug/g		17	16			0.50	4855834
Acid Extractable Selenium (Se)	ug/g		<0.50	<0.50			0.50	4855834
Acid Extractable Silver (Ag)	ug/g		<0.20	<0.20			0.20	4855834
Acid Extractable Sodium (Na)	ug/g		190	170			50	4855834
Acid Extractable Thallium (Tl)	ug/g		0.12	0.13			0.050	4855834
Acid Extractable Uranium (U)	ug/g		0.69	0.91			0.050	4855834
Acid Extractable Vanadium (V)	ug/g		31	25			5.0	4855834
Acid Extractable Zinc (Zn)	ug/g		86	79			5.0	4855834
RDL = Reportable Detection Limit								
QC Batch = Quality Control Batch								

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		DOK781	DOK782	DOK782	DOK783	DOK784		
Sampling Date		2016/11/30 14:30	2016/11/30 14:50	2016/11/30 14:50	2016/11/30 15:10	2016/12/01 09:20		
COC Number		587912-02-01	587912-02-01	587912-02-01	587912-02-01	587912-02-01		
	UNITS	SA-002	SA-004	SA-004 Lab-Dup	SA-003	SA-013	RDL	QC Batch

Inorganics								
Chromium (VI)	ug/g	<0.2	<0.2		0.3	<0.2	0.2	4856060
Metals								
Acid Extractable Mercury (Hg)	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4783794
Acid Extractable Antimony (Sb)	ug/g	<0.20	<0.20		<0.20	0.21	0.20	4854298
Acid Extractable Arsenic (As)	ug/g	10	<1.0		9.1	2.8	1.0	4854298
Acid Extractable Barium (Ba)	ug/g	68	11		66	65	0.50	4854298
Acid Extractable Beryllium (Be)	ug/g	0.32	<0.20		0.28	0.33	0.20	4854298
Acid Extractable Boron (B)	ug/g	<5.0	<5.0		<5.0	<5.0	5.0	4854298
Acid Extractable Cadmium (Cd)	ug/g	0.61	0.13		0.34	0.25	0.10	4854298
Acid Extractable Chromium (Cr)	ug/g	24	3.4		20	21	1.0	4854298
Acid Extractable Cobalt (Co)	ug/g	9.5	1.7		8.3	7.2	0.10	4854298
Acid Extractable Copper (Cu)	ug/g	17	1.6		14	12	0.50	4854298
Acid Extractable Lead (Pb)	ug/g	13	1.1		6.6	6.5	1.0	4854298
Acid Extractable Molybdenum (Mo)	ug/g	0.81	<0.50		0.65	<0.50	0.50	4854298
Acid Extractable Nickel (Ni)	ug/g	19	2.8		15	16	0.50	4854298
Acid Extractable Selenium (Se)	ug/g	<0.50	<0.50		<0.50	<0.50	0.50	4854298
Acid Extractable Silver (Ag)	ug/g	<0.20	<0.20		<0.20	<0.20	0.20	4854298
Acid Extractable Sodium (Na)	ug/g	180	72		150	150	50	4854298
Acid Extractable Thallium (Tl)	ug/g	0.16	<0.050		0.13	0.13	0.050	4854298
Acid Extractable Uranium (U)	ug/g	0.83	0.20		0.68	0.88	0.050	4854298
Acid Extractable Vanadium (V)	ug/g	23	<5.0		27	27	5.0	4854298
Acid Extractable Zinc (Zn)	ug/g	88	11		82	81	5.0	4854298

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		DOK784	DOK785	DOK786	DOK787		
Sampling Date		2016/12/01 09:20	2016/12/01 09:40	2016/12/01 10:10	2016/12/01 10:35		
COC Number		587912-02-01	587912-02-01	587912-02-01	587912-02-01		
	UNITS	SA-013 Lab-Dup	SA-009	SA-008	SA-007	RDL	QC Batch

Inorganics

Chromium (VI)	ug/g	<0.2		0.2		0.2	4856060
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Metals

Acid Extractable Mercury (Hg)	ug/g		<0.05	<0.05	<0.05	0.05	4783794
Acid Extractable Antimony (Sb)	ug/g			<0.20		0.20	4854298
Acid Extractable Arsenic (As)	ug/g			7.4		1.0	4854298
Acid Extractable Barium (Ba)	ug/g			76		0.50	4854298
Acid Extractable Beryllium (Be)	ug/g			0.42		0.20	4854298
Acid Extractable Boron (B)	ug/g			<5.0		5.0	4854298
Acid Extractable Cadmium (Cd)	ug/g			0.37		0.10	4854298
Acid Extractable Chromium (Cr)	ug/g			28		1.0	4854298
Acid Extractable Cobalt (Co)	ug/g			8.5		0.10	4854298
Acid Extractable Copper (Cu)	ug/g			21		0.50	4854298
Acid Extractable Lead (Pb)	ug/g			8.7		1.0	4854298
Acid Extractable Molybdenum (Mo)	ug/g			0.67		0.50	4854298
Acid Extractable Nickel (Ni)	ug/g			20		0.50	4854298
Acid Extractable Selenium (Se)	ug/g			<0.50		0.50	4854298
Acid Extractable Silver (Ag)	ug/g			<0.20		0.20	4854298
Acid Extractable Sodium (Na)	ug/g			190		50	4854298
Acid Extractable Thallium (Tl)	ug/g			0.14		0.050	4854298
Acid Extractable Uranium (U)	ug/g			1.5		0.050	4854298
Acid Extractable Vanadium (V)	ug/g			29		5.0	4854298
Acid Extractable Zinc (Zn)	ug/g			75		5.0	4854298

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Maxxam ID: DOK771
Sample ID: SA-015
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK771 Dup
Sample ID: SA-015
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco

Maxxam ID: DOK772
Sample ID: FIELD DUP-1
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/09	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK773
Sample ID: SA-012
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4855074	2017/02/07	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4855834	2017/02/08	2017/02/08	Viviana Canzonieri
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

TEST SUMMARY

Maxxam ID: DOK774
Sample ID: SA-011
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK775
Sample ID: SA-016
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783883	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK776
Sample ID: SA-005
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783883	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK777
Sample ID: SA-001
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4855074	2017/02/07	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4855834	2017/02/08	2017/02/08	Viviana Canzonieri
Moisture	BAL	4783883	N/A	2016/12/08	Prgya Panchal

TEST SUMMARY

Maxxam ID: DOK777
Sample ID: SA-001
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK778
Sample ID: SA-010
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4855074	2017/02/07	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4855834	2017/02/08	2017/02/08	Viviana Canzonieri
Moisture	BAL	4783883	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK778 Dup
Sample ID: SA-010
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL	4783883	N/A	2016/12/08	Prgya Panchal

Maxxam ID: DOK779
Sample ID: SA-014
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK780
Sample ID: SA-006
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/08	Barbara Wowk

TEST SUMMARY

Maxxam ID: DOK780
Sample ID: SA-006
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK780 Dup
Sample ID: SA-006
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj

Maxxam ID: DOK781
Sample ID: SA-002
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/08	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4854298	2017/02/07	2017/02/07	Daniel Teclu
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK782
Sample ID: SA-004
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/08	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4854298	2017/02/07	2017/02/07	Daniel Teclu
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

TEST SUMMARY

Maxxam ID: DOK782 Dup
Sample ID: SA-004
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos

Maxxam ID: DOK783
Sample ID: SA-003
Matrix: Soil

Collected: 2016/11/30
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/06	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4854298	2017/02/07	2017/02/07	Daniel Teclu
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK784
Sample ID: SA-013
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/09	Domnica Andronesco
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4854298	2017/02/07	2017/02/07	Daniel Teclu
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK784 Dup
Sample ID: SA-013
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin

Maxxam ID: DOK785
Sample ID: SA-009
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/09	Domnica Andronesco

TEST SUMMARY

Maxxam ID: DOK785
Sample ID: SA-009
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK786
Sample ID: SA-008
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Hexavalent Chromium in Soil by IC	IC/SPEC	4856060	2017/02/08	2017/02/08	Sally Coughlin
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4779910	N/A	2016/12/09	Domnica Andronescu
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Strong Acid Leachable Metals by ICPMS	ICP/MS	4854298	2017/02/07	2017/02/07	Daniel Teclu
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

Maxxam ID: DOK787
Sample ID: SA-007
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Methylnaphthalene Sum	CALC	4777560	N/A	2016/12/09	Automated Statchk
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	4785535	N/A	2016/12/09	Georgeta Rusu
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	4784530	2016/12/08	2016/12/09	Barbara Wowk
Mercury in Soil by CVAA	CV/AA	4783794	2016/12/08	2016/12/08	Magdalena Carlos
Moisture	BAL	4783972	N/A	2016/12/08	Prgya Panchal
PAH Compounds in Soil by GC/MS (SIM)	GC/MS	4784065	2016/12/08	2016/12/09	Mitesh Raj
Polychlorinated Biphenyl in Soil	GC/ECD	4780894	2016/12/06	2016/12/07	Farahnaz Somwaru

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.0°C
Package 2	3.0°C

PAH analysis: Detection limits were adjusted due to high moisture content for most of the samples.

PCB Analysis: Detection limits for some samples were adjusted due to high moisture content.

Revised Report (2017/02/13): Additional samples run as per client.

Revised Report (2017/09/15): BTEX/F1 results included in report.

Sample DOK771 [SA-015] : Revised report (2017/09/14): Includes all F1/BTEX parameters.

F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK772 [FIELD DUP-1] : F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK774 [SA-011] : F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK775 [SA-016] : F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK778 [SA-010] : F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK779 [SA-014] : F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK780 [SA-006] : F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK781 [SA-002] : F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK785 [SA-009] : F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK786 [SA-008] : F1-BTEX & F24 Analysis : Detection limits were adjusted for high moisture content .

Sample DOK787 [SA-007] : F24 Analysis : Detection limits were adjusted for high moisture content .

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4779910	1,4-Difluorobenzene	2016/12/06	98	60 - 140	100	60 - 140	100	%		
4779910	4-Bromofluorobenzene	2016/12/06	104	60 - 140	102	60 - 140	101	%		
4779910	D10-Ethylbenzene	2016/12/06	81	60 - 140	80	60 - 140	84	%		
4779910	D4-1,2-Dichloroethane	2016/12/06	101	60 - 140	98	60 - 140	100	%		
4780894	Decachlorobiphenyl	2016/12/06	83	60 - 130	84	60 - 130	75	%		
4784065	D10-Anthracene	2016/12/09	96	50 - 130	89	50 - 130	88	%		
4784065	D14-Terphenyl (FS)	2016/12/09	95	50 - 130	86	50 - 130	85	%		
4784065	D8-Acenaphthylene	2016/12/09	98	50 - 130	89	50 - 130	89	%		
4784530	o-Terphenyl	2016/12/08	104	60 - 130	106	60 - 130	104	%		
4785535	1,4-Difluorobenzene	2016/12/09	107	60 - 140	102	60 - 140	105	%		
4785535	4-Bromofluorobenzene	2016/12/09	118	60 - 140	110	60 - 140	91	%		
4785535	D10-Ethylbenzene	2016/12/09	95	60 - 140	83	60 - 140	92	%		
4785535	D4-1,2-Dichloroethane	2016/12/09	110	60 - 140	100	60 - 140	109	%		
4779910	Benzene	2016/12/06	62	60 - 140	84	60 - 140	<0.020	ug/g	NC	50
4779910	Ethylbenzene	2016/12/06	69	60 - 140	90	60 - 140	<0.020	ug/g	NC	50
4779910	F1 (C6-C10) - BTEX	2016/12/06					<10	ug/g	NC	30
4779910	F1 (C6-C10)	2016/12/06	62	60 - 140	96	80 - 120	<10	ug/g	NC	30
4779910	o-Xylene	2016/12/06	76	60 - 140	100	60 - 140	<0.020	ug/g	NC	50
4779910	p+m-Xylene	2016/12/06	67	60 - 140	86	60 - 140	<0.040	ug/g	NC	50
4779910	Toluene	2016/12/06	65	60 - 140	88	60 - 140	<0.020	ug/g	NC	50
4779910	Total Xylenes	2016/12/06					<0.040	ug/g	NC	50
4780894	Aroclor 1242	2016/12/07					<0.010	ug/g	NC	50
4780894	Aroclor 1248	2016/12/07					<0.010	ug/g	NC	50
4780894	Aroclor 1254	2016/12/07					<0.010	ug/g	NC	50
4780894	Aroclor 1260	2016/12/07	95	60 - 130	95	60 - 130	<0.010	ug/g	NC	50
4780894	Total PCB	2016/12/07	95	60 - 130	95	60 - 130	<0.010	ug/g	NC	50
4783794	Acid Extractable Mercury (Hg)	2016/12/08	99	75 - 125	102	80 - 120	<0.05	ug/g	NC	30
4783883	Moisture	2016/12/08							0.43	20
4783972	Moisture	2016/12/08							2.2	20
4784065	1-Methylnaphthalene	2016/12/09	93	50 - 130	91	50 - 130	<0.0050	ug/g	NC	40
4784065	2-Methylnaphthalene	2016/12/09	90	50 - 130	86	50 - 130	<0.0050	ug/g	NC	40

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4784065	Acenaphthene	2016/12/09	89	50 - 130	85	50 - 130	<0.0050	ug/g	NC	40
4784065	Acenaphthylene	2016/12/09	92	50 - 130	88	50 - 130	<0.0050	ug/g	NC	40
4784065	Anthracene	2016/12/09	87	50 - 130	84	50 - 130	<0.0050	ug/g	NC	40
4784065	Benzo(a)anthracene	2016/12/09	91	50 - 130	89	50 - 130	<0.0050	ug/g	1.8	40
4784065	Benzo(a)pyrene	2016/12/09	86	50 - 130	90	50 - 130	<0.0050	ug/g	3.8	40
4784065	Benzo(b,j)fluoranthene	2016/12/09	82	50 - 130	91	50 - 130	<0.0050	ug/g	5.6	40
4784065	Benzo(g,h,i)perylene	2016/12/09	69	50 - 130	79	50 - 130	<0.0050	ug/g	2.7	40
4784065	Benzo(k)fluoranthene	2016/12/09	83	50 - 130	86	50 - 130	<0.0050	ug/g	NC	40
4784065	Chrysene	2016/12/09	91	50 - 130	90	50 - 130	<0.0050	ug/g	8.9	40
4784065	Dibenz(a,h)anthracene	2016/12/09	76	50 - 130	77	50 - 130	<0.0050	ug/g	NC	40
4784065	Fluoranthene	2016/12/09	92	50 - 130	87	50 - 130	<0.0050	ug/g	14	40
4784065	Fluorene	2016/12/09	89	50 - 130	87	50 - 130	<0.0050	ug/g	NC	40
4784065	Indeno(1,2,3-cd)pyrene	2016/12/09	71	50 - 130	76	50 - 130	<0.0050	ug/g	1.7	40
4784065	Naphthalene	2016/12/09	81	50 - 130	82	50 - 130	<0.0050	ug/g	NC	40
4784065	Phenanthrene	2016/12/09	88	50 - 130	87	50 - 130	<0.0050	ug/g	27	40
4784065	Pyrene	2016/12/09	92	50 - 130	90	50 - 130	<0.0050	ug/g	11	40
4784530	Diesel (C10-C24)	2016/12/08					<50	ug/g		
4784530	F2 (C10-C16 Hydrocarbons)	2016/12/09	101	50 - 130	102	80 - 120	<10	ug/g	NC	30
4784530	F3 (C16-C34 Hydrocarbons)	2016/12/09	103	50 - 130	103	80 - 120	<50	ug/g	NC	30
4784530	F4 (C34-C50 Hydrocarbons)	2016/12/09	101	50 - 130	102	80 - 120	<50	ug/g	NC	30
4785535	Benzene	2016/12/09	95	60 - 140	97	60 - 140	<0.020	ug/g	3.5	50
4785535	Ethylbenzene	2016/12/09	78	60 - 140	114	60 - 140	<0.020	ug/g	6.7	50
4785535	F1 (C6-C10) - BTEX	2016/12/09					<10	ug/g	19	30
4785535	F1 (C6-C10)	2016/12/09	NC	60 - 140	101	80 - 120	<10	ug/g	18	30
4785535	Gasoline	2016/12/09	NC	60 - 140	101	60 - 140	<10	ug/g		
4785535	o-Xylene	2016/12/09	126	60 - 140	120	60 - 140	<0.020	ug/g	3.7	50
4785535	p+m-Xylene	2016/12/09	NC	60 - 140	110	60 - 140	<0.040	ug/g	6.3	50
4785535	Toluene	2016/12/09	86	60 - 140	99	60 - 140	<0.020	ug/g	6.8	50
4785535	Total Xylenes	2016/12/09					<0.040	ug/g	5.4	50
4854298	Acid Extractable Antimony (Sb)	2017/02/07	86	75 - 125	95	80 - 120	<0.20	ug/g	NC	30
4854298	Acid Extractable Arsenic (As)	2017/02/07	96	75 - 125	97	80 - 120	<1.0	ug/g	7.9	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4854298	Acid Extractable Barium (Ba)	2017/02/07	NC	75 - 125	96	80 - 120	<0.50	ug/g	1.5	30
4854298	Acid Extractable Beryllium (Be)	2017/02/07	97	75 - 125	94	80 - 120	<0.20	ug/g	5.3	30
4854298	Acid Extractable Boron (B)	2017/02/07	91	75 - 125	93	80 - 120	<5.0	ug/g	3.9	30
4854298	Acid Extractable Cadmium (Cd)	2017/02/07	95	75 - 125	95	80 - 120	<0.10	ug/g	12	30
4854298	Acid Extractable Chromium (Cr)	2017/02/07	NC	75 - 125	99	80 - 120	<1.0	ug/g	0.33	30
4854298	Acid Extractable Cobalt (Co)	2017/02/07	99	75 - 125	96	80 - 120	<0.10	ug/g	2.0	30
4854298	Acid Extractable Copper (Cu)	2017/02/07	NC	75 - 125	97	80 - 120	<0.50	ug/g	1.2	30
4854298	Acid Extractable Lead (Pb)	2017/02/07	93	75 - 125	96	80 - 120	<1.0	ug/g	3.7	30
4854298	Acid Extractable Mercury (Hg)	2017/02/07	94	75 - 125	95	80 - 120	<0.050	ug/g	NC	30
4854298	Acid Extractable Molybdenum (Mo)	2017/02/07	98	75 - 125	96	80 - 120	<0.50	ug/g	NC	30
4854298	Acid Extractable Nickel (Ni)	2017/02/07	NC	75 - 125	99	80 - 120	<0.50	ug/g	2.2	30
4854298	Acid Extractable Selenium (Se)	2017/02/07	99	75 - 125	99	80 - 120	<0.50	ug/g	NC	30
4854298	Acid Extractable Silver (Ag)	2017/02/07	96	75 - 125	96	80 - 120	<0.20	ug/g	NC	30
4854298	Acid Extractable Sodium (Na)	2017/02/07	NC	75 - 125	106	80 - 120	<50	ug/g		
4854298	Acid Extractable Thallium (Tl)	2017/02/07	90	75 - 125	93	80 - 120	<0.050	ug/g	5.6	30
4854298	Acid Extractable Uranium (U)	2017/02/07	93	75 - 125	93	80 - 120	<0.050	ug/g	5.9	30
4854298	Acid Extractable Vanadium (V)	2017/02/07	NC	75 - 125	96	80 - 120	<5.0	ug/g	1.4	30
4854298	Acid Extractable Zinc (Zn)	2017/02/07	NC	75 - 125	91	80 - 120	<5.0	ug/g	1.9	30
4855074	Chromium (VI)	2017/02/08	0 (1)	75 - 125	90	80 - 120	<0.2	ug/g	NC	35
4855834	Acid Extractable Antimony (Sb)	2017/02/08	95	75 - 125	101	80 - 120	<0.20	ug/g	NC	30
4855834	Acid Extractable Arsenic (As)	2017/02/08	102	75 - 125	96	80 - 120	<1.0	ug/g	NC	30
4855834	Acid Extractable Barium (Ba)	2017/02/08	NC	75 - 125	98	80 - 120	<0.50	ug/g	3.7	30
4855834	Acid Extractable Beryllium (Be)	2017/02/08	98	75 - 125	96	80 - 120	<0.20	ug/g	NC	30
4855834	Acid Extractable Boron (B)	2017/02/08	95	75 - 125	98	80 - 120	<5.0	ug/g	NC	30
4855834	Acid Extractable Cadmium (Cd)	2017/02/08	96	75 - 125	96	80 - 120	<0.10	ug/g	NC	30
4855834	Acid Extractable Chromium (Cr)	2017/02/08	100	75 - 125	98	80 - 120	<1.0	ug/g	0.26	30
4855834	Acid Extractable Cobalt (Co)	2017/02/08	100	75 - 125	97	80 - 120	<0.10	ug/g	3.7	30
4855834	Acid Extractable Copper (Cu)	2017/02/08	95	75 - 125	98	80 - 120	<0.50	ug/g	1.5	30
4855834	Acid Extractable Lead (Pb)	2017/02/08	95	75 - 125	99	80 - 120	<1.0	ug/g	0.84	30
4855834	Acid Extractable Mercury (Hg)	2017/02/08	100	75 - 125	99	80 - 120	<0.050	ug/g		
4855834	Acid Extractable Molybdenum (Mo)	2017/02/08	102	75 - 125	99	80 - 120	<0.50	ug/g	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4855834	Acid Extractable Nickel (Ni)	2017/02/08	101	75 - 125	98	80 - 120	<0.50	ug/g	11	30
4855834	Acid Extractable Selenium (Se)	2017/02/08	99	75 - 125	100	80 - 120	<0.50	ug/g	NC	30
4855834	Acid Extractable Silver (Ag)	2017/02/08	99	75 - 125	97	80 - 120	<0.20	ug/g	NC	30
4855834	Acid Extractable Sodium (Na)	2017/02/08	NC	75 - 125	114	80 - 120	<50	ug/g		
4855834	Acid Extractable Thallium (Tl)	2017/02/08	94	75 - 125	98	80 - 120	<0.050	ug/g	4.7	30
4855834	Acid Extractable Uranium (U)	2017/02/08	95	75 - 125	98	80 - 120	<0.050	ug/g	10	30
4855834	Acid Extractable Vanadium (V)	2017/02/08	NC	75 - 125	96	80 - 120	<5.0	ug/g	1.2	30
4855834	Acid Extractable Zinc (Zn)	2017/02/08	NC	75 - 125	97	80 - 120	<5.0	ug/g	4.0	30
4856060	Chromium (VI)	2017/02/08	11 (1)	75 - 125	86	80 - 120	0.2, RDL=0.2	ug/g	NC	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) The matrix spike recovery was below the lower control limit. This may be due in part to the reducing environment of the sample. The matrix spike was reanalyzed to confirm result.

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The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Brad Newman, Scientific Service Specialist



Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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 P.O.#: 1666131
 Project: Nuclear Demonstration Property
 Site #: Pointe Albert
 Sampled By: Paul Hurst
 Email: phurst@golder.com

PROJECT INFORMATION:
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 P.O.#: 1666131
 Project: Nuclear Demonstration Property
 Site #: Pointe Albert
 Sampled By: Paul Hurst

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										PCB	PAH				Mercury	Time Sensitive
1	SA-015		Nov 30/16	10:00	Sed					PCB	PAH	Mercury		4, 4, 4	Yes	No
2	FieldDP-1			10:00										3, 4, 3	Yes	No
3	SA-012			10:45											Yes	No
4	SA-011			11:20											Yes	No
5	SA-016			12:00											Yes	No
6	SA-005			12:35											Yes	No
7	SA-001			13:15											Yes	No
8	SA-010			13:30											Yes	No
9	SA-014			13:50											Yes	No
10	SA-006			14:10											Yes	No

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 Company Name: Paul Hurst
 Attention: Paul Hurst
 Address: phurst@golder.com
 Tel: phurst@golder.com

PROJECT INFORMATION:
 B66107
 1666131
 Nuclear Demonstration Property
 Dore/Albert

Laboratory Use Only:
 Maxxam Job #: B66107
 Bottle Order #: 57912
 Project Manager: Madison Bingley
 COC #: C#57912-02-01

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 Table 3: Agric/Other For RSC MISA Municipality
 Table 4: PWOD Other

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1 SA-002		Nov 30/16	14:30	Sed			PCB Pb Pb+CFE+Hg+HCH			4,4,4	2/14/13	
2 SA-004			14:50									
3 SA-003			15:10									
4 SA-013		Dec/16	9:20									
5 SA-004			9:40									
6 SA-008			10:10									
7 SA-007			10:35									
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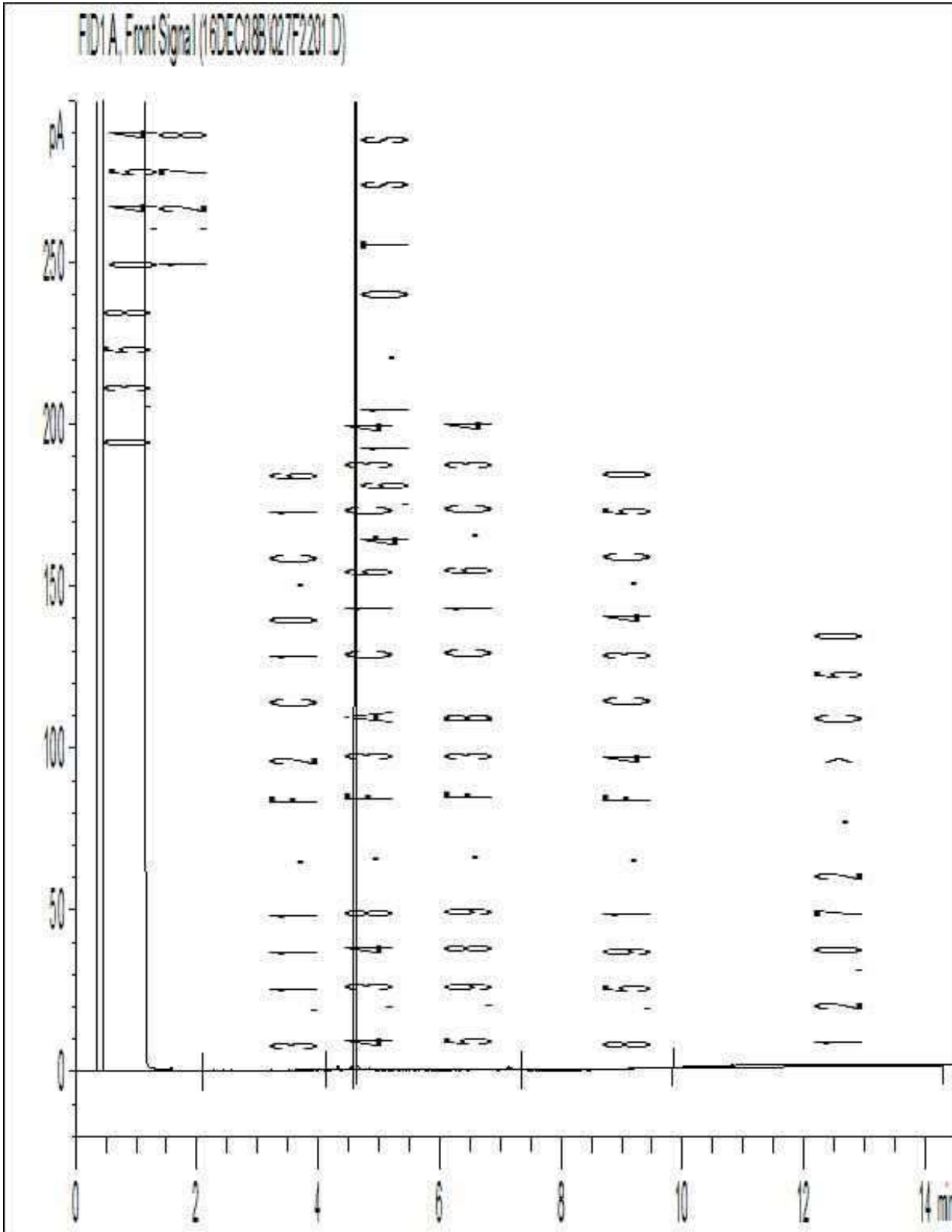
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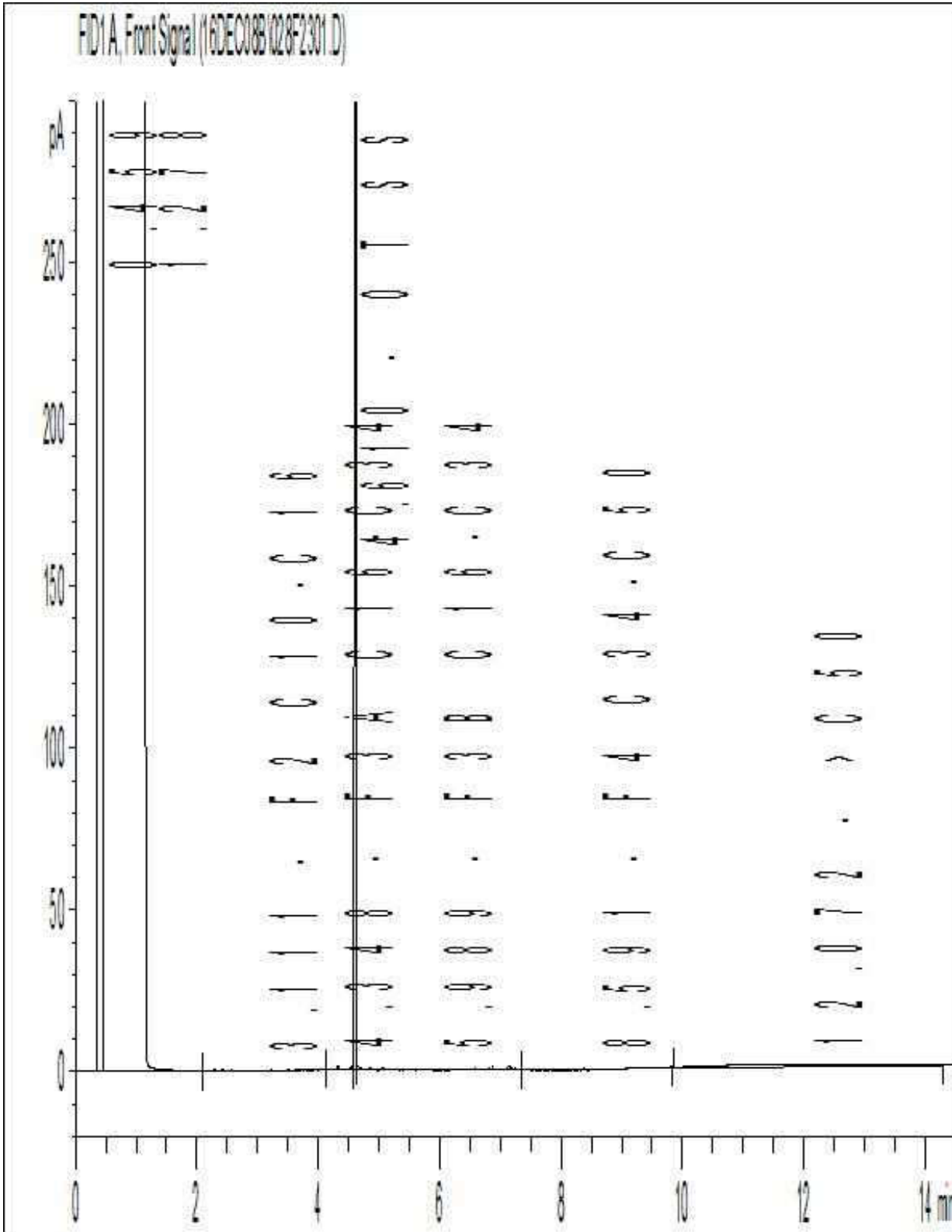
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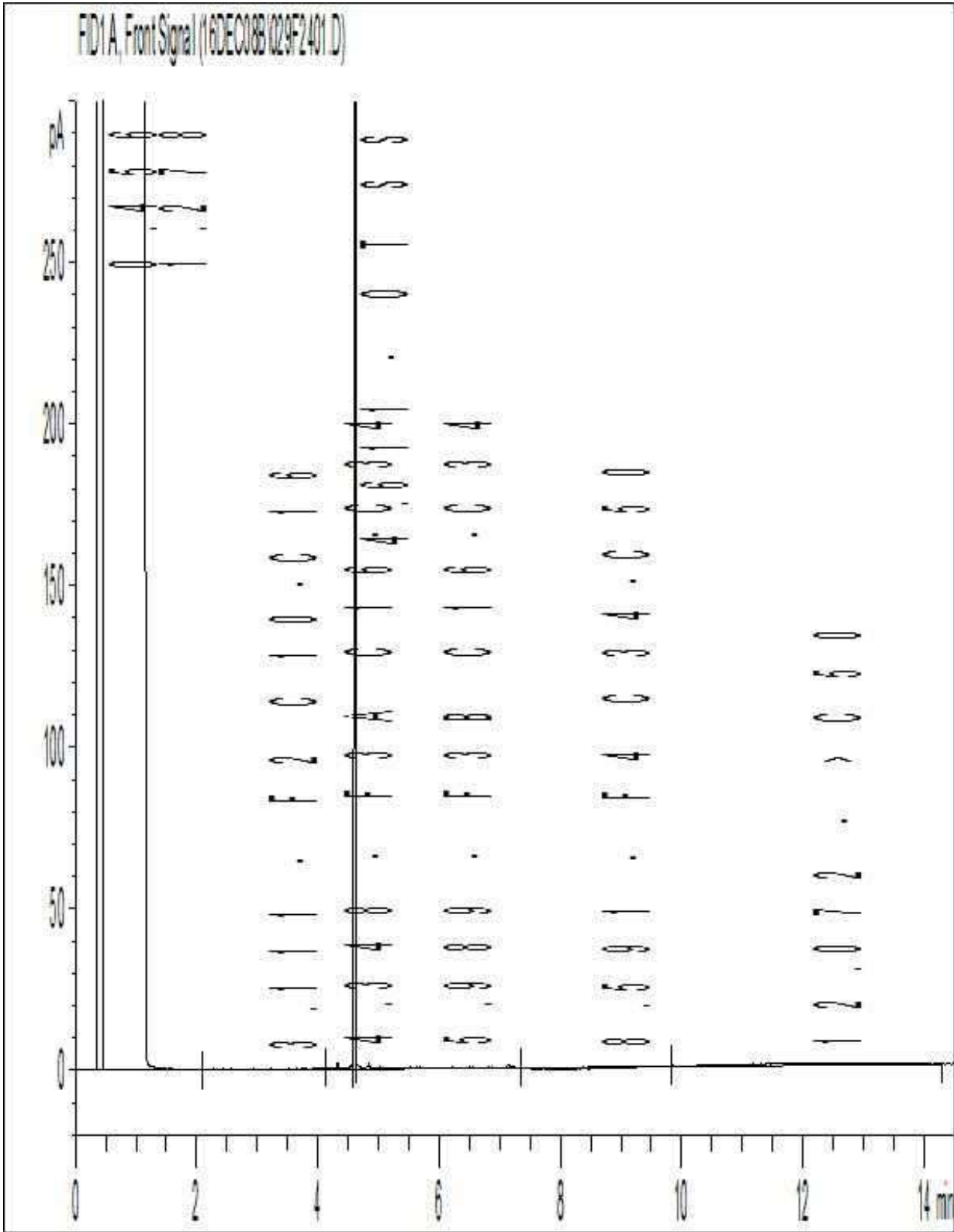
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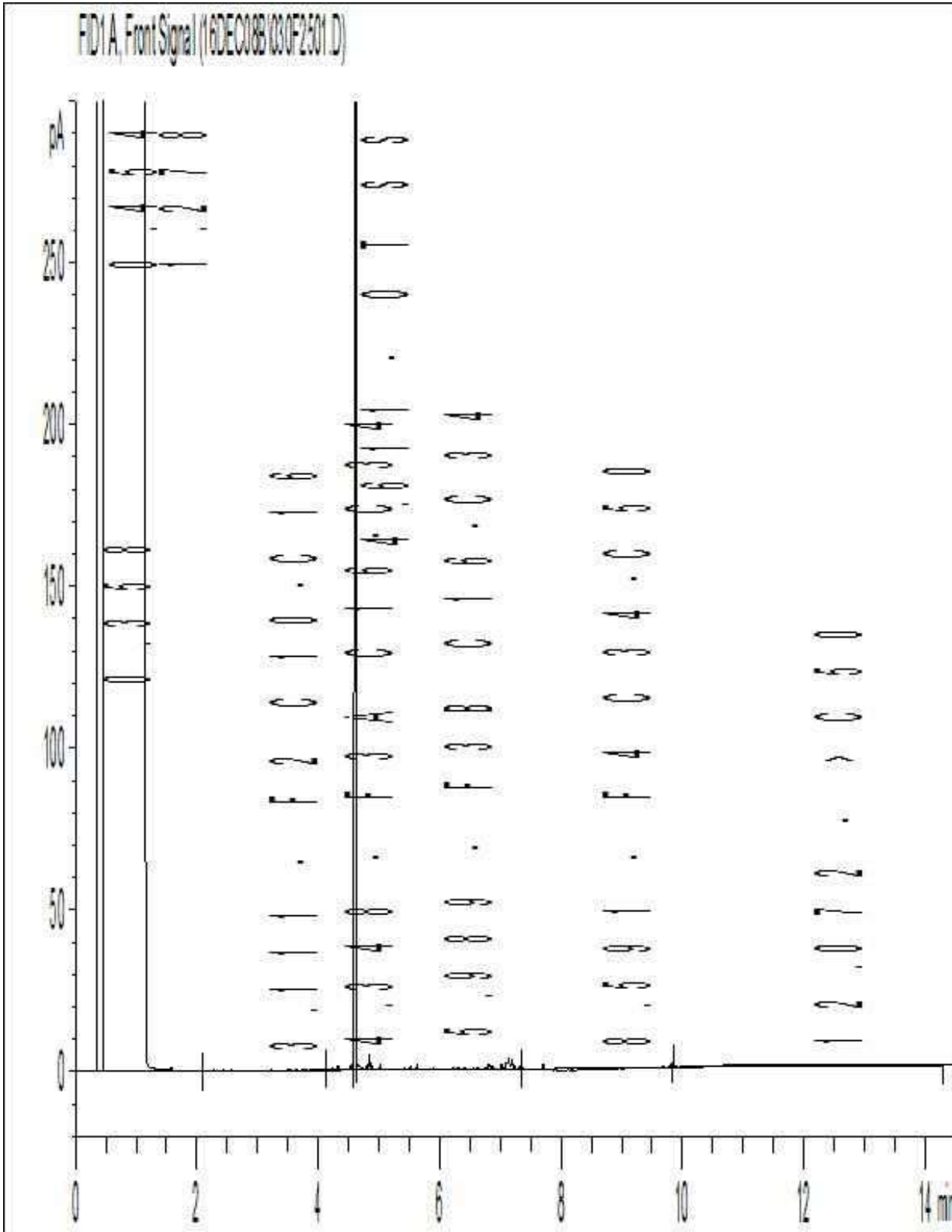
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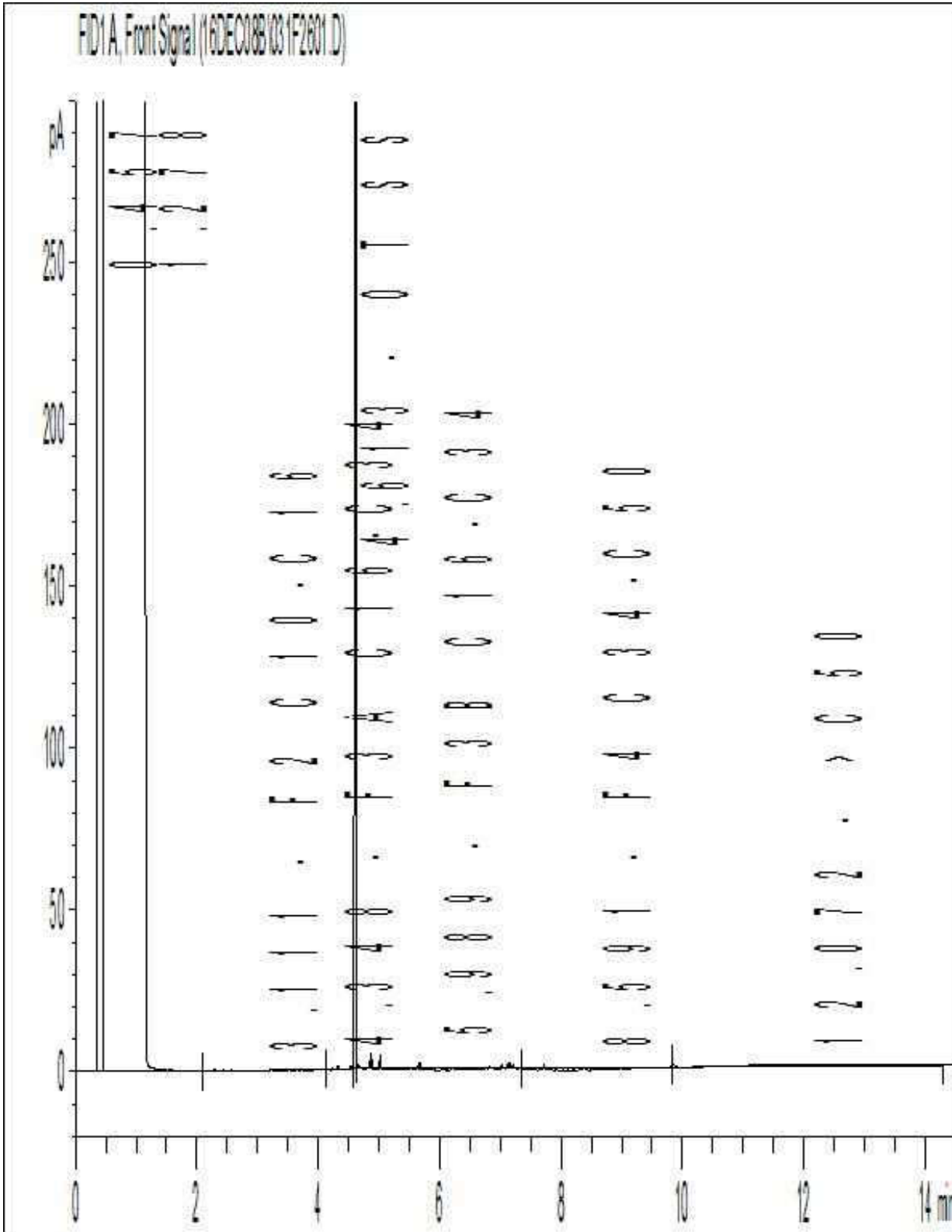
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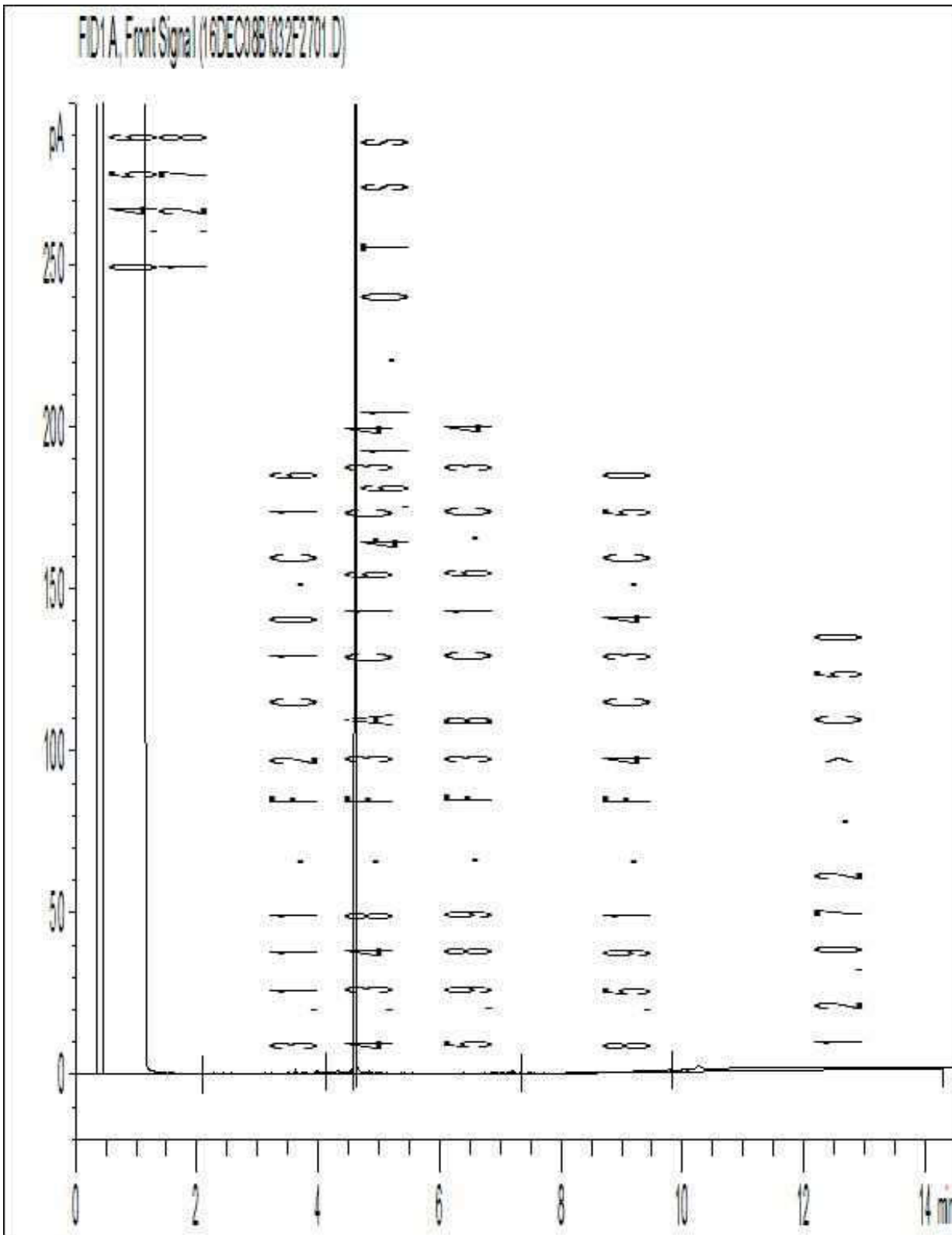
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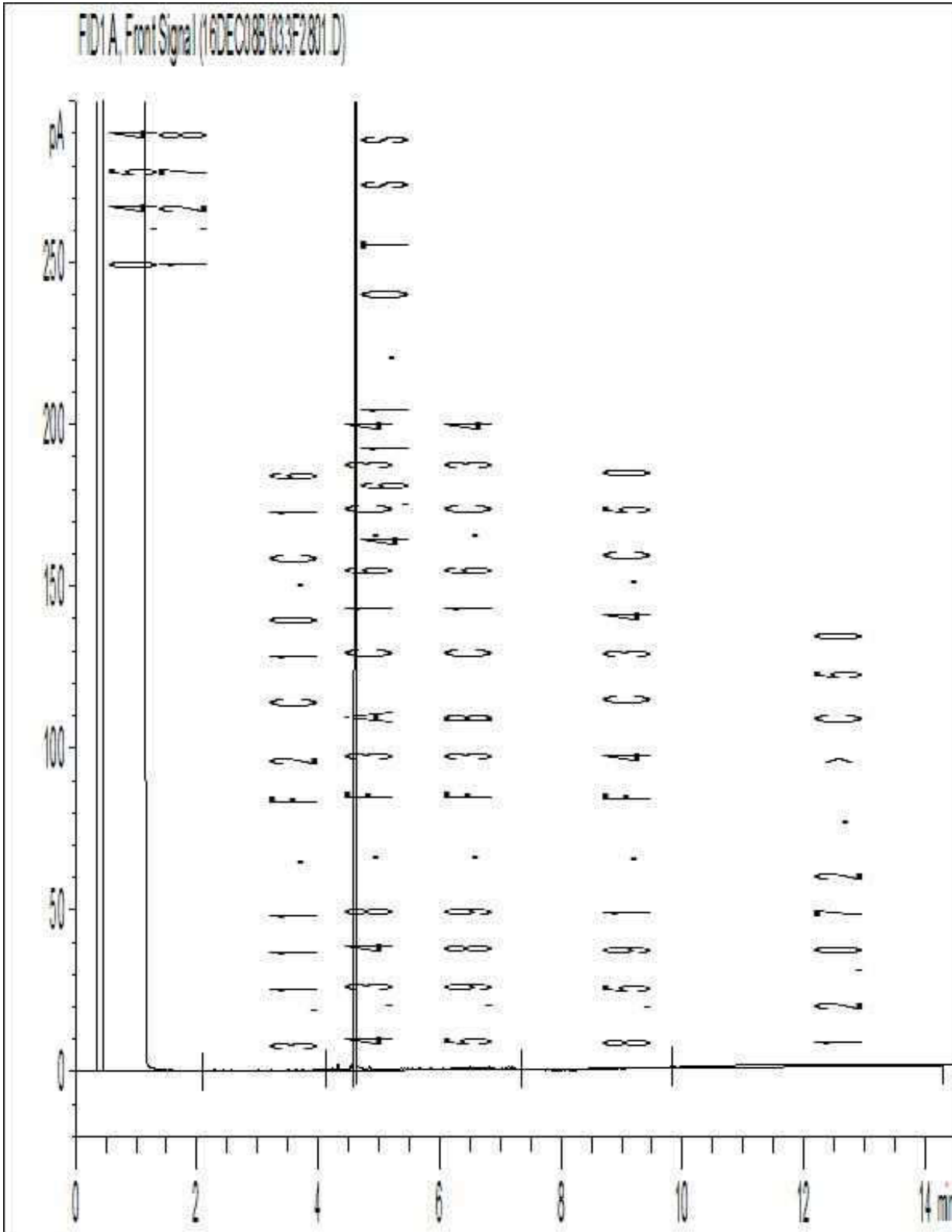
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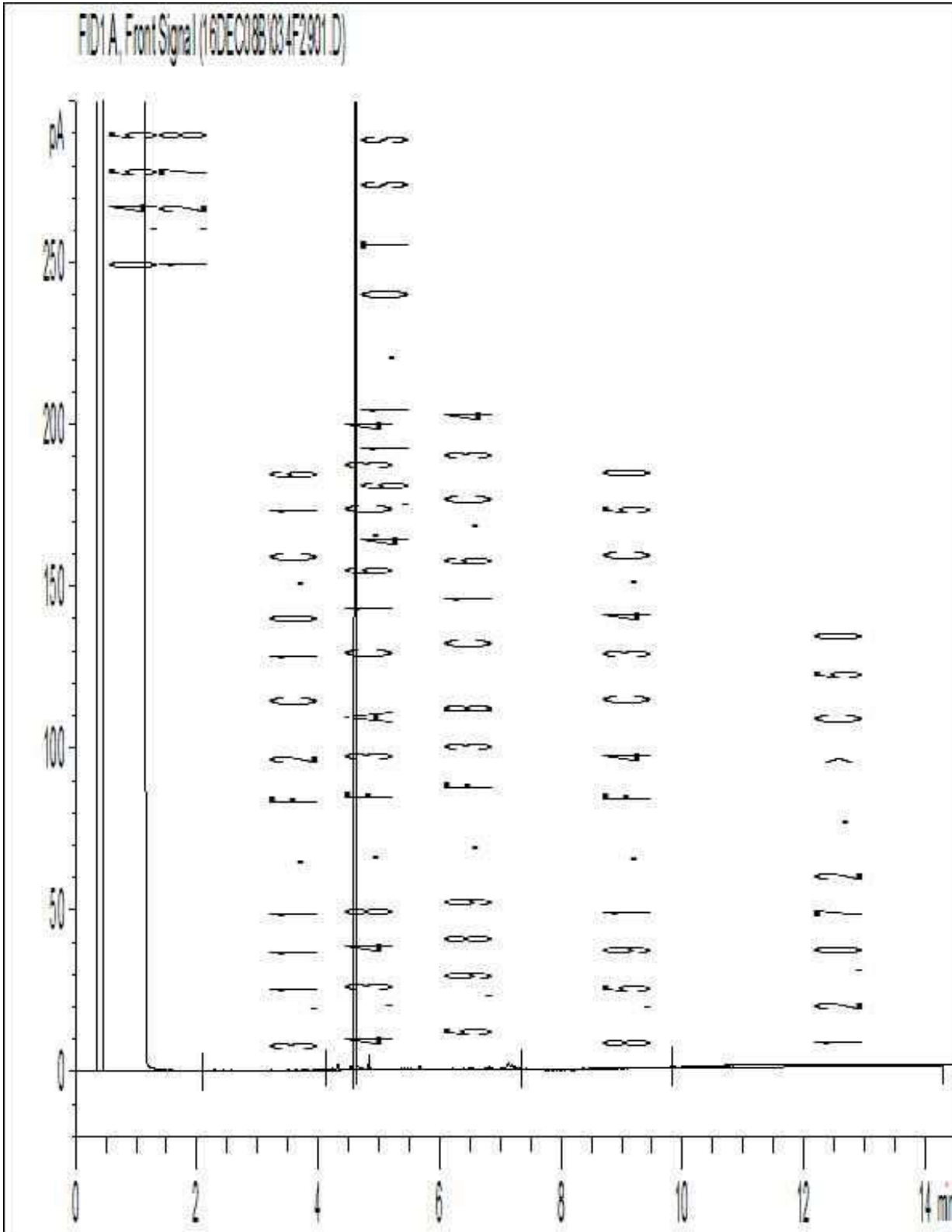
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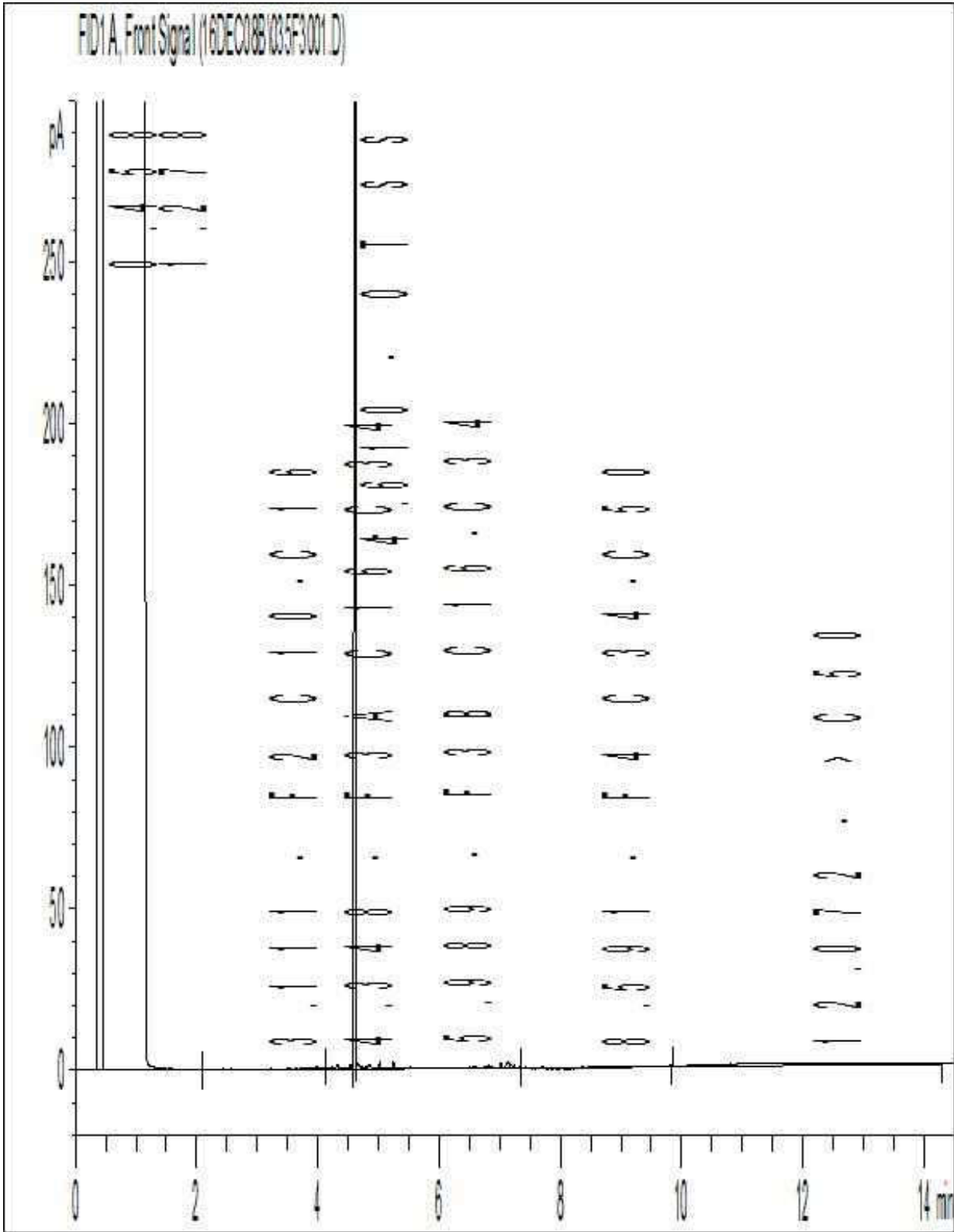
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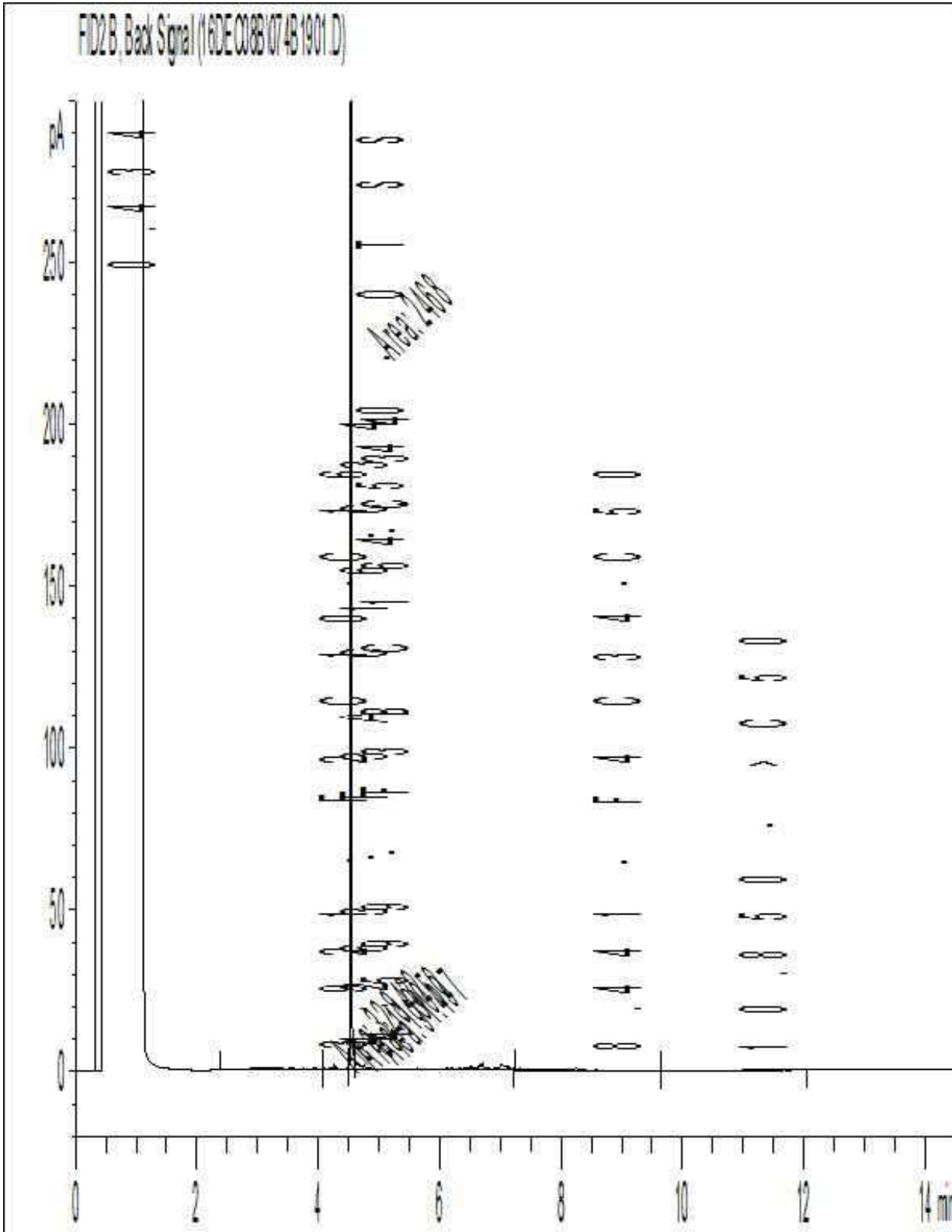
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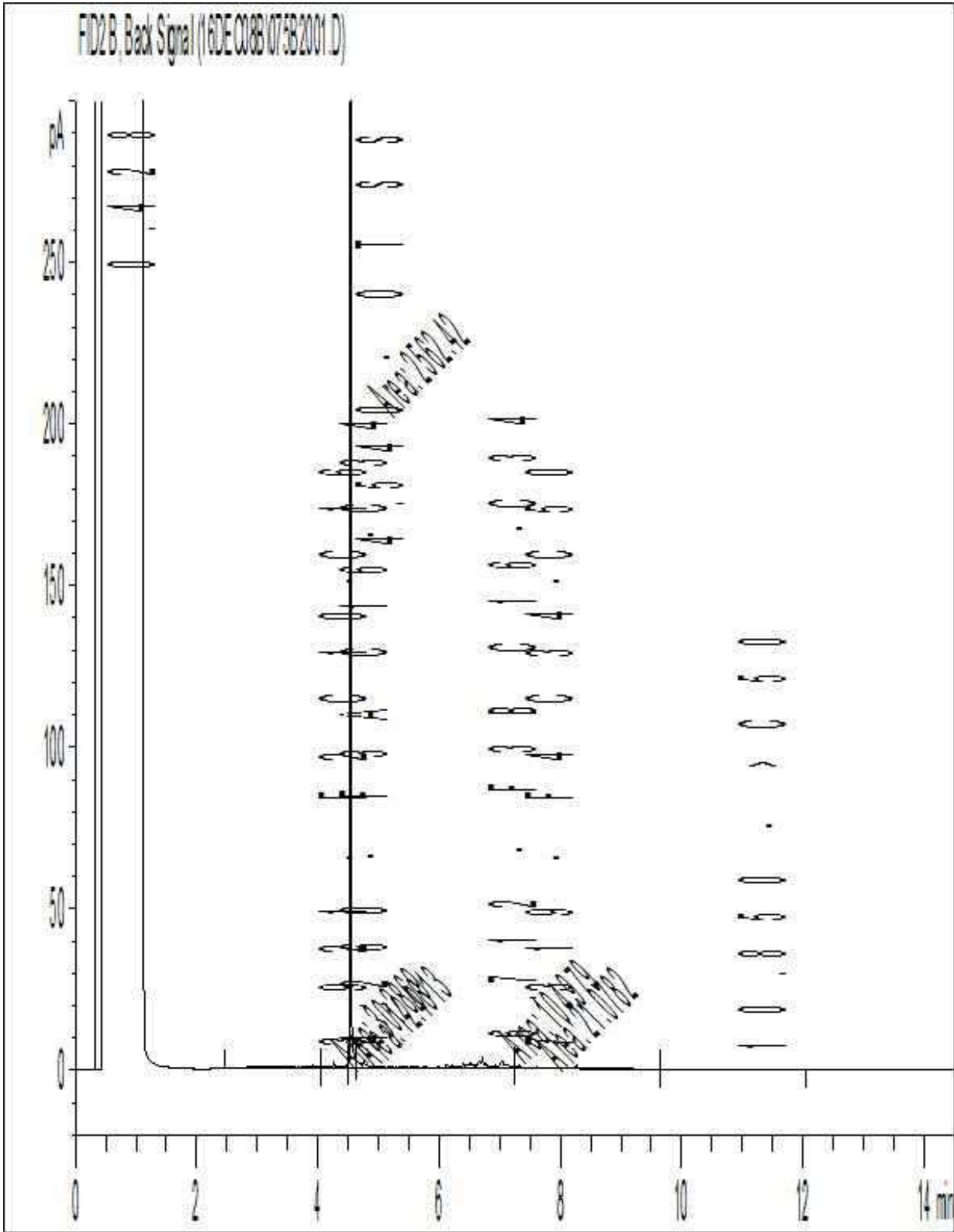
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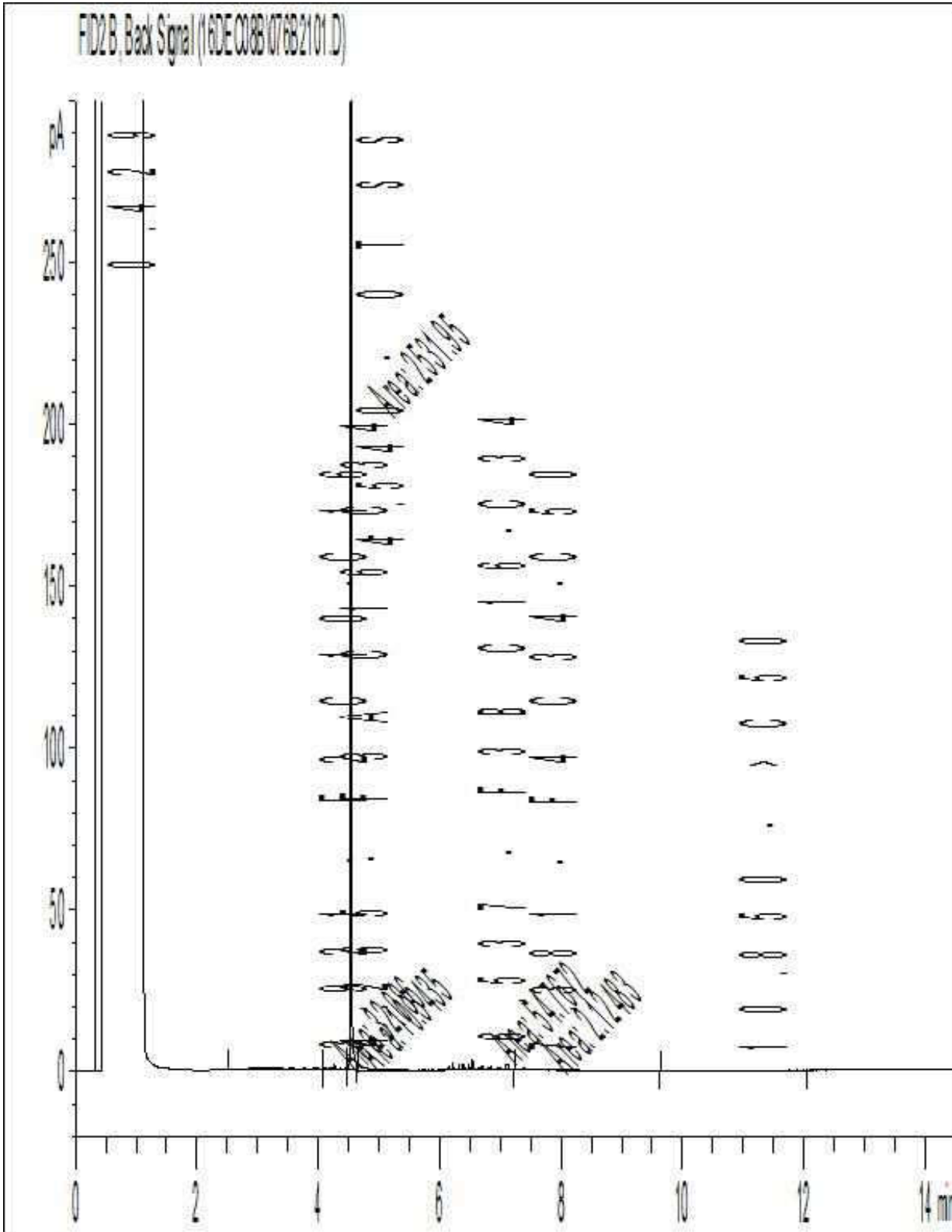
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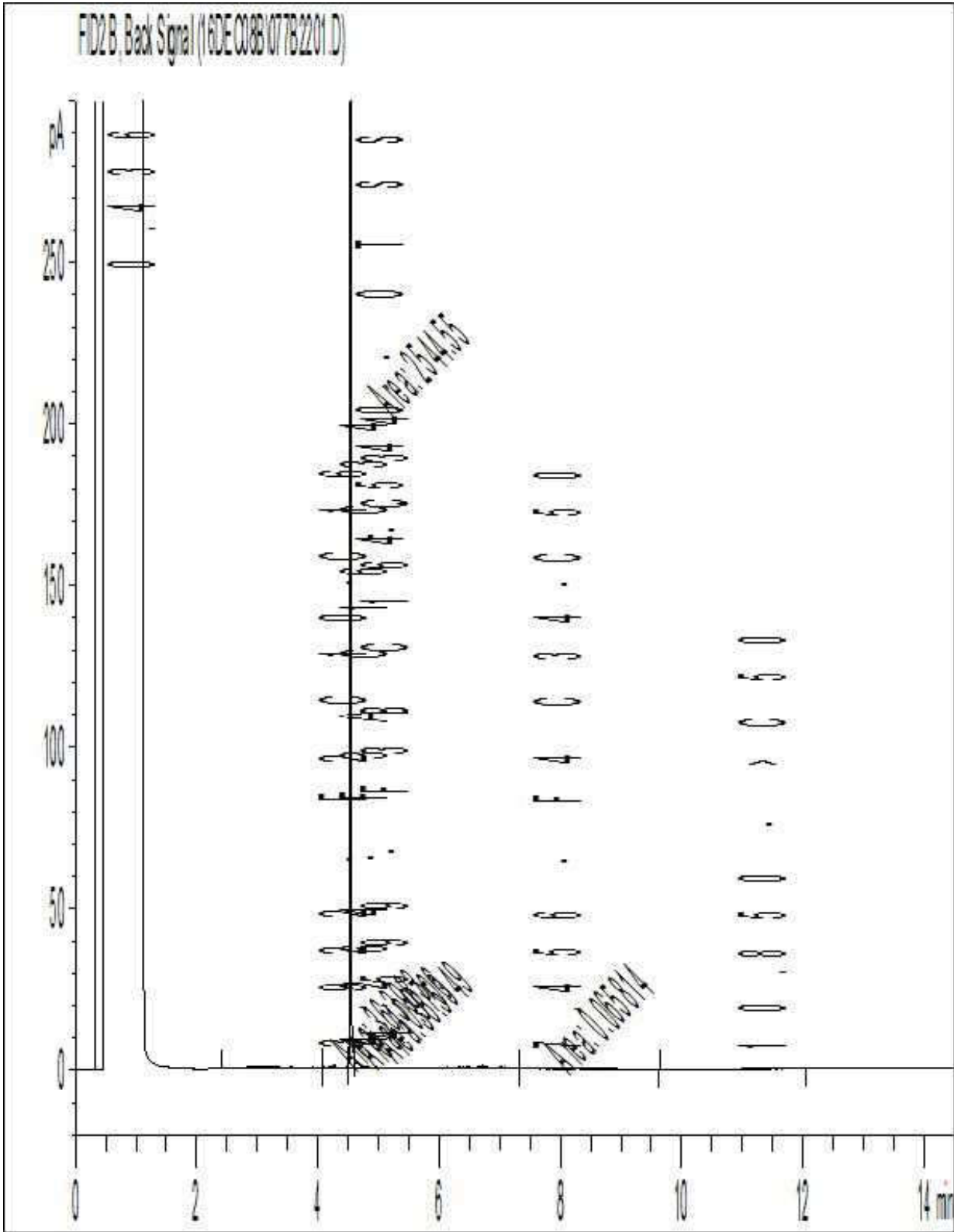
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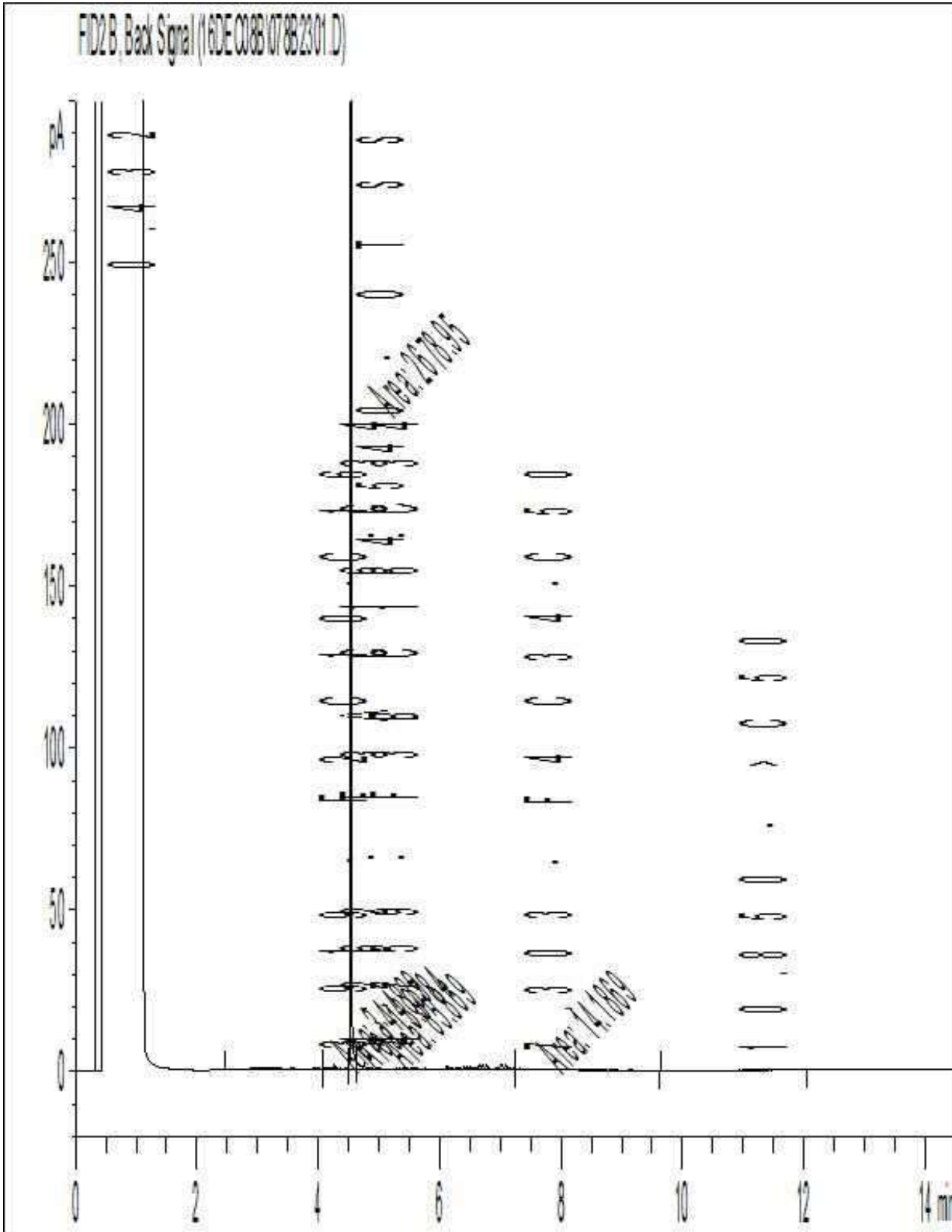
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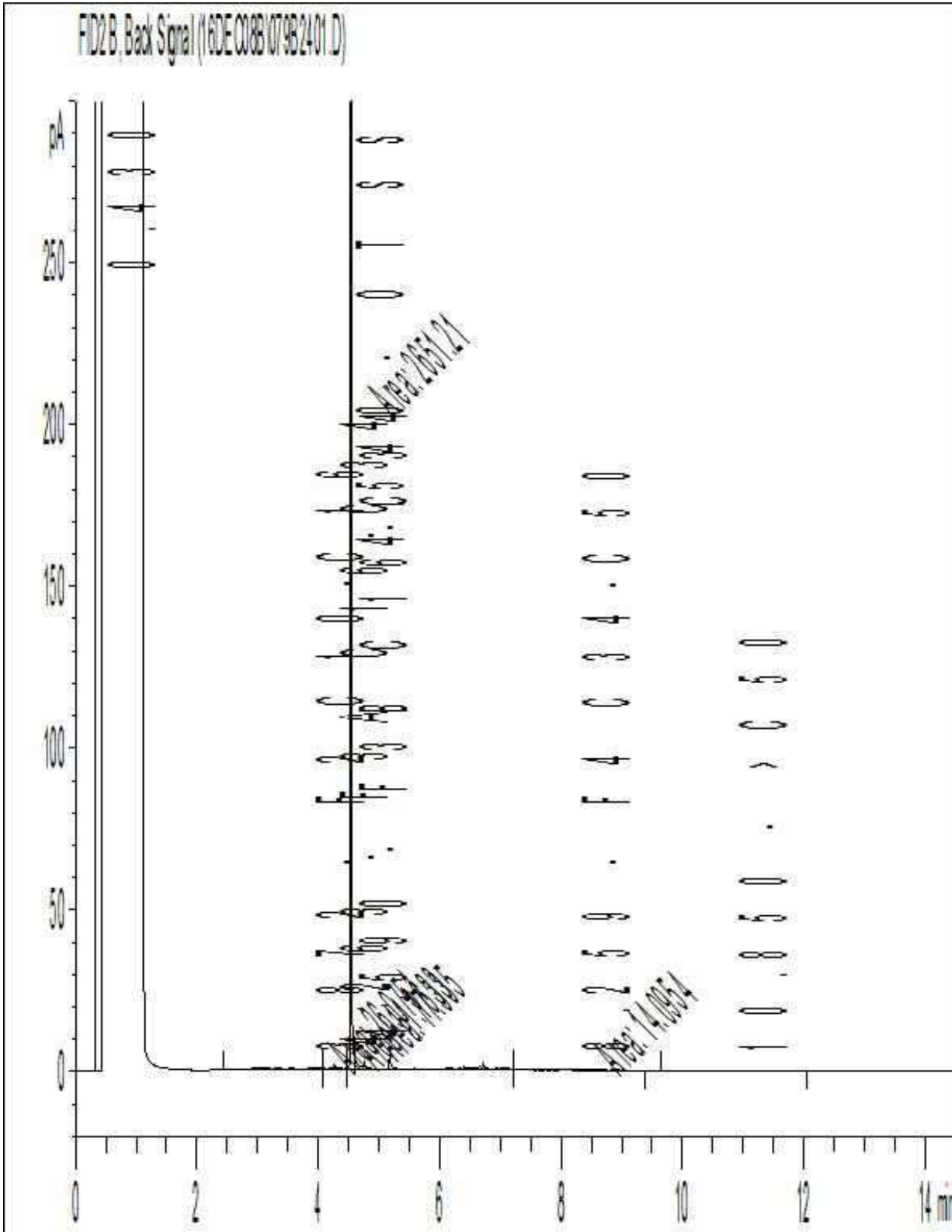
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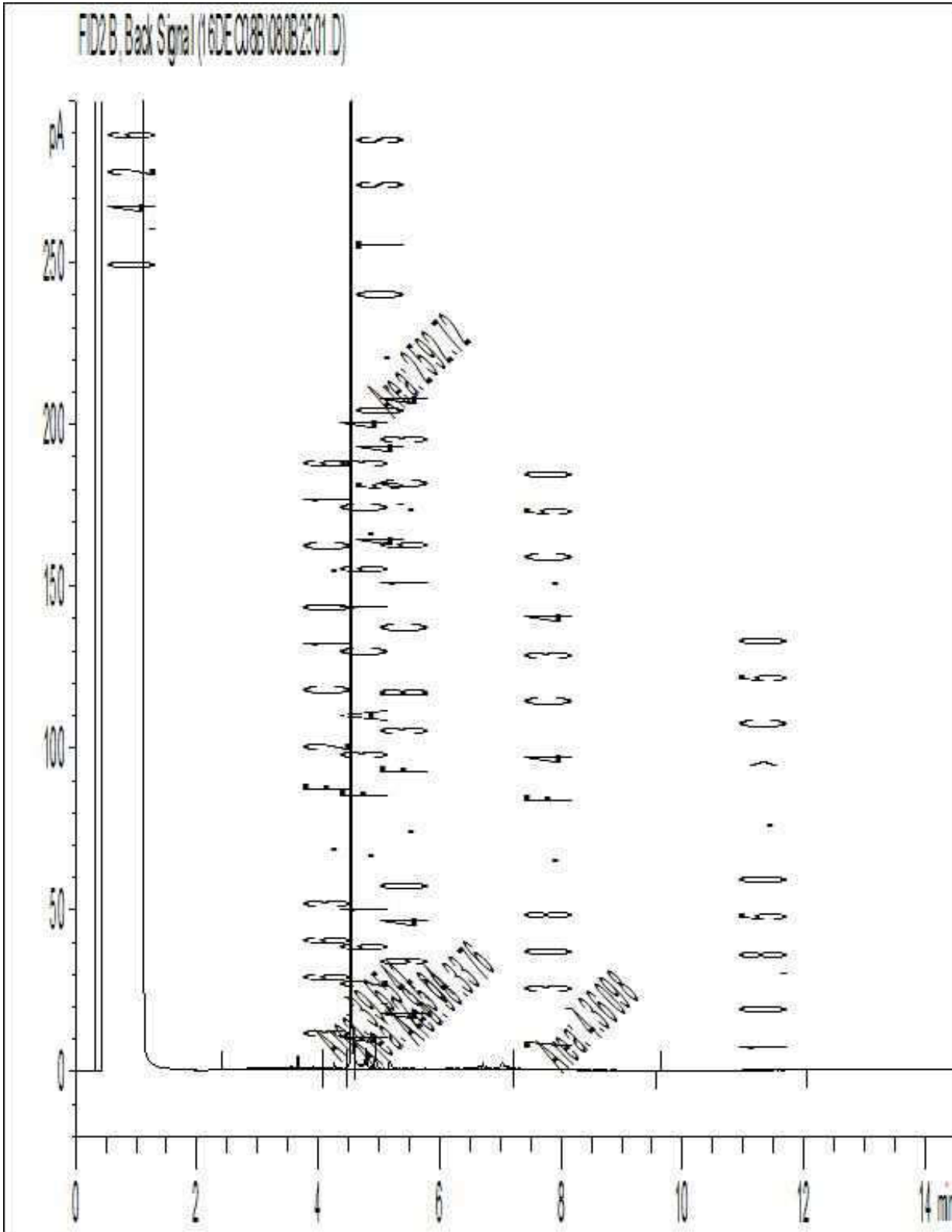
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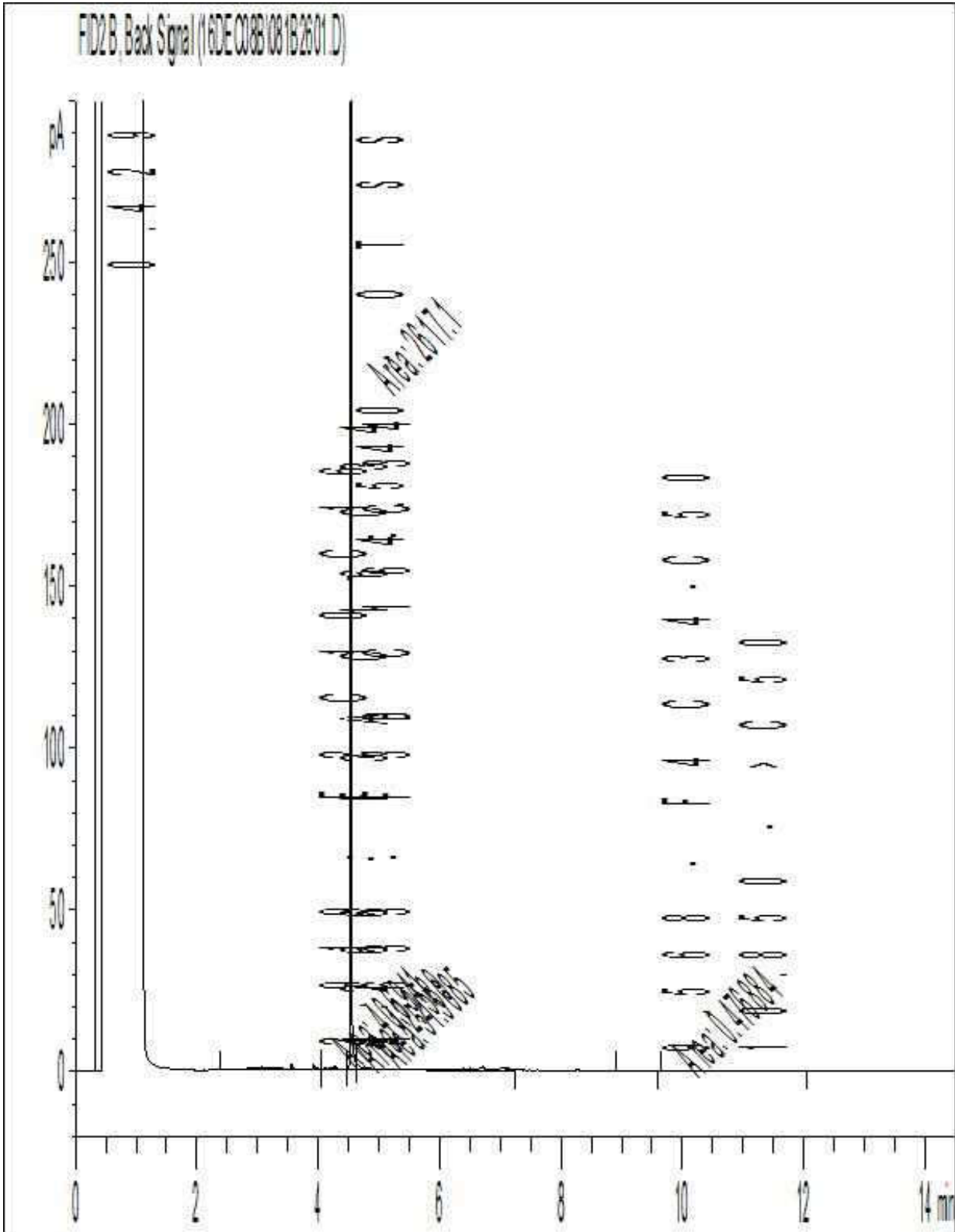
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Baseline Conditions for Ottawa River Sediment, Benthic Invertebrates and Fish Habitat Features near NPD

64-509246-ENA-001

Revision 0

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1. General Introduction

1.1 Description of the NPD Closure Project

The Nuclear Power Demonstration (NPD) site is located in the Town of Laurentian Hills in Renfrew County, Ontario, Canada, on the south bank of the Ottawa River, about 25 km upstream of the Chalk River Laboratories (CRL) site and approximately 200 km northwest of Ottawa. The NPD Nuclear Generating Station (NGS) was operated by Ontario Hydro from 1962 until being permanently shut down in 1987, when responsibility for the station was transferred to Atomic Energy of Canada Limited (AECL), a federal corporation. It is now referred to as the Nuclear Power Demonstration Waste Facility (NPDWF). Under the federal Nuclear Safety and Control Act, the NPDWF is a Class I nuclear facility presently in interim storage with surveillance and has a Waste Facility Decommissioning Licence that was issued in 2019 February by the Canadian Nuclear Safety Commission (CNSC).

The NPDWF project proposes to decommission the NPDWF to a final end state that is a permanent passive disposal facility; the NPD Disposal Facility (NPDDF). The purpose of the proposed project is to safely decommission the NPDWF, ensuring a timely reduction of Canadian legacy liabilities and eliminating interim waste storage, while reducing worker risk and transport / waste handling risk. The Government of Canada is committed to an approach to completing the decommissioning of the NPDWF that protects the public and the environment. A full description of the NPD Closure Project can be found in the Environmental Impact Statement (EIS) for the project [1].

1.2 Study Purpose, Scope and Objectives

An important component of the NPD Closure Project is the environmental monitoring of the site and the nearby Ottawa River post-decommissioning. There are several plans for follow-up monitoring at/near the NPD site, including an Environmental Monitoring Plan [2], Effluent Monitoring Plan [3] and Groundwater Monitoring Plan [4].

The focus of this report is sediment, benthic macroinvertebrate community and fish habitat in the Ottawa River near the NPD site. The EIS for the project predicted no effects on Ottawa River sediment [1]; however, if exceedances of benchmarks/guidelines are measured for contaminants in Ottawa River surface water or groundwater, sediment may also become impacted and contribute to receptor dose/exposure [2]. Sediment is along the pathway linking the source to biological receptors. The EIS also predicted no effects on the Ottawa River benthic macroinvertebrate community [1]; however, if exceedances of benchmarks/guidelines are measured for contaminants in Ottawa River sediment, benthic macroinvertebrate community sampling may be required [2]. Likewise, the EIS predicted no effects on fish or fish habitat [1]; however, if exceedances of benchmarks/guidelines are measured for contaminants in Ottawa River surface water, fish in the Ottawa River may be exposed to radiological and non-radiological contaminants and may require monitoring [2].

In order for follow-up monitoring of sediment or benthic macroinvertebrate community to occur in the future, it is essential to have recent 'baseline conditions' (i.e., pre-project

conditions) data that the monitoring data can be compared to in order to determine if there has been a change. An important component of this is the inclusion of reference locations (i.e., those unaffected by the project) so that if change is noted in future monitoring initiatives, it can be determined if this change is related to the NPD closure project, or is rather a larger region-wide environmental change caused by broader environmental shifts in conditions (e.g., climate change). The objectives of this study are to collect this required data.

It is noted that while some baseline characteristics of the aquatic environment have been compiled, detailed mapping (e.g., of substrate, fish habitat and temperature) has not been carried out specifically for the NPD Closure Project because no fish habitat impacts are anticipated from the project [1]. Because no in-water work is expected, no physical destruction to the river is expected. Similarly, no temperature or impingement/entrainment effects are expected to occur from the project. However, there was an opportunity to assemble current fish habitat knowledge for the Ottawa River near the NPD site and to provide some new fish habitat mapping information, which may be helpful for discussing Ottawa River ecology in a more holistic manner.

1.3 Description of the Ottawa River System

The north-temperate climate of the Ottawa Valley is characterized by warm, humid summers and cold, snowy winters. The Allumette Lake section of the river (between Rapides-des-Joachims and the Allumette rapids) is generally iced over from January through March. The Ottawa River flows 1,271 km from its source deep in the Abitibi-Témiscamingue region of northwestern Québec until it joins the St. Lawrence River west of Montreal, making it the second-longest Canadian river flowing to the Atlantic Ocean and the eighth largest river in Canada. The watershed, which drains an area of 146,300 km², is divided between the Provinces of Ontario and Québec (35% lies in Ontario and 65% in Québec). Before hydroelectric dams were constructed along the river system in the 1950s and 1960s, the Ottawa River consisted of significant rapids and waterfalls alternating with lakes. Today, the river is sectioned into reaches by the presence of natural rapids and hydroelectric dams. The NPD site is located in the Upper Allumette Lake reach of the river, between the Des Joachims generating station (approximately 4 km upstream of NPD) and Allumette Rapids located near Pembroke (located approximately 80 km downstream of NPD).

The Ottawa River adjacent to the NPD site is approximately 500 to 650 m wide, and between 0 and 20 m deep. Seasonal patterns of river flow are defined by periods of snow melt. Although hydroelectric development (flow regulation) has provided some moderation of the natural flow patterns, the Ottawa River still experiences the same general pattern of flow, with low flow in the fall and a sudden increase in flow with the spring melt. The mean annual river flow at NPD is 840 m³/s; however, flows can range between a summer low of ~400 m³/s and a spring freshet high of ~4,000 m³/s in flood years such as 2019.

The Ottawa River network alternates between lake-like and river-like segments. The coolwater system thermally stratifies in late July through mid-September in the deepest and slowest reaches, supporting both cool and warm water species. The banks of the Ottawa River are generally characterized as having low to moderate slopes, although steep granite cliffs

dominate sections of the Québec shoreline. Both shorelines are punctuated by points, creating bays. Shoreline substrates include silt, sand, gravel, boulders and occasional rock outcrops [5].

Situated in the Algonquin-Pontiac section of the Great Lakes-St. Lawrence Forest Region, the NPD stretch of the Ottawa River is generally forested to the river's edge by an undisturbed mixed forest consisting of jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), trembling aspen (*Populus tremuloides*), white birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), maples (*Acer* spp.), white pine (*Pinus strobus*), red pine (*Pinus resinosa*), eastern white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), red oak (*Quercus rubra*), basswood (*Tilia americana*), ash (*Sorbus americana*) and yellow birch (*Betula alleghaniensis*) [5].

Since the last period of glaciation roughly 10,000 years ago, the Ottawa River has transported and deposited sand, silt, gravel and clay from the erosion of glacial-derived soils that overlay the bedrock throughout a broad region of Ontario and Québec. The sediments in the riverbed adjacent to NPD consist of clay, silt and sand. Generally, sand predominates in shallow water, whereas clay predominates at greater depths [6]. The Ottawa River system has a great variety of habitats supporting healthy and diverse fish, wildlife, bird and plant communities [6].

2. Ottawa River Sediment

2.1 Introduction

The NPD EIS predicted no effects on Ottawa River sediment [1]; however, if exceedances of benchmarks/guidelines are measured for contaminants in Ottawa River surface water or groundwater, sediment may also become impacted and follow-up monitoring of sediments would occur [2]. To determine if sediments have been impacted, it is necessary to understand baseline (i.e., pre-project) sediment chemistry and radiochemistry characteristics.

Sonar analysis of the Ottawa Riverbed has revealed that in deeper areas of the reach, sediments are greater than 20 m thick (on top of bedrock), and the top 8 to 10 m of this is predominantly clay and silt [6]. Sandy substrate and exposed bedrock typically dominate in shallow near-shore areas of the river [6]. A number of previous studies have characterized various radiological and non-radiological constituents in Ottawa River sediments (see [6], [7], [8], [9], [10], [11]); however, few studies have focussed on targeted sampling near NPD, which is the focus of this work. Some recent data for various parameters in Ottawa River sediment near NPD is available in [9], [10], and [11], with this available information summarized in the Baseline Conditions section of the project EIS [1].

2.2 Methods

2.2.1 Sample Collection

Between 2020 June 22 and 30, Ottawa River sediment was sampled along seven cross-river transects, ranging from 2.7 km upstream of NPD to 14.9 km downstream of NPD. Along each transect, a sediment sample was collected from each of the following four depth interval bins: 0–5 m, 5–10 m, 10–15 m and 15–20 m. This was done to ensure appropriate spatial coverage

and account for the fact that different depths have different substrate compositions, some of which sorb a higher degree of contaminants than others (e.g., clay is far more sorptive than sand). This resulted in a total of 28 sediment samples collected. The upstream transect (Transect 1) represents an upstream reference site, while the farthest downstream transect (Transect 7) was chosen because this location aligns with CNL's Environmental Monitoring Program's sampling locations. The other five transects are located within a 2 km stretch adjacent to and downstream of NPD. The metadata for these sampling locations is presented in Table 1 and they are shown on a map in Figure 1.

Table 1: Metadata for sediment sampling locations on the Ottawa River near NPD.

Sample #	Sample ID	Transect	Replicate	Depth		GPS Coordinates (WKID: 4326)		Distance from NPD (km)*
				Depth Strata (m)	Depth (m)	Latitude	Longitude	
1	NPD-1-1	1	1	0–5	2.2	46°12.106	77°41.171	-2.730
2	NPD-1-2	1	2	5–10	6.8	46°12.093	77°41.136	-2.730
3	NPD-1-3	1	3	10–15	13.7	46°12.104	77°41.108	-2.730
4	NPD-1-4	1	4	15–20	16.2	46°12.083	77°41.098	-2.730
5	NPD-2-1	2	1	0–5	3.4	46°11.430	77°39.670	-0.202
6	NPD-2-2	2	2	5–10	7.0	46°11.340	77°39.646	-0.202
7	NPD-2-3	2	3	10–15	12.8	46°11.489	77°39.579	-0.202
8	NPD-2-4	2	4	15–20	19.7	46°11.508	77°39.547	-0.202
9	NPD-3-1	3	1	0–5	4.0	46°11.263	77°39.410	0.000
10	NPD-3-2	3	2	5–10	8.1	46°11.277	77°39.386	0.000
11	NPD-3-3	3	3	10–15	12.1	46°11.285	77°39.364	0.000
12	NPD-3-4	3	4	15–20	18.3	46°11.328	77°39.298	0.000
13	NPD-4-1	4	1	0–5	2.1	46°11.117	77°39.230	0.335
14	NPD-4-2	4	2	5–10	8.2	46°11.139	77°39.200	0.335
15	NPD-4-3	4	3	10–15	12.9	46°11.181	77°39.184	0.335
16	NPD-4-4	4	4	15–20	15.6	46°11.288	77°39.046	0.335
17	NPD-5-1	5	1	0–5	3.5	46°11.049	77°38.970	0.653
18	NPD-5-2	5	2	5–10	8.1	46°11.075	77°38.957	0.653
19	NPD-5-3	5	3	10–15	13.4	46°11.088	77°38.913	0.653
20	NPD-5-4	5	4	15–20	16.7	46°11.186	77°38.777	0.653
21	NPD-6-1	6	1	0–5	3.6	46°10.936	77°38.502	1.193
22	NPD-6-2	6	2	5–10	7.7	46°10.945	77°38.488	1.193
23	NPD-6-3	6	3	10–15	14.3	46°10.957	77°38.455	1.193
24	NPD-6-4	6	4	15–20	17.5	46°10.967	77°38.385	1.193
25	NPD-7-1	7	1	0–5	2.1	46°06.699	77°29.465	14.875
26	NPD-7-2	7	2	5–10	8.2	46°06.696	77°29.451	14.875
27	NPD-7-3	7	3	10–15	12.1	46°06.704	77°29.440	14.875
28	NPD-7-4	7	4	15–20	18.6	46°06.741	77°29.394	14.875

Note: * Distance from NPD refers to distance upstream of NPD (negative values), adjacent to NPD (zero) and downstream of NPD (positive values).

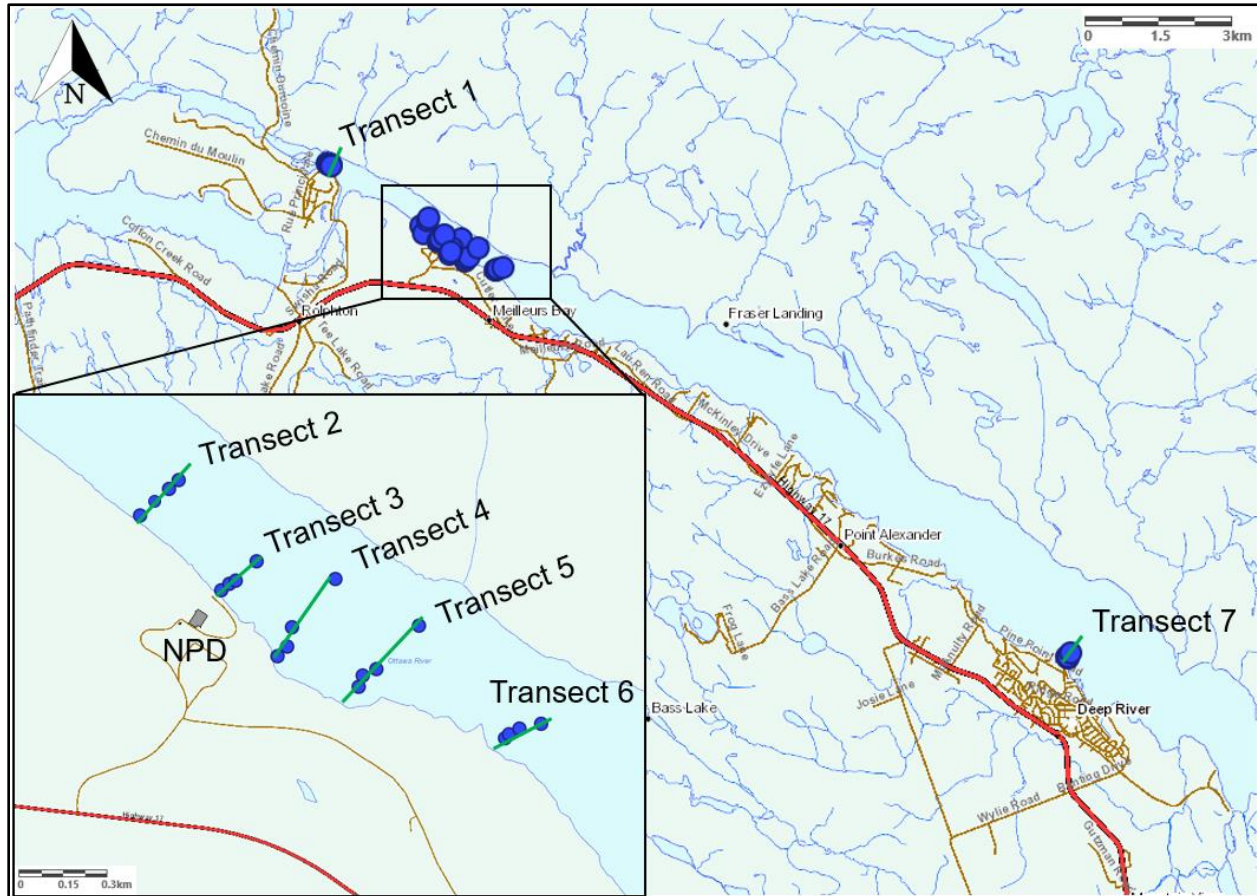


Figure 1: Map of sediment sampling locations (blue dots) along transects (green lines) on the Ottawa River near NPD.

An Ekman dredge sampler (Wildco®, 9"×9"×9", sampling an area of 81 in² or 523 cm²) was used for sample collection, with the top-5 cm of sediment collected and retained from each Ekman sample. The Ekman Dredge is used for sampling sediment and benthic communities inhabiting soft bottomed aquatic environments. Hinged upper doors swing open as the dredge is lowered, allowing water to pass through and minimize shock wave. A stainless steel messenger is sent down a rope and closes the dredge, preventing washout of the sample. Immediately after collection, sediment samples were put into pre-labelled Zip-Lock bags and put on ice in a cooler. At the end of each sampling day, sediment samples were transferred from the Zip-Lock bags into 500 mL High Density Polyethylene (HDPE) sample containers (filled to the top with no headspace) provided by GEL Laboratories, who analyzed the samples. All samples were kept refrigerated at 4°C until analysis. At each sampling location, a Global Positioning System (GPS) waypoint was taken and a depth measurement was recorded using a sonar unit. Several photos from the sampling campaign are presented in Figure 2.

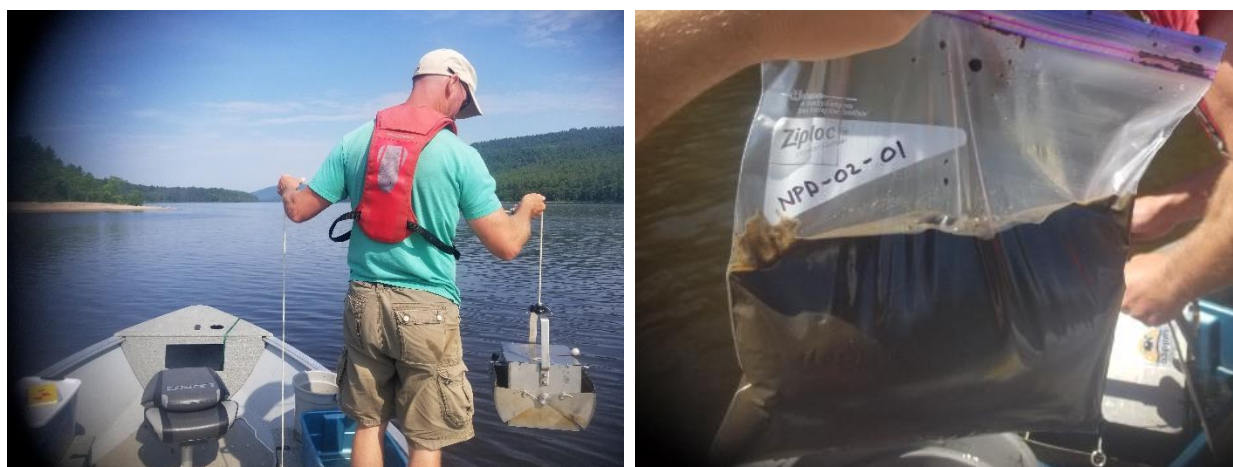


Figure 2: Photos from the sediment sampling campaign showing the Ekman dredge sampler (left) and a typical Ottawa River sediment sample (right).

2.2.2 Sample Analysis

Fresh (wet) sediment samples were shipped on ice in coolers to GEL Laboratories in South Carolina, USA, to be analyzed for a suite of radiological and chemical constituents. An overview of analytical instruments used and analytical procedures followed for the various analyses is presented in Table 2.

Table 2: Summary of analytical methods used for the analysis of sediment samples.

Analyte Group	Analysis Method	Analytical Procedures Followed
Metals		
Mercury	Cold Vapour Atomic Absorption (CVAA)	EPA SW846 7471A
Lithium	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	EPA SW846 3050S/6020
Metals Suite	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	EPA SW846 3050B/6010B
Organic Compounds		
Semi-Volatile PCBs	Gas Chromatography with Electron Capture Detector (GC/ECD)	EPA SW846 3541/8082A
Radionuclides		
Gamma-Emitters	Gamma Spectroscopy	DOE HASL 300, 4.5.2.3/Ga-01-R
Gross Beta	Gas Flow Proportional Counting (GFPC)	EPA 900.0/SW846 9310/SM 7110B Modified
Total Alpha	Gas Flow Proportional Counting (GFPC)	EPA 900.0/SW846 9310/SM 7110B Modified
Tritium	Liquid Scintillation Analysis	EPA 906.0 Modified
Carbon-14	Liquid Scintillation Analysis	EPA EERF C-01 Modified

2.2.3 Data Analysis

Data was analyzed following recommendations by Environment and Climate Change Canada's Federal Contaminated Sites Action Plan [12] and the United States Environmental Protection

Agency (US EPA) [13] for the characterizations of baseline conditions in sediment. For the sediment chemistry and radiochemistry datasets, mean values, median values, \pm standard deviation (S.D.) and the 95% Upper Confidence Limit of the Mean (ULCM) were calculated following [13], [14] and [15].

Based on the results of the report by Singh et al. [14], it is recommended to avoid the use of the Detection Limit (DL)/2 substitution method when calculating summary statistics and various other values often used to estimate the Background Threshold Values or Baseline Concentrations. Until recently, the DL/2 substitution method was the most commonly used method for calculating various statistics of interest for data sets which include non-detect (ND) results. The main reason for this has been the lack of the availability of the other rigorous methods and associated software programs that can be used to estimate the various environmental parameters of interest.

For the calculation of the 95% UCLM values, the US EPA ProUCL Version 5.1 software tool was used, as this provides for a statistical framework for analyzing data sets with and without non-detect observations, and there were many non-detect values obtained for this initiative. This ProUCL tool calculates summary statistics based on the sample size, distribution of the data (normal, lognormal, gamma or unknown), the degree of skewness exhibited by the data and the percentage of non-detects (Kaplan-Meier Method [13]). Results for all 28 sediment samples collected along the seven transects were used to calculate these summary statistics (Table 3). When datasets contained ND values, the mean, standard deviation and 95% UCLM were calculated using Kaplan-Meier statistical methods that account for the ND values. When there were no ND values in a dataset, these statistics were calculated following traditional methods. In these instances, the geometric mean and median were also possible to calculate. In situations when all results were $<$ DL, only the lowest and highest DLs are reported.

2.3 Results and Discussion

Sediment chemistry and radiochemistry results are summarized in Table 3 and Table 4 below. The complete raw dataset for these sediment results is presented in a series of tables and box plots in Appendix A through Appendix D.

Generally speaking, the results for non-radiological parameters are typical of what has been observed for Ottawa River sediments in other studies (e.g., [6], [8], [16], [17]). Metal concentrations reflect local geology for the most part. Metals in aquatic systems occur both naturally and from anthropogenic sources, such as past or present mining and mineral processing in the basin and other industrial activities ([16], [18], [19]). Additional inputs come from accelerated leaching due to acidification of soils, from soil erosion, and from atmospheric transport from more industrialized areas outside the basin [18]. It is not known what fraction of the metals currently found in the river is from natural sources and what fraction is from anthropogenic sources [18].

Observed sediment concentrations are compared to relevant benchmark values, where available, including the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG) [20], the CCME Sediment Probable Effects Levels (PEL) [20],

and the Ontario Regulation 153 sediment standards for use under part XV.1 of the *Environmental Protection Act* [21] (Table 3).

There were a number of parameters that exceeded CCME and/or OReg153 benchmark values for freshwater sediments, including Mercury, Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Silver, and Zinc (Table 3), as described below:

- **Mercury:** the highest concentration measured was 212 µg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from 13 to 126 µg/kg (mean = 45.35 ± 42.51 µg/kg; 95% UCLM = 59.39 µg/kg). By comparison, the CCME ISQG for mercury is 170 µg/kg, the OReg153 value is 200 µg/kg, and the CCME PEL (the level at which adverse effects on some sensitive species could occur) for mercury is 486 µg/kg. Mercury contamination in aquatic ecosystems is ubiquitous in eastern North America due to atmospheric sources such as metal smelting, combustion of fossil fuels and incineration of waste [19]. A 1987 study attributed elevated levels of heavy metals in sediments in this area of the Ottawa River, both upstream and downstream of NPD, to inputs from historical upstream metal mining [16]. CNL's investigations indicate that elevated levels of mercury in Ottawa River sediment are due to secondary contaminant focusing from the deposition of both natural mercury and that originating from upstream, mainly historical, contamination sources (e.g., pulp and paper milling prior to stringent regulation and logging operations) [6]. Ramamoorthy and Rust [8] found that Ottawa River sediments can act as efficient sinks for heavy metals, primarily due to the significant loading of organic material above natural amounts from the prior commercial use of the river for logging.
- **Arsenic:** the highest concentration measured was 27 mg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from 0.68 to 16.9 mg/kg (mean = 5.15 ± 5.37 mg/kg; 95% UCLM = 6.88 mg/kg). By comparison, the CCME ISQG for arsenic is 5.9 mg/kg, the OReg153 value is 6.0 mg/kg, and the CCME PEL for arsenic is 17 mg/kg. As with mercury, these elevated concentrations in arsenic are regional and have been previously described by Ramamoorthy and Rust [8].
- **Cadmium:** the highest concentration measured was 1.76 mg/kg in a single sample at ~6 m depth along Transect 4 downstream of NPD, with other concentrations typically ranging from < 0.18 to 1.11 mg/kg (mean = 0.47 ± 0.41 mg/kg; 95% UCLM = 0.61 mg/kg). By comparison, the CCME ISQG and the OReg153 value for cadmium is 0.6 mg/kg, and the CCME PEL is 3.5 mg/kg.
- **Chromium:** the highest chromium concentration measured was 71.1 mg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from 3.17 to 42.8 mg/kg (mean = 23.25 ± 15.16 mg/kg; 95% UCLM = 28.2 mg/kg). By comparison, the CCME ISQG for chromium is 37.3 mg/kg, the OReg153 value is 26 mg/kg, and the CCME PEL for chromium is 90 mg/kg.
- **Copper:** the highest copper concentration measured was 47.7 mg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from 1.92 to 40.9 mg/kg (mean = 14.73 ± 10.43 mg/kg; 95% UCLM = 18.15 mg/kg). By

comparison, the CCME ISQG for copper is 35.7 mg/kg, the OReg153 value is 16 mg/kg, and the CCME PEL for copper is 197 mg/kg.

- **Lead:** the highest lead concentration measured was 49.9 mg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from < 0.6 to 12.6 mg/kg (mean = 8.61 ± 10.04 mg/kg; 95% UCLM = 12.36 mg/kg). By comparison, the CCME ISQG for copper is 35 mg/kg, the OReg153 value is 31 mg/kg, and the CCME PEL for lead is 91 mg/kg.
- **Nickel:** the highest nickel concentration measured was 59.1 mg/kg in a single sample at ~20 m depth along Transect 7 in Deep River, with other concentrations typically ranging from 2.73 to 24.5 mg/kg (mean = 16.75 ± 11.70 mg/kg; 95% UCLM = 20.59 mg/kg). By comparison, the only available benchmark value (OReg153) is 16 mg/kg.
- **Silver:** the highest silver concentration measured was 316 mg/kg in a single sample at ~6 m depth along Transect 4 downstream of NPD, with other concentrations were highly variable and ranged from < 0.18 to 236 mg/kg (mean = 81.02 ± 91.14 mg/kg; 95% UCLM = 110.7 mg/kg). By comparison, the only available benchmark value (OReg153) is 0.5 mg/kg.
- **Zinc:** the highest zinc concentration measured was 1,150 mg/kg in a single sample at ~6 m depth along Transect 4 downstream of NPD, with other concentrations highly variable and typically ranging from < 1.8 to 1,090 mg/kg (mean = 296.9 ± 418.6 mg/kg; 95% UCLM = 431.9 mg/kg). By comparison, the CCME ISQG for zinc is 123 mg/kg, the OReg153 value is 120 mg/kg, and the CCME PEL for zinc is 315 mg/kg.

Table 3: Summary statistics for Ottawa River sediment chemistry results near NPD.

Analyte	Unit (d.w.)	Min.	Max.	Mean	Geo. Mean	Median	± S.D.	95% UCLM	% ND	CCME Sediment ISQG	CCME Sediment PEL	REG153 (11) T8-Sediment or Other
Mercury	µg/kg	< 9.1	212	45.35	33.31	-	42.51	59.39	14.8	170	486	200
Aluminum	mg/kg	1,250	26,200	8,509	7,093	7,450	5,285	10,558	0.0	-	-	-
Antimony	mg/kg	< 0.394	2.370	0.552	-	-	0.422	0.707	82.1	-	-	-
Arsenic	mg/kg	< 0.623	27.0	5.152	3.561	-	5.371	<u>6.876</u>	7.1	5.9	17	6
Barium	mg/kg	10.5	219	69.14	57.76	64.50	42.95	85.79	0.0	-	-	-
Beryllium	mg/kg	< 0.133	2.54	0.979	0.794	-	0.577	1.172	3.6	-	-	-
Boron	mg/kg	< 1.2	2.94	1.297	-	-	0.358	1.464	89.3	-	-	-
Cadmium	mg/kg	< 0.12	<u>1.76</u>	0.471	0.35	-	0.411	<u>0.610</u>	35.7	0.6	3.5	0.6
Calcium	mg/kg	712	5,740	3,165	2,935	3,080	1,141	3,539	0.0	-	-	-
Chromium	mg/kg	3.17	<u>71.1</u>	23.25	19.16	19.3	15.16	28.2	0.0	37.3	90	26
Cobalt	mg/kg	1.49	25.0	8.32	7.04	7.98	4.80	9.89	0.0	-	-	50
Copper	mg/kg	1.92	<u>47.7</u>	14.73	11.79	11.90	10.43	<u>18.15</u>	0.0	35.7	197	16
Iron	mg/kg	2,340	39,600	15,395	13,429	14,800	7,509	17,860	0.0	-	-	-
Lead	mg/kg	< 0.411	49.9	8.608	4.89	-	10.04	12.36	10.7	35	91	31
Magnesium	mg/kg	584	9,730	4,575	3,980	4,220	2,128	5,273	0.0	-	-	-
Manganese	mg/kg	55	1,420	333.4	266.8	315	258.5	418.3	0.0	-	-	-
Molybdenum	mg/kg	< 0.239	1.15	0.334	-	-	0.206	0.407	75.0	-	-	-
Nickel	mg/kg	2.73	<u>59.1</u>	16.75	13.68	14.9	11.7	<u>20.59</u>	0.0	-	-	16
Phosphorous	mg/kg	200	2,300	1,026	910.2	910.0	500.5	1,190	0.0	-	-	-
Potassium	mg/kg	< 0.71	3,150	554.6	-	-	730.8	722.9	14.3	-	-	-
Selenium	mg/kg	< 0.598	8,680	2,842	-	-	2,997	3,789	32.1	-	-	-
Silica	mg/kg	1,410	13,900	4,168	3,395	2,970	2,957	5,139	0.0	-	-	-
Silicon	mg/kg	< 0.142	6,390	1,312	-	-	1,721	1,874	50.0	-	-	-
Silver	mg/kg	< 0.12	<u>316</u>	<u>81.02</u>	-	-	91.14	<u>110.7</u>	50.0	-	-	0.5
Sodium	mg/kg	6.44	542	92.36	37.1	25.5	125.1	133.4	0.0	-	-	-
Strontium	mg/kg	2.23	1,360	186.2	46.35	53.9	315.8	289.9	0.0	-	-	-
Sulfur	mg/kg	< 0.719	1,050	132.1	-	-	242.5	218.2	10.7	-	-	-
Thallium	mg/kg	< 0.431	1,460	211.8	-	-	457.2	360.5	64.3	-	-	-
Tin	mg/kg	< 0.397	1,480	612.9	-	-	481.7	767.7	7.14	-	-	-
Titanium	mg/kg	< 1.44	710	90.3	-	-	173.1	150.4	28.6	-	-	-

Analyte	Unit (d.w.)	Min.	Max.	Mean	Geo. Mean	Median	± S.D.	95% UCLM	% ND	CCME Sediment ISQG	CCME Sediment PEL	REG153 (11) T8-Sediment or Other
Uranium	mg/kg	< 1.25	1,000	167.6	-	-	301.2	266	21.4	-	-	-
Vanadium	mg/kg	< 0.359	169	31.67	-	-	45.83	47.0	46.4	-	-	-
Zinc	mg/kg	< 1.2	<u>1,150</u>	<u>296.9</u>	-	-	418.6	<u>431.9</u>	28.6	123	315	120
Lithium	mg/kg	2.17	31.5	11.86	10.06	10.9	6.96	14.14	0.0	-	-	-
Aroclor-1016	µg/kg	< 1.37	< 2.8	-	-	-	-	-	100	-	-	-
Aroclor-1221	µg/kg	< 1.37	< 2.8	-	-	-	-	-	100	-	-	-
Aroclor-1232	µg/kg	< 1.37	< 2.8	-	-	-	-	-	100	-	-	-
Aroclor-1242	µg/kg	< 1.37	< 2.8	-	-	-	-	-	100	-	-	-
Aroclor-1248	µg/kg	< 1.37	< 2.8	-	-	-	-	-	100	-	-	-
Aroclor-1254	µg/kg	< 1.37	31.7	5.03	-	-	7.58	7.96	66.7	60	340	-
Aroclor-1260	µg/kg	< 1.37	11.2	2.28	-	-	2.39	3.19	85.2	-	-	-
pH		5.99	7.3	6.47	6.47	6.49	0.26	6.56	0.0	-	-	-
Moisture Content	%	21.1	60.5	41.3	39.88	43.2	9.92	44.53	0.0	-	-	-
4cmx	µg/kg	5.78	10.7	8.27	8.15	8.25	1.49	8.76	0.0	-	-	-
Decachlorobiphenyl	µg/kg	7.12	15.3	10.53	10.33	9.87	2.15	11.23	0.0	-	-	-

Notes:

An underlined value indicates an exceedance of CCME (2001) Interim Sediment Quality Guidelines for the Protection of Aquatic Life (freshwater) [20].

A **bold** value indicates an exceedance of CCME (2001) Sediment Probable Effect Level (freshwater) [20].

An *italicized* value indicates an exceedance of REG153 (11) T8-Sediment site condition standards [21].

The only anthropogenic radionuclide detected in Ottawa River sediments was Cesium-137, which was detected in nearly all samples at a mean activity concentration of 0.47 ± 0.52 pCi/g (Table 4). Cesium-137 in sediments upstream of CRL is due to atmospheric nuclear weapon tests during the early 1960s [7].

Primordial (or cosmogenic, naturally-occurring) radionuclides detected in Ottawa River sediments included Potassium-40 (mean of 16.99 ± 1.55 pCi/g), which is present naturally in geological formations. Primordial Bismuth-212 and -214, part of the Uranium-238 decay series, were also detected at activity concentrations of 0.80 ± 0.31 pCi/g and 0.33 ± 0.08 pCi/g, respectively. Actinium-228, another primordial radionuclide that is part of the Thorium-232 decay series, was also detected at a mean activity concentration of 0.54 ± 0.27 pCi/g (Table 4). These findings are similar to the findings of Rowan [7] in a 2012 study of radionuclides in Ottawa River sediments. Lead-210, -212 and -214 were also detected in sediments at activity concentrations of 1.12 ± 0.90 pCi/g, 0.54 ± 0.21 pCi/g and 0.42 ± 0.11 pCi/g, respectively. Lead-210 and -214 are part of the radium decay series. Lead-212 belongs to the Thorium decay series. Radium-228, part of the Thorium decay series, was detected in most samples at a mean activity concentration of 0.54 ± 0.27 pCi/g. Lastly, Thallium-208 (mean of 0.14 ± 0.09 pCi/g), part of the Thorium-232 chain, was detected in about half of the sediment samples. No other gamma-emitting radionuclides were detected (Table 4).

Mean Gross Alpha and Gross Beta activity concentrations in river sediments (\pm S.D.) were 8.79 ± 3.60 pCi/g and 25.44 ± 14.86 pCi/g, respectively (Table 4). The alpha activity in these samples is due to naturally occurring isotopes such as U-238 or Th-232 and their progeny. Indeed, gamma spectrometry of the samples confirmed the presence of uranium and thorium progeny. All samples are below the NSRDR Clearance Level of 1 Bq/g (or 27.027 pCi/g) [22] for all of natural origin. Tritium and Carbon-14 activity concentrations were below detection in all samples. Previous studies by CNL have determined that the major proportion of gross beta is due to Potassium-40 [6].

All radionuclides measured were less than the Derived Concentration Guideline Levels (DCGL), which are based on Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations [22].

Table 4: Summary statistics for Ottawa River sediment radiochemistry results near NPD.

Analyte	Unit (d.w.)	Min.	Max.	Mean	Geo. Mean	Median	± S.D.	95% UCLM	% ND	DCGL ^a
Ac-228	pCi/g	< 0.262	1.42	0.541	-	-	0.265	0.63	11.1	2.7027
Am-241	pCi/g	< 0.0456	< 0.358	-	-	-	-	-	100	27.027
Sb-124	pCi/g	< 0.0627	< 0.328	-	-	-	-	-	100	270.27
Sb-125	pCi/g	< 0.0916	< 0.206	-	-	-	-	-	100	2,703
Ba-133	pCi/g	< 0.0331	< 0.0792	-	-	-	-	-	100	2,703
Ba-140	pCi/g	< 0.60	< 1.61	-	-	-	-	-	100	270.27
Be-7	pCi/g	< 0.352	< 0.998	-	-	-	-	-	100	27,027
Bi-212	pCi/g	< 0.523	1.76	0.804	-	-	0.307	0.915	48.2	270.27
Bi-214	pCi/g	< 0.159	0.489	0.331	-	-	0.0825	0.359	3.7	-
Ce-139	pCi/g	< 0.0266	< 0.0559	-	-	-	-	-	100	2,703
Ce-141	pCi/g	< 0.0673	< 0.151	-	-	-	-	-	100	2,703
Ce-144	pCi/g	< 0.149	< 0.348	-	-	-	-	-	100	2,703
Cs-134	pCi/g	< 0.0434	< 0.102	-	-	-	-	-	100	270.27
Cs-136	pCi/g	< 0.238	< 0.626	-	-	-	-	-	100	270.27
Cs-137	pCi/g	< 0.053	2.56	0.466	-	-	0.515	0.669	14.8	270.27
Cr-51	pCi/g	< 0.461	< 1.25	-	-	-	-	-	100	27,027
Co-56	pCi/g	< 0.0486	< 0.109	-	-	-	-	-	100	270.27
Co-57	pCi/g	< 0.0199	< 0.0424	-	-	-	-	-	100	2,703
Co-58	pCi/g	< 0.0434	< 0.0899	-	-	-	-	-	100	270.27
Co-60	pCi/g	< 0.0417	< 0.102	-	-	-	-	-	100	2.7027
Eu-152	pCi/g	< 0.0861	< 0.208	-	-	-	-	-	100	2.7027
Eu-154	pCi/g	< 0.140	< 0.267	-	-	-	-	-	100	270.27
Eu-155	pCi/g	< 0.071	< 0.183	-	-	-	-	-	100	2,703
Ir-192	pCi/g	< 0.0356	< 0.0802	-	-	-	-	-	100	270.27
Fe-59	pCi/g	< 0.12	< 0.30	-	-	-	-	-	100	270.27
Pb-210	pCi/g	< 0.502	3.58	1.12	-	-	0.90	1.621	81.4	270.27
Pb-212	pCi/g	0.252	1.31	0.541	0.509	0.508	0.211	0.610	0	270.27
Pb-214	pCi/g	0.221	0.663	0.421	0.408	0.419	0.105	0.455	0	-
Mn-54	pCi/g	< 0.0408	< 0.0852	-	-	-	-	-	100	270.27
Hg-203	pCi/g	< 0.0391	< 0.0933	-	-	-	-	-	100	2,703
Nd-147	pCi/g	< 1.50	< 3.82	-	-	-	-	-	100	2,703
Np-239	pCi/g	< 0.21	< 0.40	-	-	-	-	-	100	2,703
Nb-94	pCi/g	< 0.0304	< 0.0732	-	-	-	-	-	100	270.27
Nb-95	pCi/g	< 0.0516	< 0.1020	-	-	-	-	-	100	270.27
K-40	pCi/g	12.7	19.3	16.99	16.91	17.2	1.553	17.49	0	2,703
Pm-144	pCi/g	< 0.0387	< 0.0794	-	-	-	-	-	100	-
Pm-146	pCi/g	< 0.0445	< 0.1120	-	-	-	-	-	100	-
Ra-228	pCi/g	0.262	1.42	0.541	-	-	0.265	0.63	11.1	270.27
Ru-106	pCi/g	< 0.314	< 0.652	-	-	-	-	-	100	2,703
Ag-110m	pCi/g	< 0.0514	< 0.115	-	-	-	-	-	100	270.27
Na-22	pCi/g	< 0.0398	< 0.094	-	-	-	-	-	100	270.27
Tl-208	pCi/g	0.0646	0.477	0.143	-	-	0.089	0.178	44.4	-
Th-234	pCi/g	< 0.599	1.44	0.705	-	-	0.252	-	92.6	27,027
Sn-113	pCi/g	< 0.0429	< 0.107	-	-	-	-	-	100	27,027
U-235	pCi/g	< 0.149	< 0.349	-	-	-	-	-	100	27.027
U-238	pCi/g	< 0.599	1.44	0.705	-	-	0.252	-	92.6	27.027

Analyte	Unit (d.w.)	Min.	Max.	Mean	Geo. Mean	Median	± S.D.	95% UCLM	% ND	DCGL ^a
Y-88	pCi/g	< 0.0334	< 0.12	-	-	-	-	-	100	-
Zn-65	pCi/g	< 0.0845	< 0.212	-	-	-	-	-	100	270.27
Zr-95	pCi/g	< 0.0769	< 0.192	-	-	-	-	-	100	270.27
Gross Alpha	pCi/g	< 2.61	16.2	8.786	-	-	3.596	9.99	7.4	27.027
Gross Beta	pCi/g	13.8	93.6	25.44	23.42	21.7	14.86	30.32	0	
H-3	Bq/g	< 0.138	< 0.222	-	-	-	-	-	100	100
C-14	Bq/g	< 0.0344	< 0.0964	-	-	-	-	-	100	1

Note: ^a Derived Concentration Guideline Level (DCGL) is based on Unconditional Clearance Levels, Schedule 1, SOR2000-207 Nuclear Substances and Radiation Device Regulations [22].

Results for sediment chemistry and radiochemistry are presented by sample transect in Table 5, with maximum observed mean value by transect for each parameter highlighted by bold-italic text. Interestingly, Transect 7, located nearly 15 km downstream of NPD in Deep River, had the highest mean values for many of the parameters measured.

Table 5: Mean values for chemical and radiochemical parameters in Ottawa River sediment near NPD by sampling transect.

	Transect 1; Rapides- des- Joachims, 2.73 km upstream of NPD	Transect 2; 0.20 km upstream of NPD	Transect 3; adjacent to NPD	Transect 4; 0.34 km downstream of NPD	Transect 5; 0.65 km downstream of NPD	Transect 6; Pt. Stewart 1.19 km downstream of NPD	Transect 7; Deep River, 14.86 km downstream of NPD
Hg (µg/kg)	19.1	44.8	47.9	47.2	24.3	38.7	92.6
Al (mg/kg)	3,475	7,463	10,160	8,415	7,973	8,823	11,820
Sb (mg/kg)	0.50	0.50	0.50	0.59	0.50	0.82	1.01
As (mg/kg)	1.03	3.80	4.30	6.54	5.06	3.39	10.92
Ba (mg/kg)	30.8	61.3	82.3	68.9	62.4	71.2	97.6
Be (mg/kg)	0.28	0.57	0.73	0.96	1.47	1.21	1.45
Bo (mg/kg)	1.67	1.80	1.85	2.09	1.80	1.80	1.80
Cd (mg/kg)	0.23	0.70	0.81	0.59	0.18	0.27	0.60
Ca (mg/kg)	1,428	3,245	3,410	3,348	2,993	3,325	3,893
Cr (mg/kg)	8.7	19.8	27.3	23.9	20.8	24.6	33.6
Co (mg/kg)	2.94	7.26	8.80	8.42	9.23	8.31	11.79
Cu (mg/kg)	5.94	12.26	18.68	15.95	12.41	13.23	22.12
Fe (mg/kg)	6,875	14,525	18,075	14,535	17,100	14,100	20,043
Pb (mg/kg)	0.64	5.04	5.41	10.86	8.10	8.59	19.71
Mg (mg/kg)	2,415	4,693	6,070	4,241	4,943	4,095	4,903
Mn (mg/kg)	109	283	370	327	382	279	520
Mo (mg/kg)	0.36	0.42	0.39	0.56	0.36	0.36	0.47

	Transect 1; Rapides- des- Joachims, 2.73 km upstream of NPD	Transect 2; 0.20 km upstream of NPD	Transect 3; adjacent to NPD	Transect 4; 0.34 km downstream of NPD	Transect 5; 0.65 km downstream of NPD	Transect 6; Pt. Stewart 1.19 km downstream of NPD	Transect 7; Deep River, 14.86 km downstream of NPD
Ni (mg/kg)	6.1	14.2	18.4	17.5	15.4	17.1	25.7
P (mg/kg)	423	1,165	1,543	1,256	949	733	939
K (mg/kg)	759	3	3	50	824	1,160	1,141
Se (mg/kg)	2	3,993	4,445	5,063	3,510	1	2,171
SiO ₂ (mg/kg)	2,280	1,848	2,058	2,710	5,170	7,355	7,213
Si (mg/kg)	1,053	3	3	176	1,616	3,388	2,861
Ag (mg/kg)	0.2	116.6	144.2	151.3	75.6	0.2	59.1
Na (mg/kg)	52.7	10.5	12.4	23.4	110.3	215.0	210.6
Sr (mg/kg)	4.4	223.2	307.8	416.6	84.0	11.5	210.5
S (mg/kg)	42.1	2.6	2.7	19.7	87.3	294.8	453.3
Tl (mg/kg)	1.4	0.9	0.9	431.5	720.5	0.9	275.7
Sn (mg/kg)	0.58	898	1,120	330	359	789	641
Ti (mg/kg)	513.3	0.7	0.2	99.5	53.3	24.5	57.1
U (mg/kg)	0.7	25.4	31.9	416.2	283.4	65.7	307.8
V (mg/kg)	12.6	71.0	85.6	43.6	0.5	3.2	0.5
Zn (mg/kg)	24.3	869.0	818.0	291.4	2.4	2.8	2.4
Li (mg/kg)	6.6	13.4	14.5	11.8	9.9	9.7	16.0
Moisture (%)	27.5	40.9	44.5	40.4	41.2	45.3	44.3
4cmx (µg/kg)	6.99	8.83	8.18	8.78	7.39	8.46	8.76
C ₁₂ Cl ₁₀ (µg/kg)	9.16	11.62	10.74	11.54	9.10	9.71	11.21
Ac-228 (pCi/g)	0.31	0.54	0.65	0.66	0.52	0.43	0.67
Cs-137 (pCi/g)	0.08	0.32	0.39	0.42	0.34	0.36	1.27
Pb-212 (pCi/g)	0.35	0.53	0.53	0.54	0.52	0.52	0.75
Pb-214 (pCi/g)	0.27	0.46	0.43	0.39	0.44	0.47	0.47
K-40 (pCi/g)	16.85	17.43	16.90	17.68	18.18	17.60	14.65
Ra-228 (pCi/g)	0.31	0.54	0.65	0.66	0.52	0.43	0.68
Gross Alpha (pCi/g)	4.47	9.40	9.28	8.79	7.86	9.79	11.12
Gross Beta (pCi/g)	17.13	48.25	24.53	21.13	20.33	21.98	21.70

Note: Only parameters that were above the DL/MDA for the majority of samples are included in this table. Maximum observed mean value by transect for each parameter highlighted by **bold-italic** text. All concentrations are presented as dry weight (d.w.) concentrations.

Moisture content data indicates the Ottawa River bed near NPD is erosional in nature, composed mainly of sand (water content 20 to 45%) with some transitional silty sediment (water content 50 to 70%). Based on sediment water content, this reach is not a depositional

environment and no sediment accumulation would be expected (Rowan et al. [23]). Given the cross sectional area in this reach (500 m width x 20 m depth = 10,000 m²), currents would be about 5 cm/s at low summer flows (500 m³/s) and about 20 cm/s at high spring flows (2,000 m³/s). These currents are too fast to allow for accumulation of fine grained sediment, which requires a current of less than 2 cm/s [23]. These high spring currents would be sufficient to erode any fine grained sediment that may temporarily deposit. Closer to Deep River, the river widens to about 2,000 m and deepens to about 30 m. Given the cross-sectional area of this reach (2,000 m x 30 m = 60,000 m²), currents would be < 1 cm/s at low summer flows (500 m³/s) and 3 cm/s at high spring flows (2,000 m³/s). The 2 cm/s sediment deposition threshold is reached here at flows less than about 1,200 m³/s. This suggests that the Deep River reach of the river (Transect 7) is marginally depositional (< 2 cm/s) for the majority of the year (see Figure 20 in Section 4.2.7) and this results in some accumulation of fine grained sediment at this location (sediment water content > 70% at depths > 20 m). Deep River is also near the upper limit of the deposition of marine clays from the Champlain Sea. Presence of these clays greatly increases the partition coefficient (k_d) for particle reactive contaminants in soil and sediment in Deep River and the Chalk River Laboratories site that were historically flooded by the Champlain Sea.

Overall, the Ottawa River sediment characteristics near NPD are healthy and typical of what is observed in many soft-bottomed aquatic systems. The data provided in this report—both raw sediment chemistry, and radiochemistry data (Appendix A and Appendix C) and summary statistics (Table 3 and Table 4)—can be used as baseline conditions for the river that can be compared to sediment data collected as part of NPD's Environmental Monitoring Plan, should it be required.

3. Ottawa River Benthic Invertebrate Community

3.1 Introduction

Benthic macroinvertebrate communities have been extensively used for biomonitoring of freshwater systems (e.g., [24], [25], [26], [27]). Benthic invertebrates in direct contact with, and consuming, contaminated sediments are often the biota most highly exposed to sediment-associated contamination. Analysis of benthic community structure provides important information about the *in situ* effects of contaminants on resident biota, and is generally viewed as an effective method for environmental effects monitoring in freshwater ecosystems. By evaluating community structure (i.e., diversity, richness) and the abundances (i.e., density, biomass) of the benthic invertebrate taxa at a site, one can infer a measure of ecological integrity. The NPD EIS [1] predicted no effects on the Ottawa River benthic macroinvertebrate community; however, if exceedances of benchmarks / guidelines are measured for contaminants in Ottawa River sediment, benthic macroinvertebrate community sampling may be required [2]. For this reason, it is necessary to have a good understanding of baseline benthic invertebrate community metrics in the Ottawa River near the NPD site.

When using benthic indices for biological monitoring, it is important that a number of indices be employed in unison, as an impact may be detected by one metric but not another. For

example, sediment contamination may cause a shift in species composition from a diverse and evenly represented benthic community to one dominated by one or two taxa tolerant to contaminants (e.g., [28], [29]). It is clear that some community metrics work better than others ([30], [31]), and no single sampling regime can adequately sample all components of a macroinvertebrate community [32].

Comprehensive studies of the benthic community in Ottawa River sediment near Chalk River Laboratories (CRL), located approximately 26 km downstream of NPD, have determined that the benthic community structure is relatively simple, consisting mainly of burrowing mayflies (*Hexagenia*), Oligochaetes (*Tubificidea*), pea clams (*Pisidium*) and midges (*Chironomidae*) ([24], [33], [34]). This relatively simple community structure is likely due to the oligotrophic trophic status of the Ottawa, and large areas of relatively deep, non-depositional and transitional sedimentary environments, favoured by *Hexagenia* (sediment moisture contents of about 50 to 70%; [24], [33], [35], [36]). These previous studies indicate that the Ottawa River benthic community is composed of a relatively low density (< 1,000 individuals/m²) and biomass (< 2.5 g/m²) of benthic invertebrates [24]. The most common benthic invertebrate taxa previously observed belong to the 'collector' functional feeding group [37], which obtains food by either moving around and gathering food particles from the benthic substrate or using nets or body parts to filter fine particulate organic matter out of the water.

3.2 Methods

3.2.1 Determination of Required Sample Size

The anticipated low density and high spatial variability of benthic invertebrates in Ottawa River sediments [24] can cause statistical challenges when trying to compare community structure metrics among locations or between time periods for monitoring initiatives. For this reason, an *a priori* power analysis was conducted using Ottawa River benthic invertebrate data from a previous study [24] to determine sample sizes required to conduct statistical comparisons with adequate statistical power.

Using an alpha (α) value of 0.10 and a desired statistical power of 0.8 (as recommended by Environment and Climate Change Canada [38], [39]), the number of replicate samples per site required to detect a significant difference among sites or between time periods with 90% confidence using a 1-way Analysis of Variance (ANOVA) in biomass, taxa richness, density, and Shannon diversity are estimated to be 13, 12, 25 and 86, respectively (Figure 3). Other Ottawa River benthic invertebrate estimates of density, biomass, and taxa richness have found 10–15 replicate samples per site adequate for statistical comparisons among locations [24]. One commonly used community metric, the Shannon diversity index, is highly spatially variable and requires a very large sample size (i.e., 86 replicate samples per site; Figure 3) to be useful, so this is not recommended for the Ottawa River. It was determined that a total of 20 samples per 'site' would be appropriate for the determination of baseline conditions, as described further in Section 3.2.2.

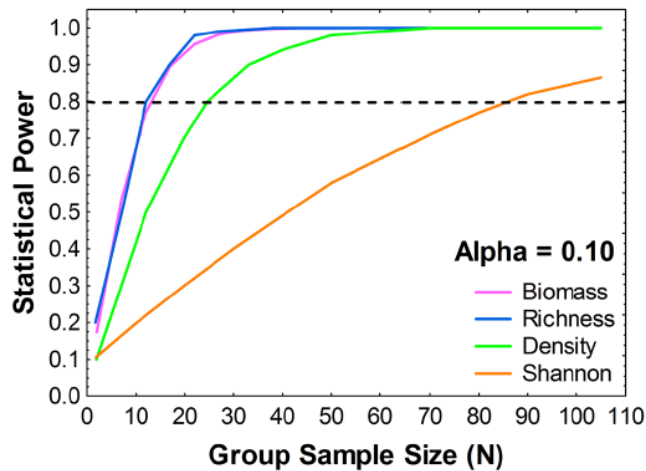


Figure 3: Power analysis plot demonstrating the required sample size necessary to conduct a 1-way ANOVA comparing various benthic community metrics using an $\alpha=0.10$ significance level. The desired statistical power (0.8) is identified by the horizontal broken black line.

3.2.2 Sample Collection

As done for the sampling design for baseline Ottawa River sediments (Section 2), Ottawa River benthic macroinvertebrate samples were collected along seven cross-river transects, ranging from 2.7 km upstream of NPD to 14.9 km downstream of NPD. Along each transect, five benthic invertebrate samples were collected from each of the following four depth interval bins: 0–5 m, 5–10 m, 10–15 m and 15–20 m. This was done to ensure appropriate spatial coverage and account for different depth strata. This resulted in a total of 20 invertebrate samples collected per transect, for a total of 140 samples overall. The upstream transect (Transect 1) represents an upstream reference site, while the farthest downstream transect (Transect 7) was chosen because this location aligns with CNL’s Environmental Monitoring Program’s sampling locations. The other five transects are located within a 2 km stretch adjacent to and downstream of NPD. The metadata for these sampling locations is presented in Table 6 and they are shown on a map in Figure 4.

Table 6: Metadata for benthic invertebrate sampling locations on the Ottawa River near NPD.

Sample #	Sample ID	Transect	Replicate	Depth Strata (m)	Depth (m)	UTM Northing	UTM Easting	Distance from NPD (km)*
1	NPD-1-1	1	1	0–5	2.3	46°12.106	77°41.171	-2.730
2	NPD-1-2	1	2	0–5	2.1	46°12.106	77°41.171	-2.730
3	NPD-1-3	1	3	0–5	2.2	46°12.106	77°41.171	-2.730
4	NPD-1-4	1	4	0–5	2.3	46°12.106	77°41.171	-2.730
5	NPD-1-5	1	5	0–5	2.3	46°12.106	77°41.171	-2.730
6	NPD-1-6	1	6	5–10	6.8	46°12.093	77°41.136	-2.730
7	NPD-1-7	1	7	5-10	6.3	46°12.093	77°41.136	-2.730

Sample #	Sample ID	Transect	Replicate	Depth Strata (m)	Depth (m)	UTM Northing	UTM Easting	Distance from NPD (km)*
8	NPD-1-8	1	8	5-10	6.8	46°12.093	77°41.136	-2.730
9	NPD-1-9	1	9	5-10	6.8	46°12.093	77°41.136	-2.730
10	NPD-1-10	1	10	5-10	6.4	46°12.093	77°41.136	-2.730
11	NPD-1-11	1	11	10-15	13.9	46°12.104	77°41.108	-2.730
12	NPD-1-12	1	12	10-15	13.8	46°12.104	77°41.108	-2.730
13	NPD-1-13	1	13	10-15	13.9	46°12.104	77°41.108	-2.730
14	NPD-1-14	1	14	10-15	13.7	46°12.104	77°41.108	-2.730
15	NPD-1-15	1	15	10-15	13.7	46°12.104	77°41.108	-2.730
16	NPD-1-16	1	16	15-20	15.5	46°12.083	77°41.098	-2.730
17	NPD-1-17	1	17	15-20	15.8	46°12.083	77°41.098	-2.730
18	NPD-1-18	1	18	15-20	15.7	46°12.083	77°41.098	-2.730
19	NPD-1-19	1	19	15-20	16.2	46°12.083	77°41.098	-2.730
20	NPD-1-20	1	20	15-20	16.1	46°12.083	77°41.098	-2.730
21	NPD-2-1	2	1	0-5	3.4	46°11.430	77°39.670	-0.202
22	NPD-2-2	2	2	0-5	3.5	46°11.430	77°39.670	-0.202
23	NPD-2-3	2	3	0-5	3.6	46°11.430	77°39.670	-0.202
24	NPD-2-4	2	4	0-5	3.7	46°11.430	77°39.670	-0.202
25	NPD-2-5	2	5	0-5	3.8	46°11.430	77°39.670	-0.202
26	NPD-2-6	2	6	5-10	6.8	46°11.340	77°39.646	-0.202
27	NPD-2-7	2	7	5-10	6.9	46°11.340	77°39.646	-0.202
28	NPD-2-8	2	8	5-10	7.0	46°11.340	77°39.646	-0.202
29	NPD-2-9	2	9	5-10	7.0	46°11.340	77°39.646	-0.202
30	NPD-2-10	2	10	5-10	7.2	46°11.340	77°39.646	-0.202
31	NPD-2-11	2	11	10-15	12.8	46°11.489	77°39.579	-0.202
32	NPD-2-12	2	12	1-15	12.8	46°11.489	77°39.579	-0.202
33	NPD-2-13	2	13	10-15	12.9	46°11.489	77°39.579	-0.202
34	NPD-2-14	2	14	10-15	12.9	46°11.489	77°39.579	-0.202
35	NPD-2-15	2	15	10-15	12.8	46°11.489	77°39.579	-0.202
36	NPD-2-16	2	16	15-20	19.8	46°11.508	77°39.547	-0.202
37	NPD-2-17	2	17	15-20	19.7	46°11.508	77°39.547	-0.202
38	NPD-2-18	2	18	15-20	19.7	46°11.508	77°39.547	-0.202
39	NPD-2-19	2	19	15-20	19.8	46°11.508	77°39.547	-0.202
40	NPD-2-20	2	20	15-20	19.9	46°11.508	77°39.547	-0.202
41	NPD-3-1	3	1	0-5	4.0	46°11.263	77°39.410	0.000
42	NPD-3-2	3	2	0-5	4.1	46°11.263	77°39.410	0.000
43	NPD-3-3	3	3	0-5	4.2	46°11.263	77°39.410	0.000
44	NPD-3-4	3	4	0-5	4.1	46°11.263	77°39.410	0.000

Sample #	Sample ID	Transect	Replicate	Depth Strata (m)	Depth (m)	UTM Northing	UTM Easting	Distance from NPD (km)*
45	NPD-3-5	3	5	0-5	4.2	46°11.263	77°39.410	0.000
46	NPD-3-6	3	6	5-10	8.0	46°11.277	77°39.386	0.000
47	NPD-3-7	3	7	5-10	8.1	46°11.277	77°39.386	0.000
48	NPD-3-8	3	8	5-10	8.1	46°11.277	77°39.386	0.000
49	NPD-3-9	3	9	5-10	8.0	46°11.277	77°39.386	0.000
50	NPD-3-10	3	10	5-10	8.1	46°11.277	77°39.386	0.000
51	NPD-3-11	3	11	10-15	12.1	46°11.285	77°39.364	0.000
52	NPD-3-12	3	12	10-15	12.2	46°11.285	77°39.364	0.000
53	NPD-3-13	3	13	10-15	12.2	46°11.285	77°39.364	0.000
54	NPD-3-14	3	14	10-15	12.1	46°11.285	77°39.364	0.000
55	NPD-3-15	3	15	10-15	12.3	46°11.285	77°39.364	0.000
56	NPD-3-16	3	16	15-20	18.4	46°11.328	77°39.298	0.000
57	NPD-3-17	3	17	15-20	18.3	46°11.328	77°39.298	0.000
58	NPD-3-18	3	18	15-20	18.2	46°11.328	77°39.298	0.000
59	NPD-3-19	3	19	15-20	18.4	46°11.328	77°39.298	0.000
60	NPD-3-20	3	20	15-20	18.5	46°11.328	77°39.298	0.000
61	NPD-4-1	4	1	0-5	2.1	46°11.117	77°39.230	0.335
62	NPD-4-2	4	2	0-5	2.1	46°11.117	77°39.230	0.335
63	NPD-4-3	4	3	0-5	2.2	46°11.117	77°39.230	0.335
64	NPD-4-4	4	4	0-5	2.2	46°11.117	77°39.230	0.335
65	NPD-4-5	4	5	0-5	2.3	46°11.117	77°39.230	0.335
66	NPD-4-6	4	6	5-10	8.2	46°11.139	77°39.200	0.335
67	NPD-4-7	4	7	5-10	8.1	46°11.139	77°39.200	0.335
68	NPD-4-8	4	8	5-10	8.2	46°11.139	77°39.200	0.335
69	NPD-4-9	4	9	5-10	8.3	46°11.139	77°39.200	0.335
70	NPD-4-10	4	10	5-10	8.3	46°11.139	77°39.200	0.335
71	NPD-4-11	4	11	10-15	12.9	46°11.181	77°39.184	0.335
72	NPD-4-12	4	12	10-15	12.9	46°11.181	77°39.184	0.335
73	NPD-4-13	4	13	10-15	13.0	46°11.181	77°39.184	0.335
74	NPD-4-14	4	14	10-15	12.7	46°11.181	77°39.184	0.335
75	NPD-4-15	4	15	10-15	12.7	46°11.181	77°39.184	0.335
76	NPD-4-16	4	16	15-20	15.2	46°11.288	77°39.046	0.335
77	NPD-4-17	4	17	15-20	15.3	46°11.288	77°39.046	0.335
78	NPD-4-18	4	18	15-20	15.2	46°11.288	77°39.046	0.335
79	NPD-4-19	4	19	15-20	15.6	46°11.288	77°39.046	0.335
80	NPD-4-20	4	20	15-20	15.5	46°11.288	77°39.046	0.335
81	NPD-5-1	5	1	0-5	3.5	46°11.049	77°38.970	0.653

Sample #	Sample ID	Transect	Replicate	Depth Strata (m)	Depth (m)	UTM Northing	UTM Easting	Distance from NPD (km)*
82	NPD-5-2	5	2	0-5	3.6	46°11.049	77°38.970	0.653
83	NPD-5-3	5	3	0-5	3.6	46°11.049	77°38.970	0.653
84	NPD-5-4	5	4	0-5	3.7	46°11.049	77°38.970	0.653
85	NPD-5-5	5	5	0-5	3.3	46°11.049	77°38.970	0.653
86	NPD-5-6	5	6	5-10	8.1	46°11.075	77°38.957	0.653
87	NPD-5-7	5	7	5-10	8.3	46°11.075	77°38.957	0.653
88	NPD-5-8	5	8	5-10	8.0	46°11.075	77°38.957	0.653
89	NPD-5-9	5	9	5-10	7.9	46°11.075	77°38.957	0.653
90	NPD-5-10	5	10	5-10	8.1	46°11.075	77°38.957	0.653
91	NPD-5-11	5	11	10-15	13.5	46°11.088	77°38.913	0.653
92	NPD-5-12	5	12	10-15	13.4	46°11.088	77°38.913	0.653
93	NPD-5-13	5	13	10-15	13.3	46°11.088	77°38.913	0.653
94	NPD-5-14	5	14	10-15	13.2	46°11.088	77°38.913	0.653
95	NPD-5-15	5	15	10-15	13.0	46°11.088	77°38.913	0.653
96	NPD-5-16	5	16	15-20	16.5	46°11.186	77°38.777	0.653
97	NPD-5-17	5	17	15-20	16.7	46°11.186	77°38.777	0.653
98	NPD-5-18	5	18	15-20	16.9	46°11.186	77°38.777	0.653
99	NPD-5-19	5	19	15-20	16.3	46°11.186	77°38.777	0.653
100	NPD-5-20	5	20	15-20	16.4	46°11.186	77°38.777	0.653
101	NPD-6-1	6	1	0-5	3.8	46°10.936	77°38.502	1.193
102	NPD-6-2	6	2	0-5	3.6	46°10.936	77°38.502	1.193
103	NPD-6-3	6	3	0-5	3.7	46°10.936	77°38.502	1.193
104	NPD-6-4	6	4	0-5	3.7	46°10.936	77°38.502	1.193
105	NPD-6-5	6	5	0-5	3.8	46°10.936	77°38.502	1.193
106	NPD-6-6	6	6	5-10	7.6	46°10.945	77°38.488	1.193
107	NPD-6-7	6	7	5-10	7.7	46°10.945	77°38.488	1.193
108	NPD-6-8	6	8	5-10	7.6	46°10.945	77°38.488	1.193
109	NPD-6-9	6	9	5-10	7.7	46°10.945	77°38.488	1.193
110	NPD-6-10	6	10	5-10	7.5	46°10.945	77°38.488	1.193
111	NPD-6-11	6	11	10-15	14.3	46°10.957	77°38.455	1.193
112	NPD-6-12	6	12	10-15	14.0	46°10.957	77°38.455	1.193
113	NPD-6-13	6	13	10-15	14.0	46°10.957	77°38.455	1.193
114	NPD-6-14	6	14	10-15	14.1	46°10.957	77°38.455	1.193
115	NPD-6-15	6	15	10-15	14.2	46°10.957	77°38.455	1.193
116	NPD-6-16	6	16	15-20	17.9	46°10.967	77°38.385	1.193
117	NPD-6-17	6	17	15-20	17.6	46°10.967	77°38.385	1.193
118	NPD-6-18	6	18	15-20	17.5	46°10.967	77°38.385	1.193

Sample #	Sample ID	Transect	Replicate	Depth Strata (m)	Depth (m)	UTM Northing	UTM Easting	Distance from NPD (km)*
119	NPD-6-19	6	19	15–20	16.8	46°10.967	77°38.385	1.193
120	NPD-6-20	6	20	15–20	16.8	46°10.967	77°38.385	1.193
121	NPD-7-1	7	1	0–5	2.0	46°06.699	77°29.465	14.875
122	NPD-7-2	7	2	0–5	2.1	46°06.699	77°29.465	14.875
123	NPD-7-3	7	3	0–5	2.2	46°06.699	77°29.465	14.875
124	NPD-7-4	7	4	0–5	2.1	46°06.699	77°29.465	14.875
125	NPD-7-5	7	5	0–5	2.2	46°06.699	77°29.465	14.875
126	NPD-7-6	7	6	5–10	8.1	46°06.696	77°29.451	14.875
127	NPD-7-7	7	7	5–10	8.2	46°06.696	77°29.451	14.875
128	NPD-7-8	7	8	5–10	8.3	46°06.696	77°29.451	14.875
129	NPD-7-9	7	9	5-10	8.1	46°06.696	77°29.451	14.875
130	NPD-7-10	7	10	5-10	8.0	46°06.696	77°29.451	14.875
131	NPD-7-11	7	11	10–15	12.2	46°06.704	77°29.440	14.875
132	NPD-7-12	7	12	10–15	12.1	46°06.704	77°29.440	14.875
133	NPD-7-13	7	13	10–15	12.3	46°06.704	77°29.440	14.875
134	NPD-7-14	7	14	10–15	12.0	46°06.704	77°29.440	14.875
135	NPD-7-15	7	15	10–15	12.4	46°06.704	77°29.440	14.875
136	NPD-7-16	7	16	15–20	18.5	46°06.741	77°29.394	14.875
137	NPD-7-17	7	17	15–20	18.6	46°06.741	77°29.394	14.875
138	NPD-7-18	7	18	15–20	18.6	46°06.741	77°29.394	14.875
139	NPD-7-19	7	19	15–20	18.9	46°06.741	77°29.394	14.875
140	NPD-7-20	7	20	15–20	18.6	46°06.741	77°29.394	14.875

Note: * Distance from NPD refers to distance upstream of NPD (negative values), adjacent to NPD (zero) and downstream of NPD (positive values).

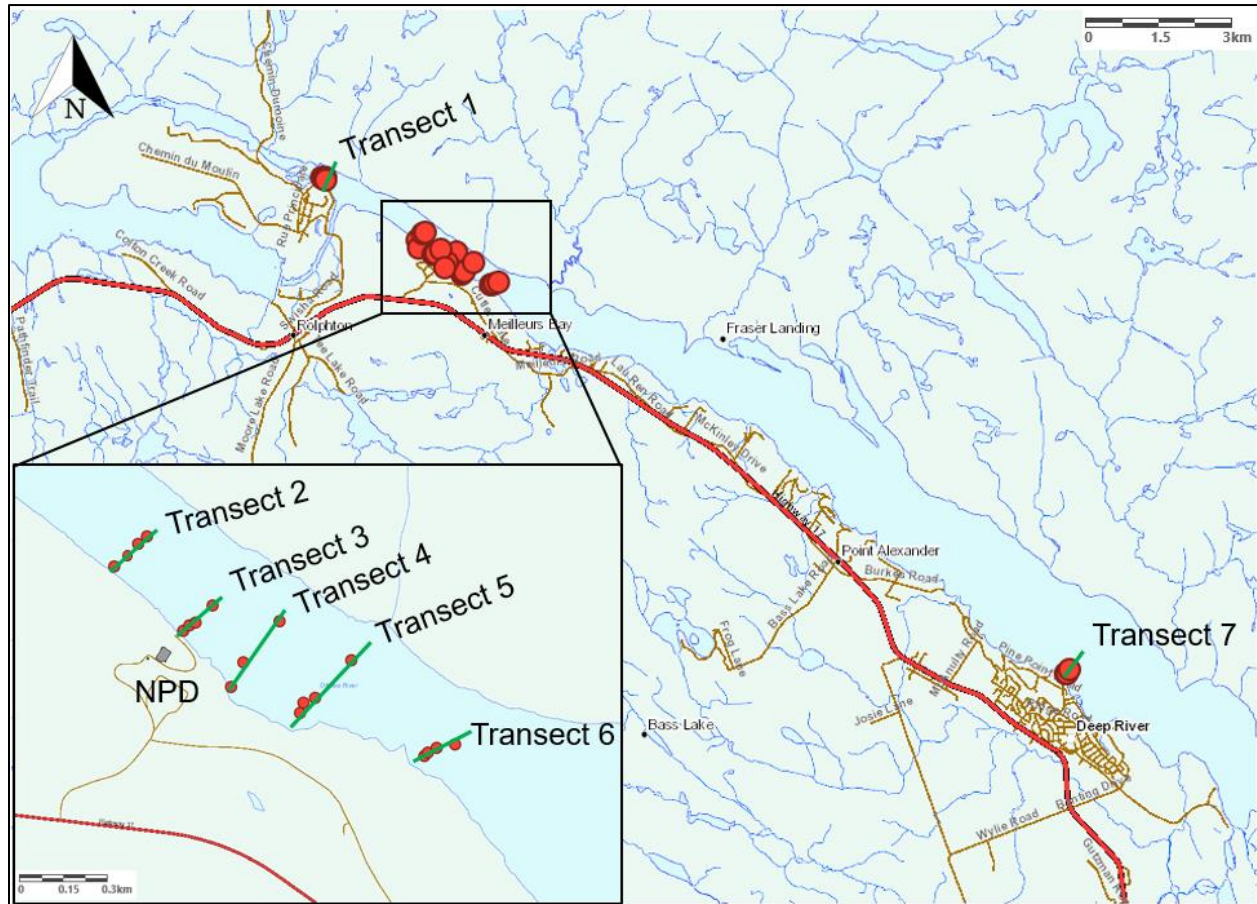


Figure 4: Map of benthic macroinvertebrate sampling locations (red dots) along transects (green lines) on the Ottawa River near NPD. At each sampling location (red dot), five replicate samples were collected.

Between 2020 June 22 and 30, an Ekman dredge sampler (Wildco®, 9"x9"x9", sampling an area of 81 in² or 523 cm²) was used for sample collection. The entire contents of the bottom sample contained in each Ekman were rinsed through a wash bucket with a 541 µm screen at the bottom to filter out sediments, but retain invertebrates and other debris larger than 541 µm. The contents retained in the wash bucket were transferred to pre-labelled 250 mL glass sample jars and immersed in a 70% ethanol preservative solution until analysis. A selection of photos from the benthic invertebrate sampling campaign is presented in Figure 5.



Collection of a sample using an Ekman dredge near NPD



View of the NPD stack from the river



Contents of an Ekman sample to be sorted for invertebrates



Example of a freshwater mussel

Figure 5: Photos from the benthic macroinvertebrate sampling campaign.

3.2.3 Sample Identification

Benthic invertebrate samples were sent to RiverLabs, an arm of the St. Lawrence River Institute in Cornwall, Ontario, for processing and identification by a certified invertebrate taxonomist. Specimens were identified to family-level following [40] and [41] identification guides. Most specimens were identified to Family, with few specimens identified to Order (as a result of damage to the specimen). Complete samples were picked and contents identified. A maximum of two hours was spent picking and sorting each sample. After two hours, picked organisms were considered to be representative of the whole sample. After 30 minutes with no organisms found in a whole sample, picking was stopped and the results were considered to be representative of the whole sample. Invertebrate results were tallied and sample contents were put back into the sample jars for future quality assurance (QA) checks (re-count by another taxonomist) and determination of sample biomass. After identification and QA checks were performed, invertebrate samples were dried at 50°C temperature in a drying oven until a stable

mass was attained so that biomass metrics could be calculated (i.e., g dry weight per unit area sampled).

3.2.4 Data Analysis

The benthic invertebrate community descriptors/metrics recommended for use to determine effects (also called effect endpoints) by Environment and Climate Change Canada ([38], [39]) include total benthic invertebrate density, taxa richness and evenness index (Simpson's). For this reason, these metrics were calculated with the Ottawa River baseline data to assist with future monitoring, if required. Additional community descriptors that can be calculated to assist in data interpretation but that are not typically used in the determination of effects (i.e., supporting endpoints) include biomass, Hilsenhoff Biotic index, Simpson's diversity index and Shannon-Wiener index [38]. These metrics are described below.

Total invertebrate density: The total number of individuals of all taxonomic categories collected at the sample site/transect expressed per unit area (e.g., numbers/m²). Values are reported for each sample site, as well as the arithmetic mean ± standard deviation (SD). This spatially-based metric was adjusted to number per m² (10,000 cm²) based on the densities observed in the Ekman samples (522 cm²) by multiplying the result by 19.18.

Biomass: The total dry mass of all taxonomic categories collected at the sample site/transect expressed per unit area (e.g., numbers/m²). Values are reported for each sample site, as well as the arithmetic mean ± standard deviation (SD). This spatially-based metric was adjusted to number per m² (10,000 cm²) based on the densities observed in the Ekman samples (522 cm²) by multiplying the result by 19.18.

Taxa (i.e., family) richness (S): The total number of different taxonomic categories collected at the sample site/transect, and the arithmetic mean ± S.D. for the area.

Ephemeroptera, Plecoptera and Trichoptera (EPT): The EPT index is commonly used to assess the ecological health of streams and rivers, as the presence of these taxa is a strong indicator of ecosystem health. The EPT index is the sum of the proportion of each of the three orders (mayflies, stoneflies, and caddisflies), and it is expressed as a percentage of all identified taxa; larger scores typically indicate healthier streams or rivers.

Hilsenhoff Biotic Index (HBI): The HBI estimates the overall tolerance of the benthic invertebrate community in a sampled area, weighted by the relative abundance of each taxonomic group (family, genus, etc.). Organisms are assigned a tolerance value from 0 to 10 pertaining to that group's known sensitivity to contaminants; 0 being most sensitive and 10 being most tolerant. Tolerance values for various taxa can be found in [42]. The formula for calculating HBI is:

$$HBI = \frac{\sum n_i \times a_i}{N}$$

Equation 1

where:

n = number of specimens in taxa i

a = tolerance value of taxa i

N = the total number of specimens in the sample

Simpson's Diversity Index (D): Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, diversity increases. The index measures the probability that two randomly selected individuals from a sample will be the same. The value of D will always fall between 0 and 1, with 0 representing complete diversity and 1 representing complete uniformity. The formula for calculating the value of the index (D) is:

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Equation 2

where:

n = number of individuals of one taxa in a sample

N = the total number of all individuals in a sample

Shannon–Wiener index (H'): H' is another index that is commonly used to characterize diversity in a community. Like Simpson's index (D), the Shannon–Wiener index accounts for both abundance and evenness of the taxa present. The proportion of species i relative to the total number of species (p_i) is calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1, as shown below. Values can range from 0 to 5, with larger values representing greater diversity.

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

Equation 3

where:

S = total number of taxa in the sample (richness)

P_i = proportion of S made up of the i th taxa

The benthic invertebrate community metrics and indices described above were calculated for all samples, with results presented in Appendix F. Using the five replicate samples per depth strata per transect (e.g., Transect 1, 0–5 m depth strata samples [$n=5$], Transect 1, 5–10 m depth strata samples [$n=5$], etc.), arithmetic mean values (\pm standard deviation) were calculated and are presented in Figure 7 through Figure 13. Together, these metrics describe the abundance, diversity and structure of the current benthic macroinvertebrate community in the Ottawa River near NPD. Should monitoring of the Ottawa River benthic invertebrate community be required in the future, this study can be repeated and metrics compared.

For Environmental Effects Monitoring (EEM), Environment and Climate Change Canada ([38], [39]) recommends that the Bray–Curtis (B–C) Similarity Index be used (in addition to the above

metrics) to monitor for change in the benthic macroinvertebrate community. This can be done either between/among (i) locations or (ii) time intervals. In the context of environmental monitoring for the NPD project, if future monitoring of the benthic invertebrate community were to be triggered, this study should be repeated and new data compared to baseline data presented in Appendix E and Appendix F, with the addition of B–C Similarity index calculations.

The B-C Index is a distance coefficient that reaches a maximum value of 1 for two sites that are entirely different and a minimum value of 0 for two sites that are identical. The B-C Index measures the percentage of difference between sites or time intervals [43], where the distance statistic is calculated as below:

$$B - C = \frac{\sum_{i=1}^n |y_{i1} - y_{i2}|}{\sum_{i=1}^n (y_{i1} + y_{i2})}$$

Equation 4

where:

B-C = Bray-Curtis distance between sites 1 and 2

y_{i1} = count for taxon i at site 1

y_{i2} = count for taxon i at site 2

n = total number of taxa present at the two sites

3.3 Results and Discussion

A total of 7.308 m² of riverbed was sampled and sorted for benthic macroinvertebrates. A total of 5,288 benthic macroinvertebrates that constitute 32 unique Families from 15 different Orders were collected among the 140 samples (see raw count data in Appendix E and summary in Table 7 below). The most frequently collected taxa included midge flies (Chironomidae; 31.5% of total count), segmented worms (Naididae; 17.8% of total count), fingernail clams (Sphaeriidae; 16.5% of total count), crane fly larvae (Tipulidae; 8.9% of total count), burrowing mayflies (Ephemeroidea; 7.5% of total count), long-horned caddisflies (Leptoceridae; 3.3% of total count), freshwater scuds (Gammaridae; 2.6% of total count), valve snails (Valvatidae; 2.1% of total count), riffle beetles (Elmidae; 1.4% of total count), tube/net-spinning caddisflies (Polycentropodidae; 1.3% of total count), mud snails (Hydrobiidae; 1.2% of total count) and no-see-ums (Ceratopogonidae; 1.1% of total count). Images of the most common invertebrate taxa are shown in Figure 6. The results of this invertebrate community study are similar to those obtained in a recent study of Ottawa River benthic invertebrate community structure near Chalk River Laboratories ([6], [24], [33]).

Table 7: Summary of benthic invertebrate results for all samples showing overall species composition by relative abundance.

Order	Family	Common Name	Total Count	Proportion of Total Count (%)
Diptera	Chironomidae	Midge fly	1666	31.505
Oligochaeta	Naididae	Segmented worm	943	17.833
Bivalvia	Sphaeriidae	Fingernail/pea clam	871	16.471
Diptera	Tipulidae	Crane fly larvae	473	8.945
Ephemeroptera	Ephemeridae	Burrowing mayfly	396	7.489
Trichoptera	Leptoceridae	Long-horned caddisfly	173	3.272
Amphipoda	Gammaridae	Freshwater scud	140	2.648
Gastropoda	Valvatidae	Valve snail	113	2.137
Coleoptera	Elmidae	Riffle beetle	75	1.418
Trichoptera	Polycentropodidae	Tube/net-making caddisfly	70	1.324
Gastropoda	Hydrobiidae	Mud snail	65	1.229
Diptera	Ceratopogonidae	No-see-um/biting midge	58	1.097
Bivalvia	Unionidae	Bivalve mollusc	48	0.908
Isopoda	Asellidae	Aquatic sow bug	47	0.889
Oligochaeta	Lumbriculidae	Segmented worm	21	0.397
Trichoptera	Molannidae	Hood casemaker caddisfly	14	0.265
Nemata	*unknown*	Roundworm	14	0.265
Odonata	Macromiidae	Cruiser dragonfly larvae	9	0.170
Ephemeroptera	Caenidae	Small squaregill mayfly	8	0.151
Hirudinea	Glossiphoniidae	Freshwater jawless leach	8	0.151
Gastropoda	Physidae	Bladder snail	7	0.132
Megaloptera	Sialidae	Alderfly	7	0.132
Amphipoda	Crangonyctidae	Cave-dwelling scud	5	0.095
Odonata	Gomphidae	Club-tailed dragonfly nymph	5	0.095
Trichoptera	Glossosomatidae	Saddle casemaker caddisfly	4	0.076
Trichoptera	Helicopsychidae	Snail-case caddisfly	3	0.057
Trichoptera	Brachycentridae	Humpless casemaker caddisfly	2	0.038
Amphipoda	Hyalellidae	Freshwater scud	1	0.019
Ephemeroptera	Baetidae	Small minnow mayfly	1	0.019
Hemiptera	Corixidae	Water boatmen	1	0.019
Hydrachnidia	*unknown*	Water mite	1	0.019
Megaloptera	Corydalidae	Dobsonfly/fishfly	1	0.019
Trichoptera	Odontoceridae	Mortarjoint casemaker caddisfly	1	0.019
Sum			5,288	100

Functional feeding groups are a classification approach that is based on behavioral mechanisms of food acquisition rather than taxonomic group [44]. The most common taxa living in Ottawa River sediments near NPD belong to two functional feeding groups: collector-gatherers, which collect fine particulate organic matter (FPOM) from the bottom substrate, and collector-filterer, which collect FPOM from the water column using a variety of filters [44]. This is typical for benthic invertebrate community structure in large, relatively deep rivers, such as the Ottawa River. The structure of aquatic invertebrate communities is influenced by many factors including channel width, depth, velocity, nutrient composition, and availability, substrate

composition and density of riparian and aquatic vegetation [45]. The river continuum concept [46] hypothesizes that the macroinvertebrate community exists in a way that is compatible with its source of nutrition. For example, the invertebrate community in smaller stream channels will be dominated by shredders and scrapers that can deal with the coarse particulate organic matter that is usually found in smaller stream channels, whereas in larger stream channels or river systems (like the Ottawa River), FPOM typically dominates and the invertebrate community will reflect this, being dominated by filter feeders and collector-gatherers ([44], [45], [46]).

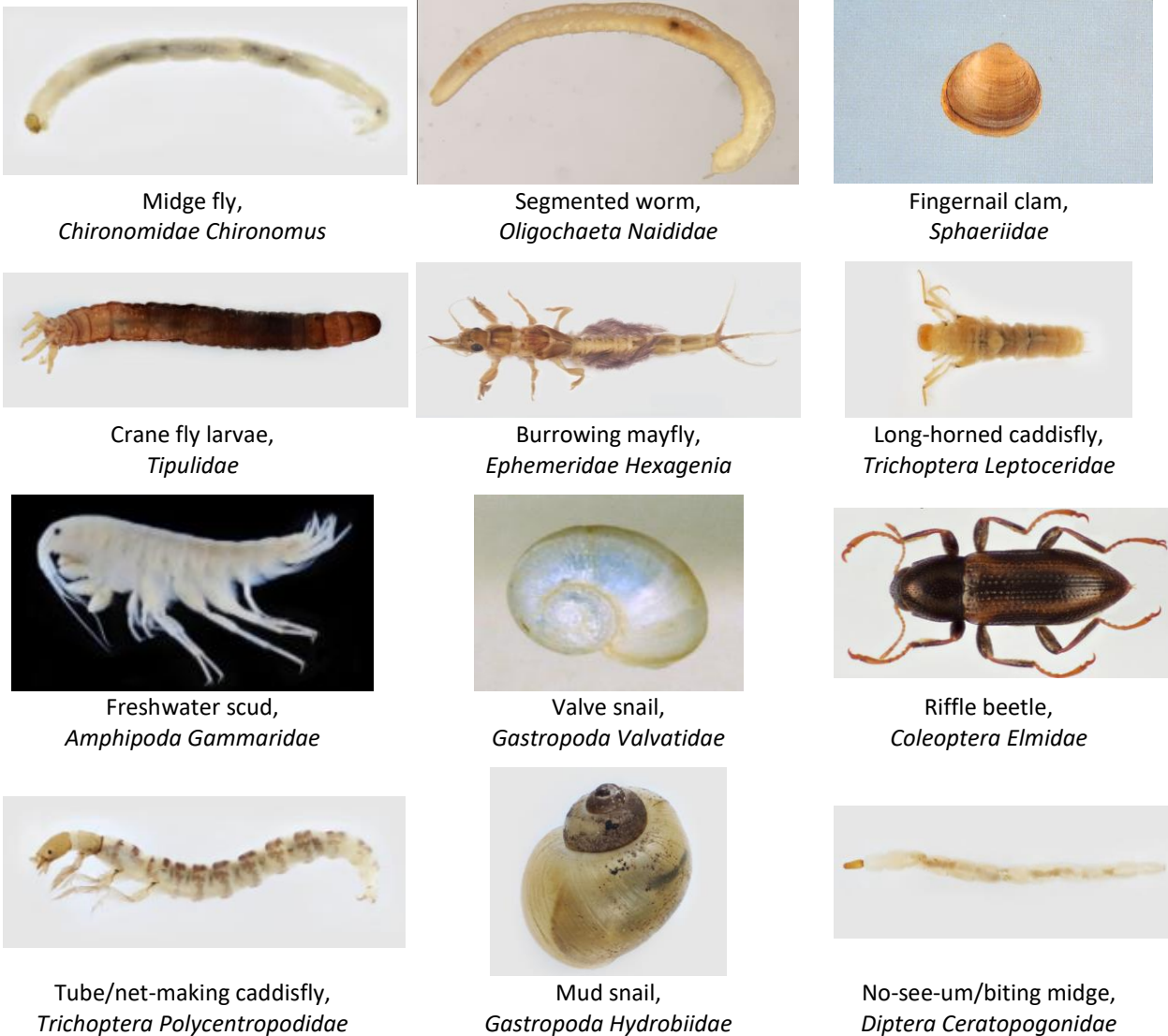


Figure 6: Photos of the most common (> 1% of total composition) benthic invertebrate taxa occurring in the Ottawa River near the NPD site (taken from www.macroinvertebrates.org).

Community structure metrics and indices for density, biomass, taxa richness, Ephemeroptera, Plecoptera and Trichoptera index (%EPT), Hilsenhoff Biotic Index (HBI), Simpson's Diversity index and Shannon–Wiener index are presented in Figure 7 through Figure 13.

The benthic invertebrate community in Ottawa River sediment near NPD is typical of low-productivity, oligotrophic systems, with low density (typically $< 1,500$ individuals/m²) and low biomass (typically < 2.5 g/m²) estimates. Mean benthic invertebrate density ranged from 310 to 1,964 individuals/m², with the majority of samples less than 1,000 individuals/m² (Figure 7). This is in good agreement with a recent study of Ottawa River benthic invertebrate community near CRL, which also reported a mean invertebrate density of $< 1,000$ individuals/m² [24]. There was no clear trend related to depth.

Of the 32 taxa collected from Ottawa River sediments, 3 taxa accounted for 66% of the total numerical standing stock. These included Chironomidae, Naididae and Sphaeriidae (Table 7). Midges (Chironomidae) often dominate the aquatic insect community in freshwater streams and rivers in abundance and biomass [44], and the Ottawa River is no exception.

As shown in Figure 8, biomass values are highly variable and somewhat chaotic. This is in large part due to the fact that invertebrates with relatively dense calcified structures (e.g., snail, mussel shells) were included in biomass measures. Due to their patchy spatial distribution in the river, a small number of samples contained very high biomass relative to others that contained few calcified structures and soft tissues only. For this reason, it is not recommended that biomass be used as a monitoring metric for the Ottawa River benthic invertebrate community. When these eight anomalously high (~ 18 – 600 g/m²) samples are removed (see inset in Figure 8), biomass values agree with those previously observed in the Ottawa River [24]. Mean biomass values range from 0.5 to 4.4 g/m², with the majority of locations less than 2 g/m² (Figure 8).

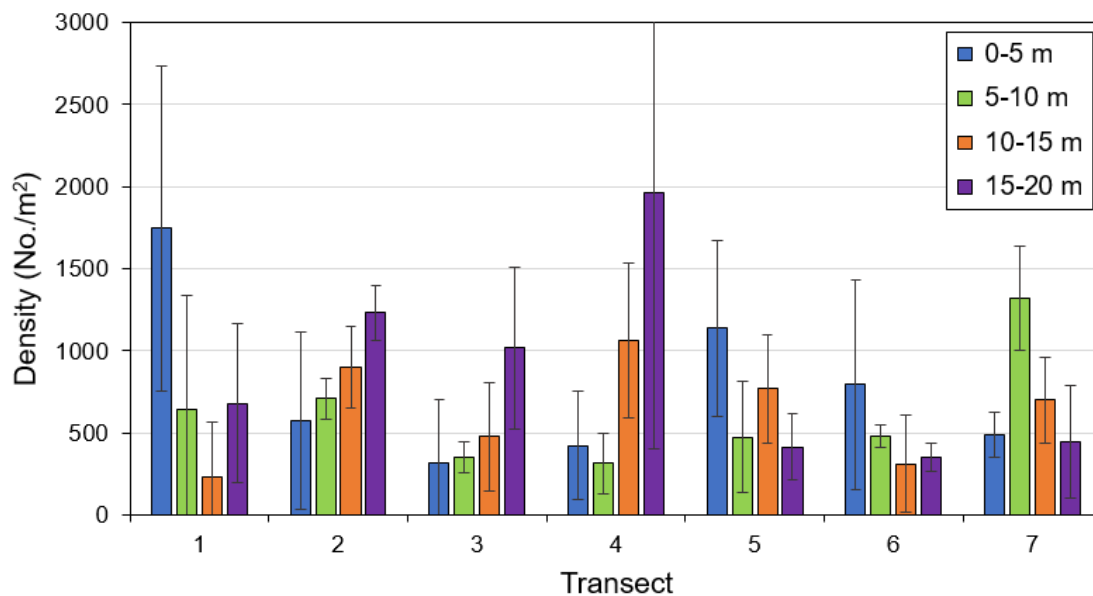


Figure 7: Density (total number of individuals per m² ± S.D.) of benthic invertebrates in the Ottawa River near NPD at four different depth strata.

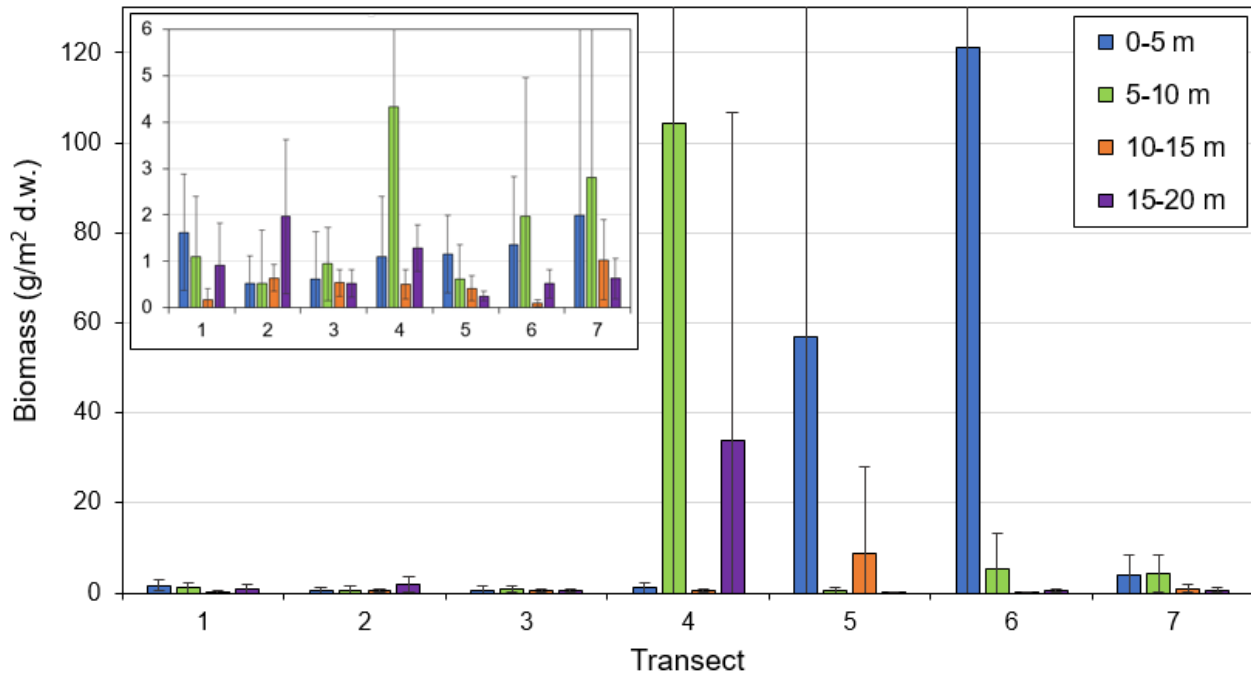


Figure 8: Biomass (g dry mass of all taxa per m² ± S.D.) of benthic invertebrates in the Ottawa River near NPD at four different depth strata. The main graph shows biomass with calcified structures included and the inset graph shows biomass with calcified structures excluded (note difference in y-axis scales).

Mean benthic invertebrate taxa richness ranged from 3.2 to 9.2 unique taxa per sample, with an overall mean of about 6 (Figure 9). This result is in excellent agreement with previous studies of invertebrate structure on the Ottawa River near CRL, which found that taxa richness ranged from 4 to 10 unique taxa per sample [24]. As with density and biomass, there was no clear trend with depth.

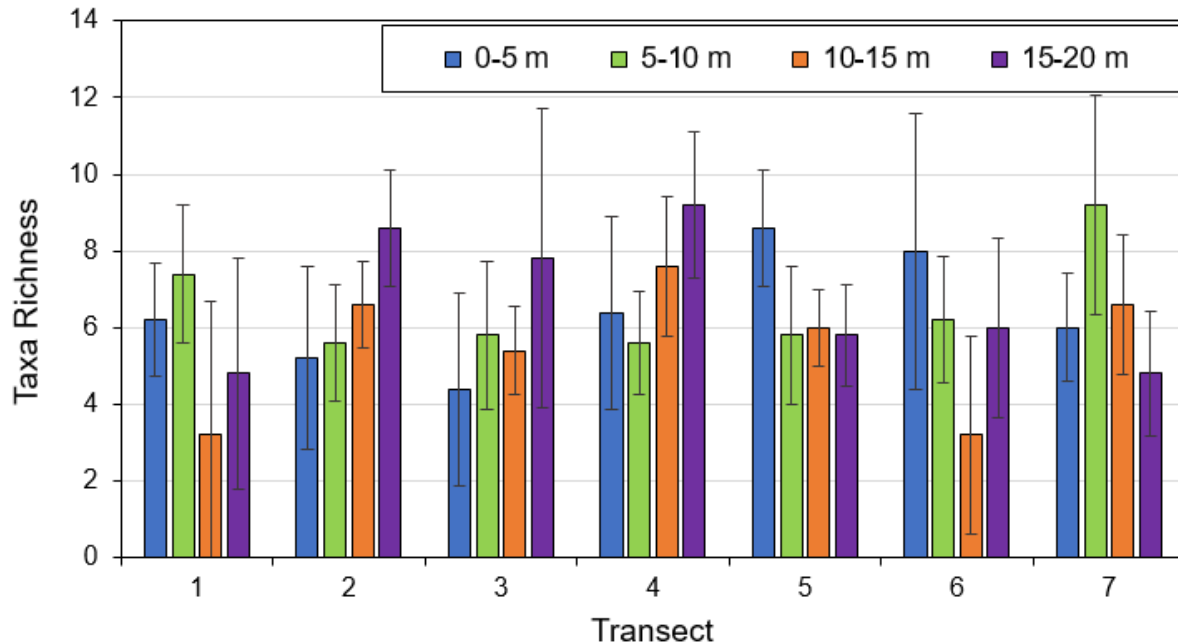


Figure 9: Taxa Richness (number of discrete taxa per sample \pm S.D.) of benthic invertebrates in the Ottawa River near NPD at four different depth strata.

Mean %EPT ranged from 4 to 32% of total sample composition, with an overall mean of about 16% (Figure 10). No Plecoptera taxa were collected in any of the samples, which is not surprising as Plecoptera taxa are typically found in smaller rocky river/stream systems, so these EPT values are represented by %E (overall mean of \sim 9.0%) and %T (6.6%) only. The presence of Ephemeroptera and Trichoptera taxa in the majority of samples is an indicator of ecosystem health. There was no clear trend between %EPT and depth; however, we only sampled to a maximum depth of 20 m because that is the maximum depth near the NPD site. Previous studies of Ottawa River benthic invertebrate community structure found that burrowing mayflies (Ephemeroidea, the most common Ephemeroptera taxa found in this study) do not occur at depths greater than 22 m ([6], [33]). This suggests that locations sampled at depths greater than 22 m would have %EPT values significantly lower than those shown in Figure 10.

Mean Hilsenhoff Biotic Index values ranged from 0.57 to 3.71, with an overall mean of about 1.4 (Figure 11). There was no clear trend with depth. The HBI estimates the overall tolerance of the benthic community, weighted by the relative abundance of each taxonomic group. Organisms are assigned a tolerance value from 0 to 10 pertaining to that group's known sensitivity to contaminants; 0 being most sensitive and 10 being most tolerant. Nearly all samples collected fell into the 'excellent' HBI category (see scoring system from [42] on the right-side of Figure 11), suggesting excellent ecological health. This indicates that the Ottawa River benthic invertebrate community is composed of a large proportion of taxa intolerant to pollutants [42]. The rest of the samples fell into the 'very good' or 'good' categories. A small number ($n=2$; NPD-1-2 and NPD-4-16) of samples fell into the 'poor' and 'very poor' categories because they were dominated by a large abundance of 'tolerant' taxa such as Chironomidae and Asellidae.

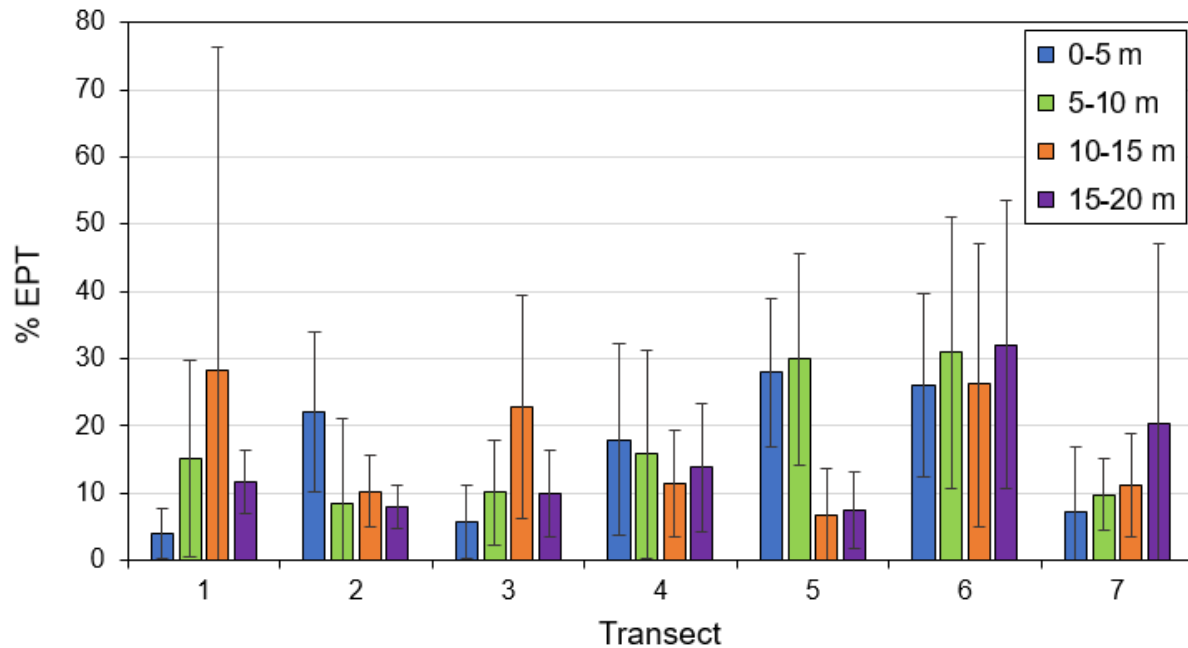


Figure 10: Ephemeroptera, Plecoptera and Trichoptera index (%EPT ± S.D.) in the Ottawa River near NPD at four different depth strata.

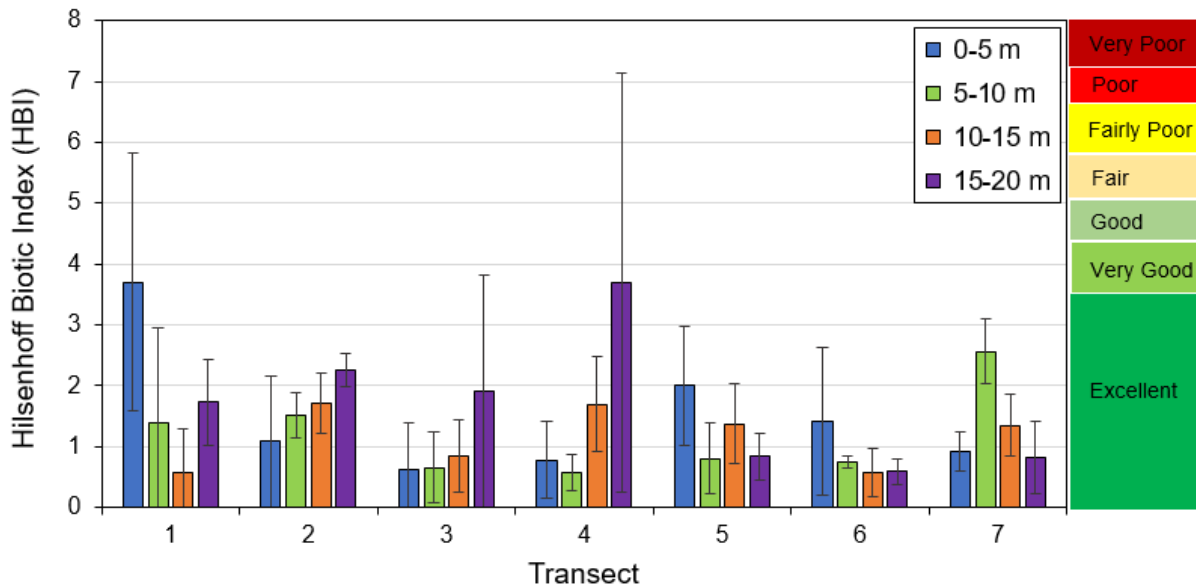


Figure 11: Hilsenhoff Biotic Index (HBI ± S.D.) in the Ottawa River near NPD at four different depth strata. The scale on the right shows HBI aquatic ecosystem health scores.

Simpson’s Diversity Index (*D*) measures the probability that two randomly selected individuals from a sample will be the same. The value of *D* will always fall between 0 and 1, with 0 representing complete diversity and 1 representing complete uniformity. Mean Simpson’s Diversity Index ranged from 0.20 to 0.83, with an overall mean of 0.31 (Figure 12). This suggests a good deal of diversity within the Ottawa River benthic invertebrate community. Like with the

other metrics, there was no clear trend with depth. The least diverse location was in the 0 to 5 m depth strata at Transect 1 near Rapides-des-Joachims. Interestingly, this location has relatively high invertebrate density, lowest %EPT score and highest HBI score, suggesting that the invertebrate community is least ‘healthy’ at this location. This is driven by the fact that it is dominated by a high number of tolerant taxa (Chironomidea). Transect 7 also had considerably sandier (moisture content ~27%) sediment than the other six transects (moisture content ~40–45%), which may be a factor in limited diversity at this location.

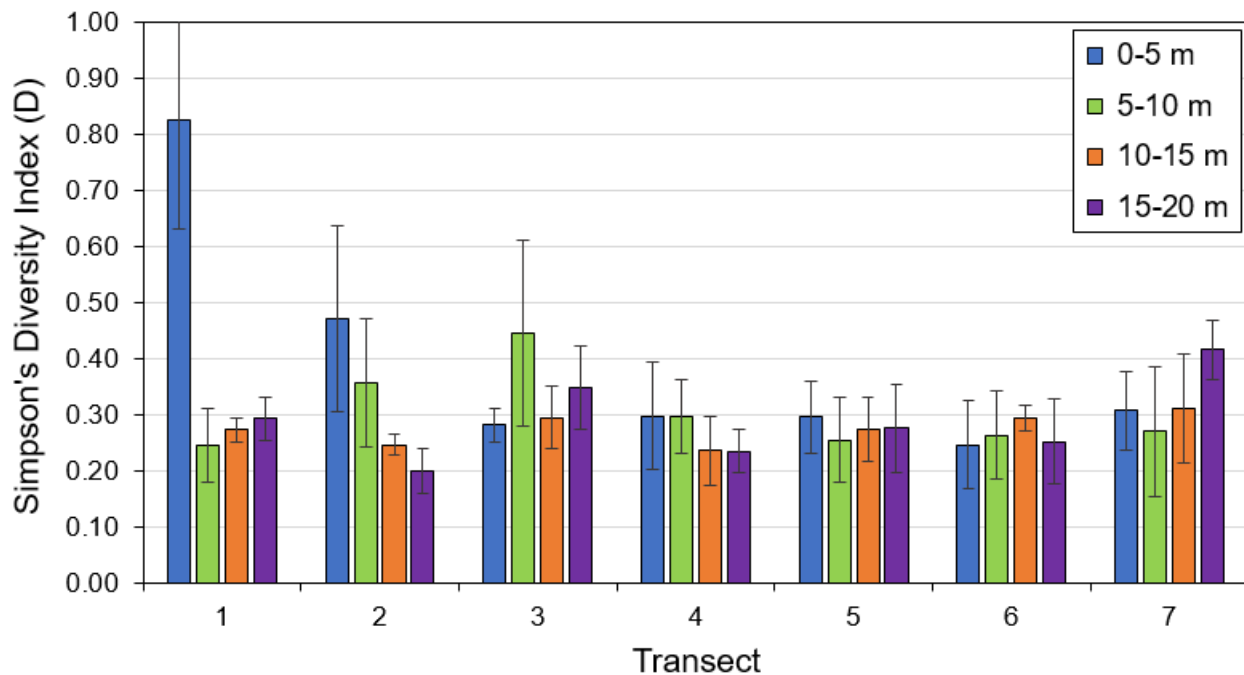


Figure 12: Simpson's Diversity Index ($D \pm S.D.$) in the Ottawa River near NPD at four different depth strata.

The Shannon-Wiener Index (H') is another index that is commonly used to characterize diversity in a community. Like the Simpson's index, the Shannon–Wiener index accounts for both abundance and evenness of the taxa present. Values can range from 0 to 5, with larger values representing greater diversity. Mean H' values ranged from 0.58 to 1.80, with an overall mean value of 1.44 (Figure 13). These values are in excellent agreement with a previous study of benthic invertebrate community in Ottawa River sediments near CRL, which found H' values ranging from 1.2 to 2.2, with an overall mean of about 1.5 [24]. There was no clear trend with depth. As with the Simpson's Diversity Index, the least diverse location was in the 0 to 5 m depth strata at Transect 1 near Rapides-des-Joachims for the reasons discussed above.

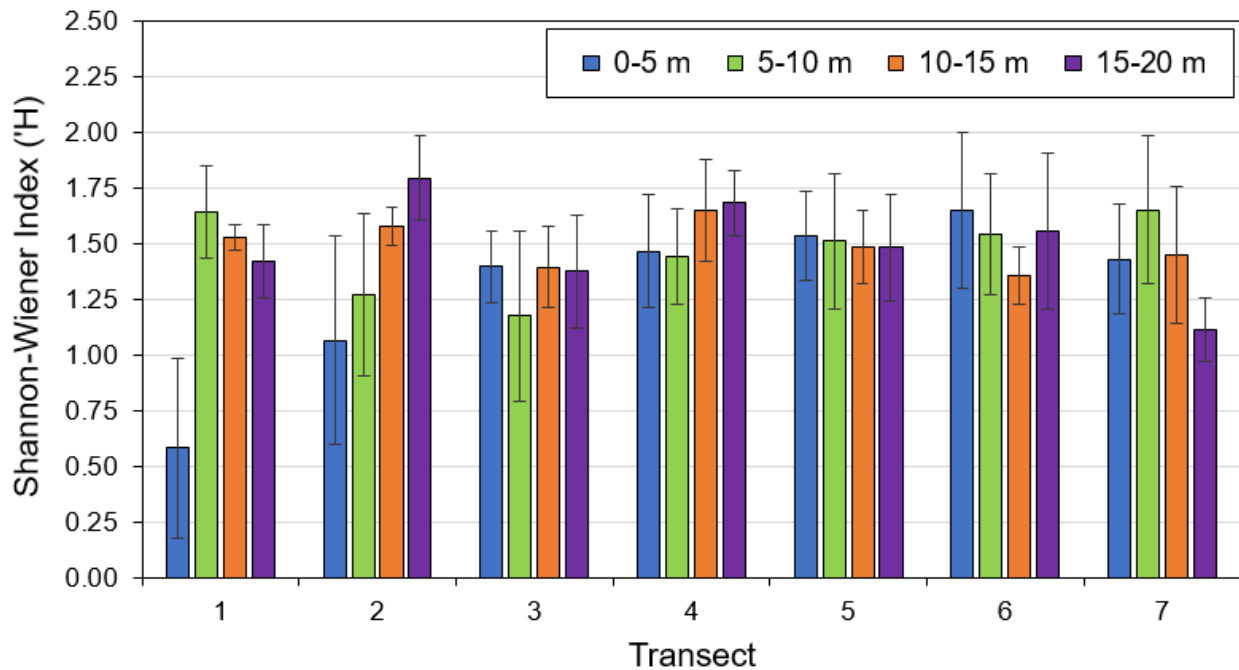


Figure 13: Shannon-Wiener Index ($H \pm S.D.$) in the Ottawa River near NPD at four different depth strata.

Overall, the Ottawa River benthic invertebrate community near NPD is healthy and typical of what is observed in many large, relatively deep, oligotrophic river systems. The data provided in this report—both raw invertebrate data (Appendix E) and calculated metrics and indices (Appendix F and Figure 7 through Figure 13) can be used as baseline conditions for the river, which can be compared to future invertebrate community data collected as part of NPD's Environmental Monitoring Plan, should it be required.

4. OTTAWA RIVER FISH HABITAT

4.1 Introduction

4.1.1 Purpose and Scope

Fish habitat is defined in subsection 2(1) of the *Fisheries Act* [47] to include all waters frequented by fish and any other areas upon which fish depend directly or indirectly to carry out their life processes. The types of areas that can directly or indirectly support life processes include, but are not limited to, spawning grounds and nursery habitat, rearing habitat, food supply and migration areas. In other words, fish habitat includes a broad suite of components, such as physical parameters (e.g., water flow, temperature, turbidity, bottom substrate, physical structure), chemical parameters (e.g., water pH, dissolved oxygen levels, level of contaminants and nutrients), and ecological/biological parameters (e.g., food resources, aquatic plant beds). A comprehensive overview of fish habitat classification is provided in [48] and a summary of Ottawa River fish habitat can be found in the Fisheries Management Plan for the Ottawa River [49].

While some baseline characteristics of the aquatic environment were compiled in the NPD EIS [1], detailed mapping (e.g., of substrate, fish habitat, and temperature) was not carried out because no fish habitat impacts are anticipated from the project. More specifically, because no in-water work is expected, no physical destruction to the river is expected. Similarly, no temperature or impingement/entrainment effects are expected to occur from the project [1]. Exposure (i.e., chemical and radiological) effects to aquatic species in the Ottawa River are assessed in the Ecological Risk Assessment for the NPD project [50].

In this section of the report, current information about fish habitat in the Ottawa River near the NPD site is presented. This information is supplemented with the results of a 2020 visual Unmanned Aerial Vehicle (UAV) survey of littoral zone fish habitat directly adjacent to the NPD site. Section 2 (sediment characteristics) and Section 3 (benthic macroinvertebrate community) of this report also provide information relevant to fish habitat in the Ottawa River near NPD. The purpose of this section of the report is not to provide a comprehensive description of fish habitat, rather it is to provide a general overview of Ottawa River fish habitat near NPD and provide some baseline quantitative measurements of physical fish habitat variables in the littoral zone near the NPD site.

4.2 Current Knowledge of Ottawa River Fish Habitat near NPD

4.2.1 Fish Community Composition

Each fish species has different habitat requirements and needs. It is not possible to map all habitats or to measure the absolute amount of fish habitat; for this reason, effort tends to be focused on key habitats that support reproduction as they are often the limiting factor to fish populations. Spawning habitats associated with specific water features such as rapids are easiest to identify; however, few habitat mapping projects have been undertaken on the Ottawa River [49]. Limited information is available about spawning areas for walleye, sauger, lake sturgeon and muskellunge, but key habitats are not mapped for many key fish species [49].

The NPD reach of the Ottawa River supports diverse warmwater and coolwater fish communities with at least 55 species documented [5]. This fish community is important ecologically, recreationally, spiritually, for traditional subsistence diets and economically. This fish community is presented in Table 8. Rainbow smelt (*Osmerus mordax*) and trout-perch (*Percopsis omiscomaycus*) are the most numerically abundant and ecologically important forage fish in deep sections of the Ottawa River near NPD, and rainbow smelt are the main prey items of adult walleye in the Upper Allumette Lake section of the Ottawa River ([6], [51]).

Table 8: Fish species present in the Allumette Lake segment of the Ottawa River where the CRL site is located (from [5]).

Common Name	Scientific Name	Environment †	Trophic Class ‡
American eel [*SAR]	<i>Anguilla rostrata</i>	benthic	invertivore/carnivore
banded killifish	<i>Fundulus diaphanus</i>	benthopelagic	invertivore/planktivore
blackchin shiner	<i>Notropis heterodon</i>	benthopelagic	invertivore
blacknose shiner	<i>Notropis heterolepis</i>	benthopelagic	invertivore/herbivore
bluntnose minnow	<i>Pimephales notatus</i>	benthopelagic	detritivore
brassy minnow	<i>Hybognathus hankinsoni</i>	benthic	planktivore/detritivore
brook stickleback	<i>Culea inconstans</i>	benthopelagic	planktivore/invertivore
burbot	<i>Lota lota</i>	benthic	invertivore/carnivore
channel catfish	<i>Ictalurus punctatus</i>	benthic	invertivore/carnivore
common carp	<i>Cyprinus carpio</i>	benthopelagic	invertivore/detritivore
creek chub	<i>Semotilus atromaculatus</i>	benthopelagic	invertivore/carnivore
emerald shiner	<i>Notropis atherinoides</i>	benthopelagic	planktivore
fallfish	<i>Semotilus corporalis</i>	benthopelagic	invertivore/carnivore
fathead minnow	<i>Pimephales promelas</i>	benthopelagic	detritivore/invertivore
finescale dace	<i>Phoxinus neogaeus</i>	benthopelagic	invertivore/planktivore
freshwater drum	<i>Aplodinotus grunniens</i>	benthic	invertivore/carnivore
golden shiner	<i>Notemigonus crysoleucas</i>	benthopelagic	invertivore/herbivore
Iowa darter	<i>Etheostoma exile</i>	benthic	invertivore
johnny darter	<i>Etheostoma nigrum</i>	benthic	invertivore
lake herring / cisco	<i>Coregonus artedii</i>	pelagic	planktivore/invertivore
lake sturgeon [*SAR]	<i>Acipenser fulvescens</i>	benthic	invertivore/herbivore
lake trout	<i>Salvelinus namaycush</i>	benthopelagic	invertivore/carnivore
lake whitefish	<i>Coregonus clupeaformis</i>	benthic	invertivore/carnivore
largemouth bass	<i>Micropterus salmoide</i>	benthopelagic	invertivore/carnivore
logperch	<i>Percina caprodes</i>	benthic	invertivore
longnose dace	<i>Rhinichthys cataractae</i>	benthic	invertivore
longnose gar	<i>Lepisosteus osseus</i>	benthopelagic	carnivore
longnose sucker	<i>Catostomus catostomus</i>	benthic	invertivore
mimic shiner	<i>Notropis volucellus</i>	benthopelagic	invertivore/herbivore
mooneye	<i>Hiodon tergisus</i>	pelagic	invertivore
mottled sculpin	<i>Cottus bairdi</i>	benthic	invertivore
muskellunge	<i>Esox masquinongy</i>	benthopelagic	carnivore
ninespine stickleback	<i>Pungitius pungitius</i>	benthopelagic	planktivore
northern pike	<i>Esox lucius</i>	benthopelagic	carnivore
northern redbelly dace	<i>Phoxinus eos</i>	benthopelagic	invertivore/planktivore
pearl dace	<i>Semotilus margarita</i>	benthopelagic	invertivore/carnivore
pumpkinseed	<i>Lepomis gibbosus</i>	benthopelagic	invertivore/carnivore
rainbow smelt	<i>Osmerus mordax</i>	pelagic	invertivore/carnivore
rainbow trout	<i>Salmo gairdneri</i>	benthopelagic	invertivore/carnivore
river redhorse [*SAR]	<i>Moxostoma carinatum</i>	benthic	invertivore
rock bass	<i>Ambloplites rupestris</i>	benthopelagic	invertivore/carnivore
rosyface shiner	<i>Notropis rubellus</i>	benthopelagic	invertivore/detritivore/herbivore
sand shiner	<i>Notropis stramineus</i>	benthopelagic	invertivore/detritivore
sauger	<i>Stizostedion canadense</i>	benthopelagic	invertivore/carnivore
shorthead redhorse	<i>Moxostoma macrolepidotum</i>	benthic	invertivore
silver lamprey	<i>Ichthyomyzon unicuspis</i>	benthopelagic	herbivore/detritivore/carnivore

Common Name	Scientific Name	Environment †	Trophic Class †
silver redhorse	<i>Moxostoma anisurum</i>	benthic	invertivore
slimy sculpin	<i>Cottus cognatus</i>	benthic	invertivore
smallmouth bass	<i>Micropterus dolomieu</i>	benthopelagic	invertivore/carnivore
spottail shiner	<i>Notropis hudsonius</i>	benthopelagic	invertivore/planktivore
tessellated darter	<i>Etheostoma olmstedii</i>	benthic	invertivore
threespine stickleback	<i>Gasterosteus aculeatus</i>	benthopelagic	invertivore
walleye	<i>Sander vitreus</i>	benthopelagic	invertivore/carnivore
white sucker	<i>Catostomus commerson</i>	benthic	invertivore/detritivore
yellow bullhead	<i>Ictalurus natalis</i>	benthic	invertivore/carnivore
yellow perch	<i>Perca flavescens</i>	benthopelagic	invertivore/carnivore

Note: [* SAR] indicates a Species at Risk, as identified by the Species at Risk Act; † Environment and Trophic Class information taken from [52] and [53].

Popular sport and food fish abundant in the Ottawa River near NPD include walleye (*Sander vitreus*), sauger (*Sander canadensis*), northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*). Other abundant, non-sport species include channel catfish (*Ictalurus punctatus*), burbot (*Lota lota*), yellow perch (*Perca flavescens*) and lake sturgeon (*Acipenser fulvescens* – a species at risk). The Upper Allumette Lake section of the Ottawa River where NPD is located supports a relatively healthy population of the threatened lake sturgeon in the Ottawa River system ([54], [55], [56]).

Some data from a recent survey of fish in the Allumette Lake segment of the Ottawa River conducted by the Ontario Ministry of Natural Resources and Forestry, as a part of their Broad-scale Monitoring Program ([57], [58]), are provided below in Table 9. Fish populations were surveyed using large and small mesh nets to provide information on fish species present and their characteristics, such as growth, age, and abundance. The catch data show that 14 species were surveyed in large mesh nets. Additional fish species observed in small mesh nets were emerald shiner, logperch, longnose gar, rainbow smelt, spottail shiner and trout-perch [57].

The hydropower generating station and control dam in Rapides-des-Joachims act as barriers to fish, and these structures are not passable (see Figure 15). The rapids downstream near Pembroke act as a downstream barrier for most species. For example, Haxton et al. [56] found that lake sturgeon did not move significant distances within Upper Allumette Lake, with maximum distance traveled being 10 km and mean home range was 1,528 ha. Haxton et al. [59] also found that walleye displayed limited movement among Ottawa River reaches, and movement was predominately upstream.

Table 9: Summary of catch from a recent gill-netting survey of the Allumette Lake segment of the Ottawa River (from [57]).

Fish Species	Total Catch (% of total)	Maximum Length (cm)	Minimum Length (cm)	Average Length (cm)
channel catfish (<i>Ictalurus punctatus</i>)	40	85.5	22.6	49.0
walleye (<i>Sander vitreus</i>)	27	61.3	22.1	33.4
sauger (<i>Sander canadensis</i>)	8	45.4	20.3	34.0
white sucker (<i>Catostomus commersonii</i>)	7	52.9	29.8	41.7
smallmouth bass (<i>Micropterus dolomieu</i>)	5	48.4	16.4	32.9
yellow perch (<i>Perca flavescens</i>)	4	24.2	14.6	16.9
northern pike (<i>Esox lucius</i>)	2	106.3	39.1	68.6
lake whitefish (<i>Coregonus clupeaformis</i>)	2	54.1	28.0	46.8
rock bass (<i>Ambloplites rupestris</i>)	1	24.8	13.0	18.1
shorthead redhorse (<i>Moxostoma macrolepidotum</i>)	1	55.3	42.1	48.3
burbot (<i>Lota lota</i>)	1	58.9	26.1	43.4
cisco, also called lake herring (<i>Coregonus artedi</i>)	< 1	50.5	41.8	46.3
mooneye (<i>Hiodon alosoides</i>)	< 1	39.6	34.3	37.3
silver redhorse (<i>Moxostoma anisurum</i>)	< 1	50.3	42.5	46.9

4.2.2 Protected Species and Habitats

Of the fish species present in the Ottawa River, the lake sturgeon is the only fish species at risk per the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) known to be present near NPD. Lake sturgeon are present in the Ottawa River, are relatively abundant in the Allumette Lake reach near the CRL site, and have been studied extensively by Haxton and colleagues (e.g., [54], [55], [56]). Although lake sturgeon are relatively abundant in the Allumette Lake segment of the Ottawa River [54], the stretch of river near NPD is relatively slow-moving and deep with sand/silt substrate. Thus, it is not considered to be important spawning habitat for lake sturgeon which select spawning habitat that is relatively shallow, fast-flowing (usually below waterfalls, rapids or dams) with gravel and boulder bottom substrate [60].

The American eel was historically present near CRL, but has not been sighted in the Ottawa River near the CRL site recently, due in large part to the presence of multiple barriers (dams) between their spawning grounds in the Saragasso Sea and Allumette Lake. Eel populations have experienced substantial declines in many regions throughout their North American range. River redhorse, a species designated as 'Special Concern' in Ontario, has also been historically documented in the Ottawa River [5]. However, the presence of this species in the Allumette Lake region of the river near NPD has been disputed and range maps of this species provided by the province of Ontario indicate that their range is confined to lower reaches of the river (downstream of Renfrew).

There is a fish sanctuary located about 5 km upstream of the NPD site at McConnell Lake, with no fishing permitted between April and June [49] to protect the spawning grounds of a number of spring-spawning species that congregate in this location.

4.2.3 Ottawa River Foodweb

Components of the Ottawa River benthic and pelagic food webs were assessed using stable nitrogen and carbon isotope ratios, which can be used to estimate trophic position of biota ([51]). When plotted, overlap in $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ signatures signifies important trophic interactions among these biota. When there is no overlap among biota on these plots, this signifies that there is minimal trophic interaction. The Ottawa River food web in the Allumette Lake section of the Ottawa River is relatively straightforward. For the pelagic food web, the diet of walleye, the top aquatic predator in this reach of the Ottawa River, consists predominantly of rainbow smelt ([51]; Figure 14). The smelt diet consists predominantly of pelagic zooplankton and the zooplankton diet is assumed to be phytoplankton ([51], [61]; Figure 14). For the benthic food web, the diet of juvenile yellow perch (*Perca flavescens*) consists almost entirely of benthic invertebrates, primarily the burrowing mayfly *Hexagenia* ([6], [35], [51]). The diet of older yellow perch typically consists of young-of-year yellow perch and is supplemented by benthic invertebrates ([6], [51], [61]).

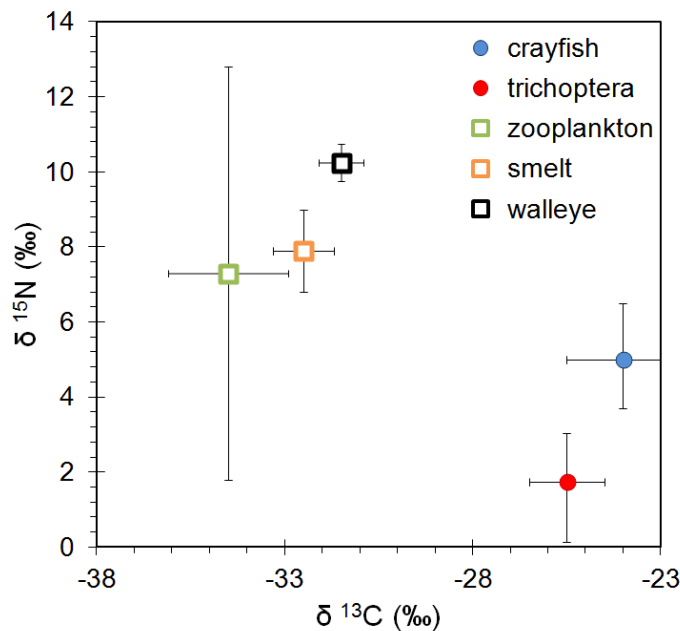


Figure 14: N-15/C-13 plot for Ottawa River biota (from Rowan [51]).

4.2.4 Unique Fish Habitat Features near NPD

A qualitative overview of locations of likely importance for fish habitat near NPD are shown on a map in Figure 15. A description of these locations, and their importance in terms of fish habitat, are described in Table 10.

There are a number of man-made features in the littoral zone of the river near NPD resulting from historic log-driving down the river, including rock cribs, shown on the red circles on Figure 16. There is minimal littoral zone in this stretch of the Ottawa River, with relatively steep slope along both shores (Figure 16). Depths directly adjacent to NPD approach 20 m, while they approach up to 50 m downstream of Point Stewart and 84 m about 1.5 km upstream of NPD

near Rapides-des-Joachims at the hydropower generating station tailrace (Figure 16). The release of cool hypolimnetic water from the Des-Joachims hydropower station’s reservoir results in relatively cool water throughout the year.

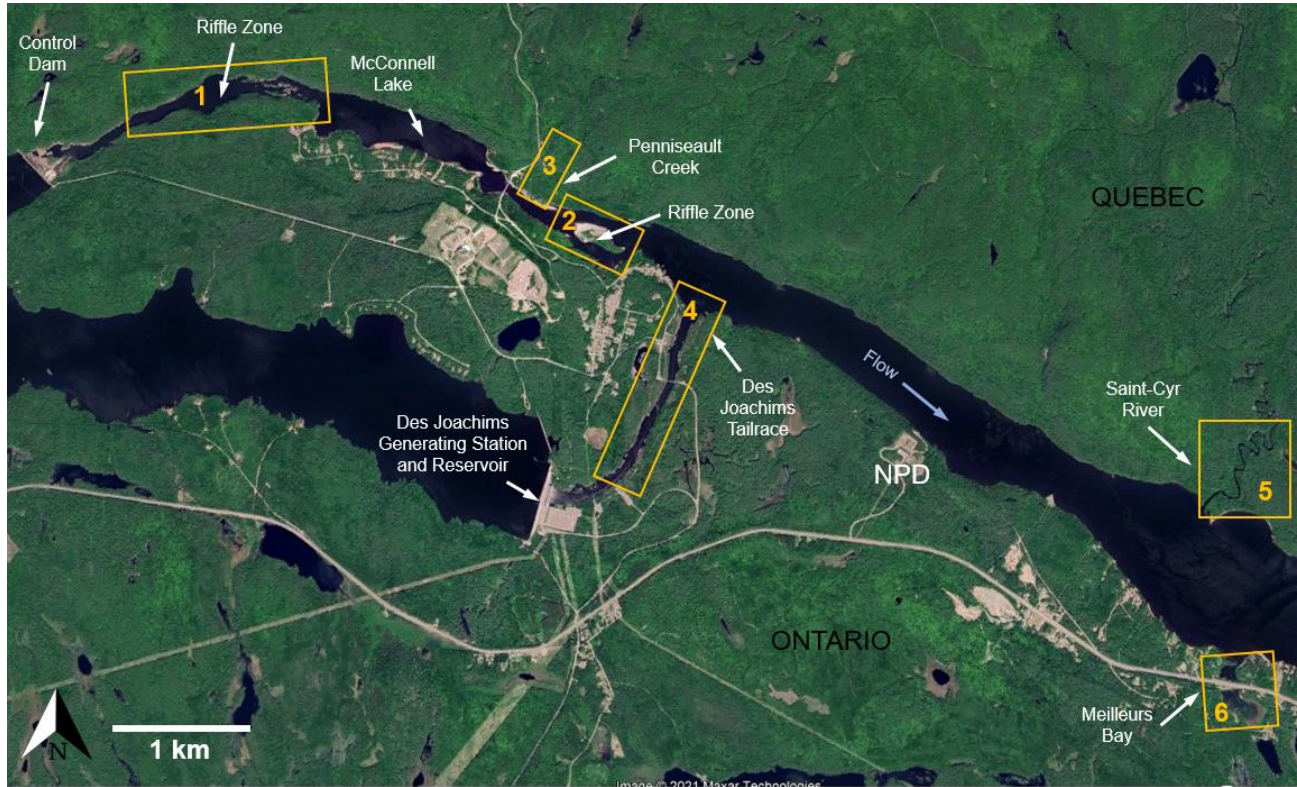







Figure 15: Map of the Ottawa River near NPD showing fish habitat locations of particular interest (see Table 10 for more information; imagery from Google Earth Pro).

Table 10: Descriptions of important fish habitat features on the Ottawa River near NPD.

ID on Figure 15 Map	Location Name	Description of Feature	Zoomed-In Imagery of Feature (from Google earth Pro)
1 and 2	Riffle Zones below Control Dam	These locations provide relatively shallow water riffle habitat with relatively clean rubble/cobble and gravel/pebble substrate. Such conditions are unique and not commonly found elsewhere in the Upper Allumette Lake segment of the river, but provide important spawning habitat for a number of species including lake sturgeon and walleye. McConnell Lake is a fish sanctuary [49] for this reason.	

ID on Figure 15 Map	Location Name	Description of Feature	Zoomed-In Imagery of Feature (from Google earth Pro)
3	Penniseault Creek	Penniseault Creek is a relatively small (~10 m channel width), high-gradient, rocky creek that drains an upstream lake (lac à la truite) into the Ottawa River. The creek bed is composed of large bedrock stones and quartz formations. 150 m of this creek are considered to be a fish sanctuary in the spring [49].	
4	Des Joachims Tailrace	This location provides consistent (year-round) swift flow from the hydropower facility in a relatively deep (~9 m) channel. This channel is rich in nutrients, which is typical for waters directly downstream of dams that are enriched in food resources from the upstream reservoir ([62], [63]). For this reason, a relatively high density of fish, particularly walleye, congregate near the confluence of the tail race and the main Ottawa River channel to feed.	
5	Saint-Cyr River	The Saint-Cyr River (also called Boom Creek) is a medium-sized (~30 m channel width) meandering soft-bottomed creek. This system receives a large run of white suckers in the spring. As a result, large predatory fish such as northern pike and walleye typically congregate at the creek confluence with the Ottawa River in the spring to feed.	
6	Meilleurs Bay	This shallow (< 1.5 m depth), soft-bottomed bay (1.4 km ² in area) provides important spawning, nursery, rearing and feeding habitat for a number of fish species, including smallmouth bass, northern pike, yellow perch, bluegill, pumpkinseed and various forage fish species. The southern portion of this bay is connected to the river by a culvert under Highway 17, and contains a high density of aquatic plants. In the spring, this bay warms up faster than the main river channel, and species that seek out warm waters (e.g., pike, bass) congregate here.	

4.2.5 Bathymetry

Both river banks are relatively steep in slope, resulting in minimal littoral zone. Water depths near NPD range from about 1 m to 20 m mid-river channel (Figure 16). Directly downstream of NPD (but upstream of Pt. Stewart), there is a relatively shallow bay ranging in depth from about 1 m to 2 m. Upstream of NPD near Rapides-des-Joachims, there is a deep hole approaching 63 m and downstream of NPD there is a deep hole approaching 50 m (Figure 16).

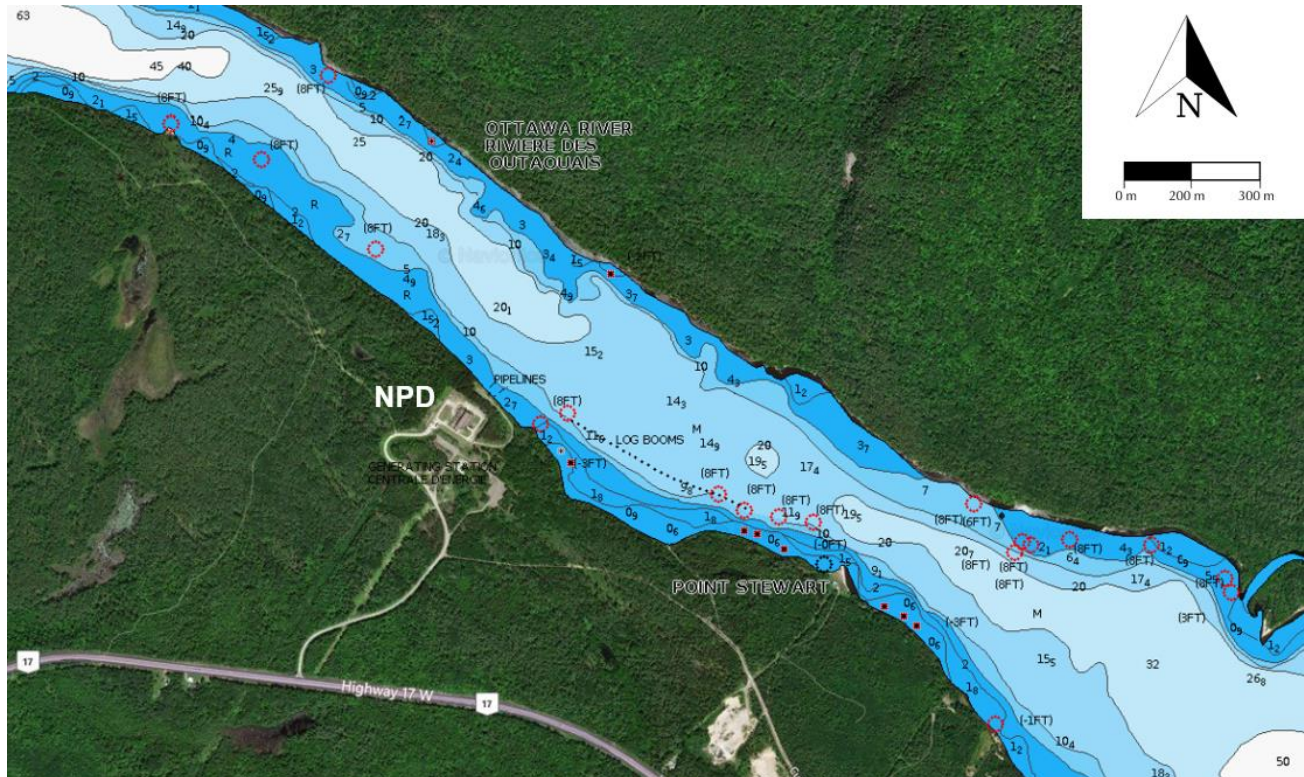


Figure 16: Bathymetry map of the Ottawa River near the NPD site. Depth contour values are expressed in metres (m). Map provided by Navionics.

4.2.6 Temperature

The Ottawa River thermally stratifies in the summer, much like a lake. The depth of the hypolimnion varies along the course of the river, but it typically establishes somewhere between about 18 and 25 m depth. Figure 17 shows a typical summer temperature profile of the Ottawa River column. This hypolimnion can also be clearly seen on Figure 21 at about 25 m depth as a result of large schools of rainbow smelt congregating there. It is typical for fish to congregate at the thermocline as prey such as zooplankton will settle along these temperature gradients, and in the late summer and early fall, fish will go below the thermocline seeking out the cooler water. As the area near NPD is only 20 m deep (maximum), stratification is not expected to occur.

There is long-term temperature data for the Ottawa River as part of CNL's Environmental Monitoring Program, taken near Chalk River Laboratories, about 26 km downstream of NPD.

This data was collected at 15 m water depth, and is presented in Figure 18 and Figure 19. Figure 18 clearly shows the seasonal variability in water temperature, with temperature ranging from ~0–3°C in winter months to ~14–20°C in summer months. This water temperature dataset is broken down in Figure 19 to show the proportion of days in various thermal categories. The Upper Allumette Lake section of the Ottawa River typically has about 1,955 Growing Degree Days [49] – a metric used for explaining variation in fish growth and development based on water temperatures [64].

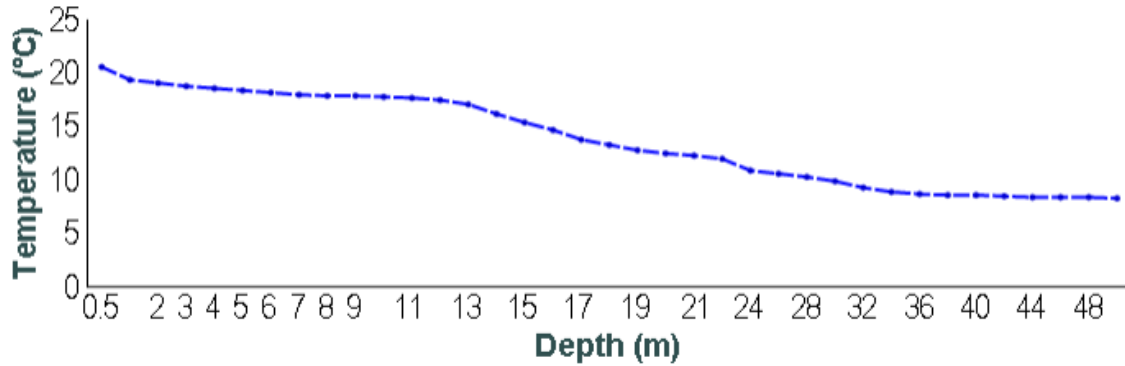


Figure 17: Vertical thermal profile of the Ottawa River water column, taken mid-summer near Deep River (from [57]).

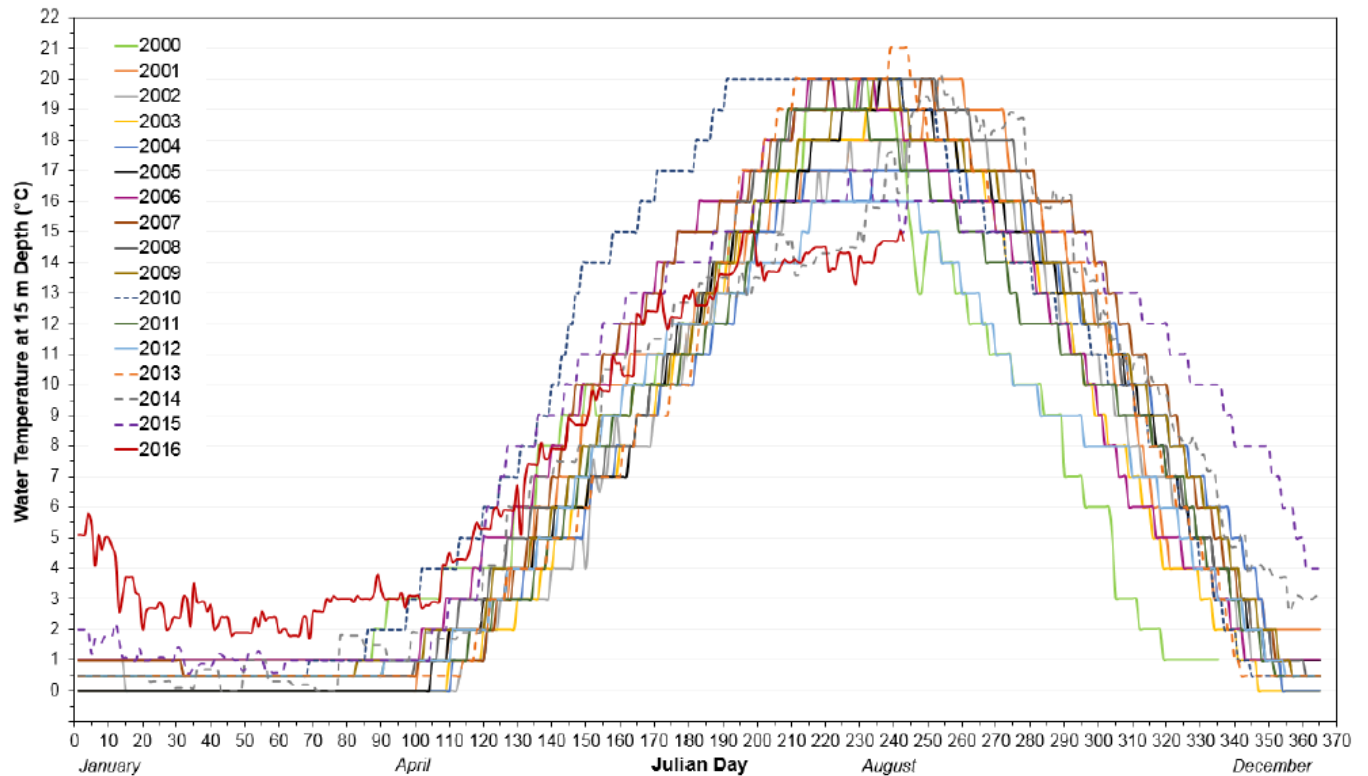


Figure 18: Water temperature trends in the Ottawa River from 2000 through 2016. All data are from 15 m water depth adjacent to CRL (from [65]).

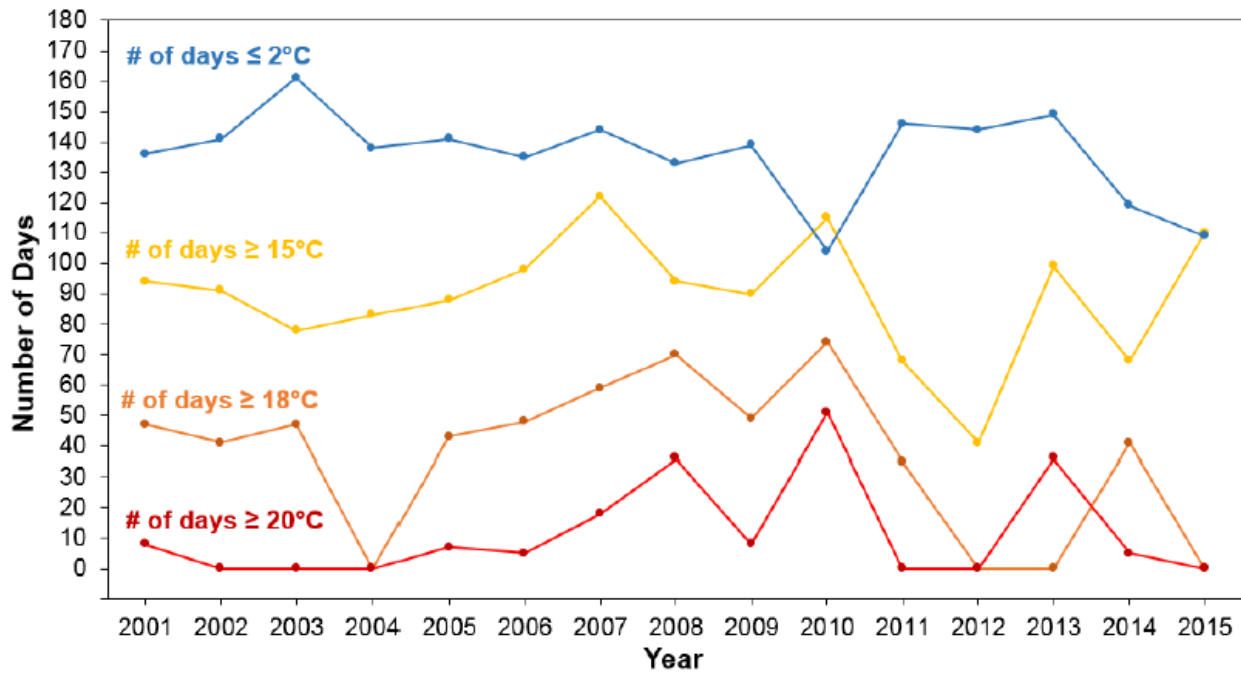


Figure 19: Ottawa River water temperature trends at 15 m water depth from 2001 to 2015 showing the number of days in different cool ($\leq 2^{\circ}\text{C}$), warm ($\geq 15^{\circ}\text{C}$ and $\geq 18^{\circ}\text{C}$) and hot ($\geq 20^{\circ}\text{C}$) thermal categories (from [65]).

4.2.7 River Flows

Like many large river systems, Ottawa River flows are highly variable. Seasonal patterns of river flow are defined by periods of snow melt and the regulated system is operated under a ‘natural’ flow regime [49]. Although hydroelectric development (flow regulation) has provided some moderation of the natural flow patterns, the Ottawa River still experiences the same general pattern of flow, with low flow in the fall and a sudden increase in flow with the spring melt. The mean annual river flow at NPD is $\sim 840 \text{ m}^3/\text{s}$; however, flows can range between a summer low of $\sim 400 \text{ m}^3/\text{s}$ and a spring freshet high of $\sim 4,000 \text{ m}^3/\text{s}$ in flood years such as 2019 (Figure 20). This seasonal flow variability is an important component of fish habitat in the Ottawa River, as high spring freshet flows inundate the floodplain and provide important spawning habitat for some spring-spawning fish species. This shoreline/floodplain habitat provides shallow water nesting/spawning and nursery habitats that benefit muskellunge, northern pike, smallmouth bass, black crappie, and forage fishes [49]. Fast water, rocky riffle spawning habitats, such as those found upstream near Rapides-des-Joachims or downstream near Pembroke, benefit walleye, sauger, lake sturgeon, suckers and redhorse species [49].

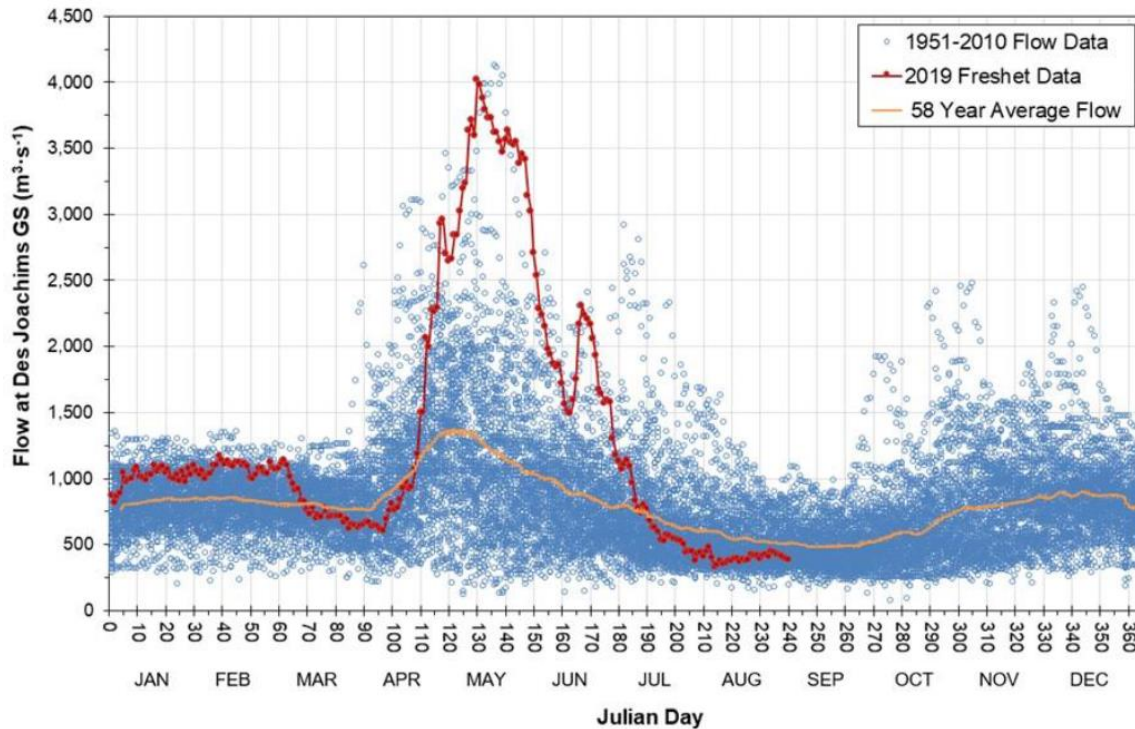


Figure 20: Historical Ottawa River flows at NPD, showing daily flow records since 1951 (blue dots), the historical mean daily flow (orange line) and a flood year flow (2019; red line).

4.2.8 Hydroacoustic Study

A 2012 fish community study for the Ottawa River employed hydroacoustic technologies and surveyed the river between Deep River and Chalk River Laboratories, downstream of the NPD site ([6], [66]). High frequency acoustic surveys have been used as an alternative method to determine fish distribution because of the large volume of water that can be continuously surveyed. Fisheries hydroacoustics is a survey method that uses transmitted sound to detect fish. Sound is transmitted as a pulse, and travels quickly and efficiently through water. As the pulse travels through the water, it encounters objects (i.e., fish) that are of different density than the surrounding medium (i.e., water). These objects reflect sound back toward the source of the sound, creating an echo. The echo or return signal provides information about fish size, location, and abundance.

Fish density in a water body can vary by season and by daily cycles, and can be influenced by a range of abiotic, biotic and behavioural factors including temperature, oxygen concentration, and vertical distribution of predators and prey [67]. These factors frequently lead to fish density and distributions that are higher near the bottom of a given water body. This makes quantifying their numbers difficult to do hydroacoustically [68]; however, at night fish tend to distribute more evenly within the water column. For this reason, the hydroacoustic surveys were completed overnight during early October of 2012. Complete methods for the survey are described in [66].

Fish density and the depth and size of individual echoes were obtained using Biosonics Digital Analyzer 4.1 software. For these analyses, all potential planktivorous fish (prey fish) were combined, and all targets $> -46\text{dB}$ and $< -70\text{dB}$ were classified as prey fish, which corresponds to fish lengths $< 100\text{ mm}$ [68]. The fish were then separated into 2 groups, smaller ($< 100\text{ mm}$) planktivorous fish, and larger ($> 100\text{ mm}$) benthivorous and piscivorous fish [66]. In order to process echoes, Visual Analyzer requires a bottom location. Figure 21 shows a typical echogram from one of the deeper ($\sim 40\text{ m}$) basins in the Ottawa River near Chalk River. The green and yellow lines show the bottom of the river from the Ontario shore to the Quebec shore, while the blue dots show locations of fish.

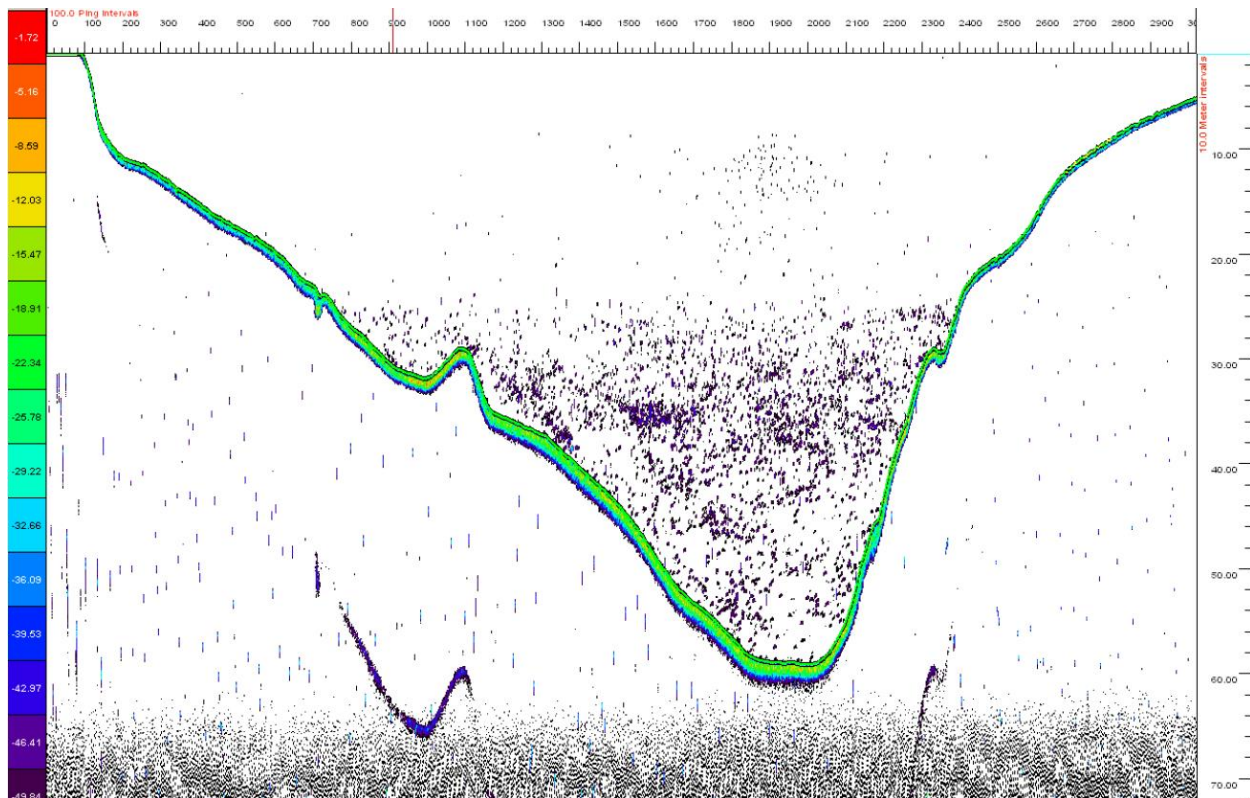


Figure 21: Typical echogram showing $> -46\text{dB}$ $< -70\text{dB}$ targets (from [66]).

Fish density was found to be highly variable, with variability decreasing with increasing depth (Figure 22). As expected, the density of planktivorous fish is greater than that of benthivorous and piscivorous fish, and ranges from 1000 to 10,000 individuals/ha, whereas benthivorous and piscivorous fish range from 100 to 1,000 individuals/ha.

Figure 23 extends the depth range to $\sim 80\text{ m}$ and shows that fish density is more variable at shallow depths, decreasing with depth. This is expected, as shallow water habitat is highly variable, whereas deep water habitat is very consistent with low variability. Planktivore fish density approaches 105 fish/ha, while benthivore and piscivore fish density approaches 104 fish/ha.

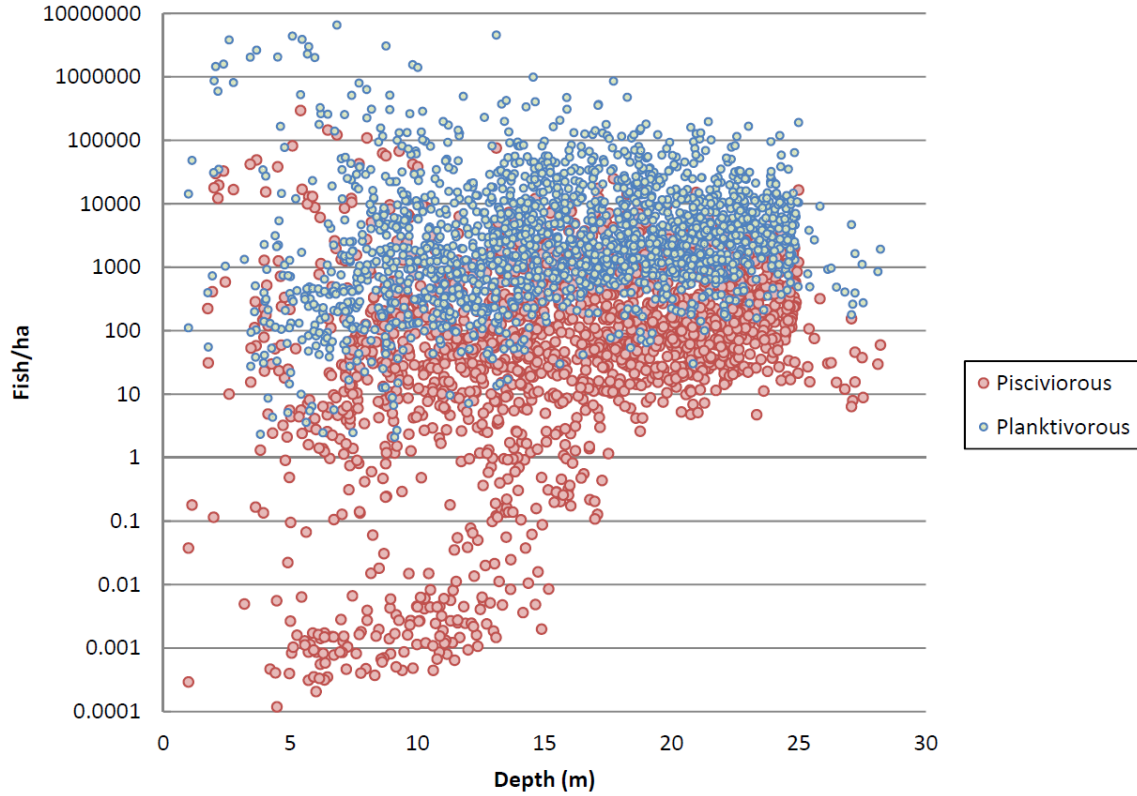


Figure 22: Fish density as a function of depth (0-25 m; from [66]).

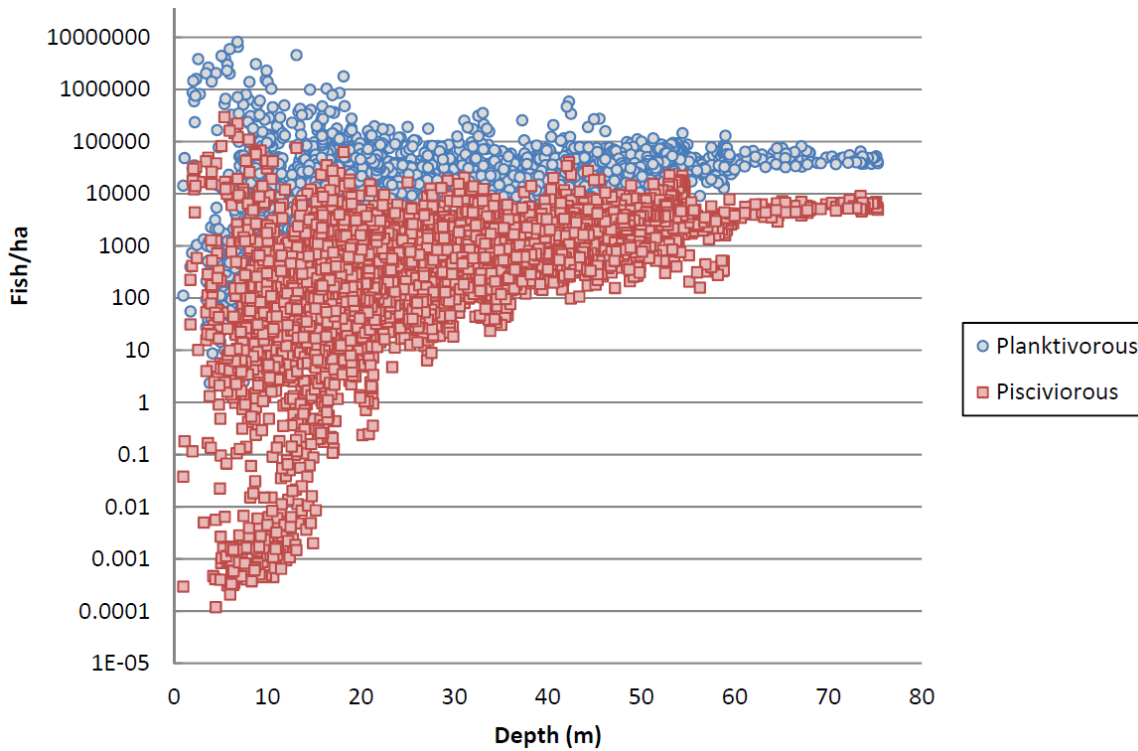


Figure 23: Fish density as a function of depth (all depths; from [66]).

Results of this hydroacoustic study show that fish density is highly variable within this reach of the Ottawa River and that variability in fish density is inversely related to water depth. This is expected, as fish habitat in shallow water areas can be highly variable, with slope, sediment type, woody debris, aquatic macrophytes, currents and waves leading to a variety of habitat types. Deep water areas are much more uniform, with fine-grained sediments, low slope, and less interaction with currents and waves.

4.2.9 Vegetation and In-Stream Structure

In-stream vegetation in the Ottawa River includes a variety of macrophytes. Since the Ottawa River bottom is generally steep nearshore, in-stream vegetation is relatively rare along its course and is mostly associated with its shallow, sandy areas in bays or near stream discharges. The littoral zone near the NPD site is composed of a mix of aquatic macrophytes, including pond lily (*Nuphar variegatum*), wild celery (*Vallisneria americana*), Canadian pond weed (*Elodea canadensis*), floating pond weed (*Potamogeton natans*) and watermilfoil (*Myriophyllum*), among others. The nearest wetland connected to the Ottawa River is Meilleurs Bay, located about 2.8 km downstream of NPD (see description in Table 10).

The historical log-drive down the Ottawa River (see [5]) left behind relics that are relevant to fish habitat in the river today. Restraining log booms and cribs were constructed along the nearshore zone to restrain large numbers of logs being floated down the river to mills. This involved making large piles of rock to secure the booms to. The Ottawa River near NPD was home to a number of these large log boom structures and remnants of this can be seen on Figure 16 (red circles). The photos in Figure 24 show what an active log boom on the Ottawa River looked like (left photo) and what remains today in the form of man-made rock piles (right photo). These log boom structures provide structure habitat for a number of species and are therefore a popular fishing location for anglers.



Figure 24: Photos of log boom structures along the Ottawa River shoreline.

4.3 Methods

4.3.1 UAV Survey

Remote sensing is a useful tool for assessment and quantification of fish habitat variables ([69]). A visual survey of the Ottawa River littoral zone near the NPD site was conducted on

2020 August 13 using an Unmanned Aerial Vehicle (UAV) outfitted with a high resolution 4K camera to survey physical habitat in the littoral zone. The aircraft used for these flights was a DJI (Da-Jiang Innovations Science and Technology Co. Ltd., Shenzhen, China) Mavic 2 Zoom UAV, which was piloted by Transport Canada certified staff from CNL's Mechanical Equipment Development Branch. The camera was fitted with a specialized polarized lens to improve visibility through the water.

A software package called 'Drone Deploy' was used to perform the flight planning and operations, as well as the post processing of the NPD Shoreline data. Drone Deploy is a drone mapping software application that includes autonomous flight planning, flight execution and image post processing. The area covered at the NPD shoreline is quite large (over 1.5 km of shoreline) so flight height, speed and direction were all closely tuned to cover the area in a reasonable number of flights. An example of the flight plan is shown in Figure 25.

The UAV survey was conducted at an altitude of 61 m and a flight speed of 4 m/s. The entire survey took approximately 40 minutes of flight time, and involved the capture of 531 geotagged high-resolution images, providing a spatial coverage of 15 hectares of littoral and shoreline habitat. Under these flight conditions, image resolution was approximately 22 cm/pixel. The imagery was collected using a high level of overlap (65–75%) to allow for subsequent processing. A photo of the UAV survey in action is shown in Figure 26.

During the August 13 survey, conditions were clear and sunny and wind was < 15 km/h. The Ottawa River water level at the Des Joachims generating station just upstream of NPD was 152.10 m, with a river flow of 498 m³/s (data taken from the Ottawa River Regulation Planning Board database [70]). If flights are repeated in the future to compare results, it is crucial that flow conditions are very similar. Also important to note are the upstream (Easting 294775, Northing 5118519) and downstream (Easting 295715, Northing 5117843) shoreline boundaries of the survey area, recorded using NAD1983 UTM Zone 18N coordinate system.

This GeoTIFF file was imported into a GIS environment (ArcMap, ESRI Ltd, Redlands, USA) for spatial analysis. Using the measurement tools within ArcMap, manual measurement and classification of substrate by type and/or size was completed to provide a quantitative description of the physical fish habitat components in the Ottawa River littoral zone near the NPD site. Components identified, measured/counted and mapped from the imagery included:

- Total littoral area (total area submersed in water between shoreline and drop-off where light penetrates to the bottom);
- Bottom substrate type based on the Wentworth scale (see Table 11);
- Large woody debris area (i.e., sticks, logs);
- Weed beds (mats of macrophytes, either emergent, floating or submersed);
- Man-made structures (typically remnants of old logging cribs).

Results are shown on a map in Figure 27 and habitat features are quantified in Table 12. These outputs allow, for the first time, a spatially continuous and explicit characterization of the physical habitat at this location, especially when paired with the bathymetry map presented in Figure 16.

Table 11: Bottom substrate categories used for the NPD fish habitat survey (based on the Wentworth Scale [71]).

Substrate Type	Definition
Bedrock	exposed rock with no overburden
Boulder	rock > 256 mm in diameter
Rubble/Cobble	rock 80 mm to 256 mm in diameter
Gravel/Pebble	rock 2 mm to 80 mm in diameter
Sand	crystalline rock 0.0625-2.0 mm in diameter
Silt	inorganic material finer than sand (0.0039-0.0625 mm in diameter)
Clay	inorganic material with a greasy feel, no apparent structure (< 0.0039 mm)
Muck	composed of silt and clay mixture with considerable amounts of organic material
Detritus	organic material composed of sticks, leaves, and decaying plants
Marl	material composed of carbonates derived from algae and mollusc shells (light grey colour)

Various substrate types are of critical importance to the productivity, abundance and diversity of fish species. Substrate is an important component of fish habitat because it provides incubation areas for eggs, invertebrate (food) production, sites for nest building, nursery habitat and cover ([48], [72]). In ArcMap software, nearshore substrate was recorded by delineating the boundaries of homogeneous substrate types as polygons, and area measured using a measurement tool. Substrate type was determined by particle size and relative consistency (Table 11). Results from the imagery analysis were compared with results from the sediment sampling (Section 2) to verify the UAV-derived observations. A visual survey by boat was also conducted to validate the UAV observations.

Aquatic vegetation is also an important component of fish habitat. It provides fish with feeding, spawning, nursery and cover opportunities. Edges and open water pockets within densely vegetated areas are critical for sight-feeding predators such as northern pike and largemouth bass [72]. Areas of macrophyte growth were identified as either emergent, submergent or floating dominant and its boundaries were delineated in polygon form using ArcMap. Likewise,

a number of fish species are attracted to large woody debris structures such as fallen trees, stumps and logs for the cover and microhabitats they provide [72]. For example, largemouth bass prefer these areas for spawning, resting, refuge, feeding and ambushing prey ([72], [73], [74]). These locations were delineated as polygons and measured, again using ArcMap.

4.4 Results and Discussion

Figure 27 shows the processed high-resolution orthomosaic image of the Ottawa River littoral zone near the NPD site. Locations and areas of differing physical habitat types are shown, as are some examples of zoomed-in images. The location of the NPD site’s effluent release point is identified on the map by a yellow star.

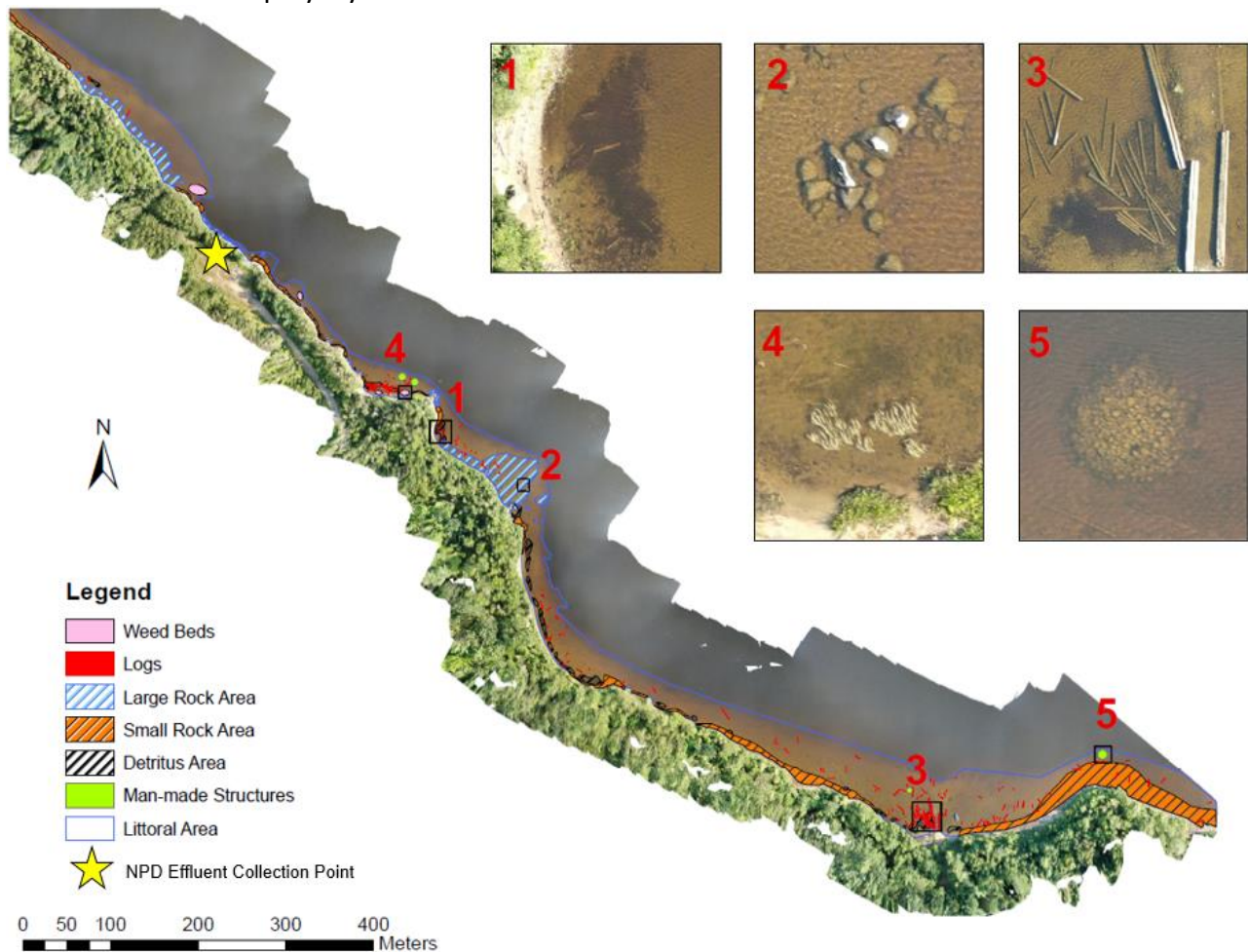


Figure 27: Orthomosaic image of the Ottawa River near-shore segment near NPD showing physical fish habitat features including for example (1) detritus/coarse particulate organic matter, (2) large rock/boulder, (3) large woody debris, (4) weed beds and (5) man-made structures (log boom).

At the survey conditions described above, a total littoral zone of about 30,863 m² was surveyed, imaged and analyzed (Table 12). Of this, the majority (76%) consisted of sand, 13% consisted of small rock (gravel / cobble) and 8% consisted of large rock. Much smaller proportions of the

littoral zone consisted of detritus (2.5%), large woody debris (0.6%), weed beds (0.5%) and man-made structures (0.4%). This physical habitat composition is consistent with what is observed at upstream and downstream locations with a relatively steep slope (i.e., drop-off).

Table 12: Quantitative results for physical habitat mapping of the Ottawa River littoral zone near NPD.

	Area (m ²)	Count	% of Total Littoral Area
Total Littoral Area	30,863		
Sandy Area	23,498		76.1
Small Rock Area	4,103		13.3
Large Rock Area	2,371		7.7
Detritus and Coarse Particulate Organic Matter	764		2.5
Large Woody Debris Area (i.e., sticks, logs)	185	239	0.6
Weed beds	154	5	0.5
Man-Made Structures	129	5	0.4

Based on the physical substrate composition in the littoral zone, which is dominated by sand (76%) and gravel/pebble (13%), and the fact that the slope is high and rocky (i.e., minimal floodplain habitat), it is possible to speculate which fish species would use this habitat, based on known species habitat preferences documented in the literature [72]. This information is presented in Table 13.

Table 13: Habitat use by substrate type for various Ottawa River fish species.

	Sand (76% of Area)	Gravel/Pebble (13% of Area)	Large Rock (Boulder) (8% of Area)
Blackchin shiner	S, N, F ([52],[53])		
Blacknose shiner	S, N, F ([52],[53])		
Bluntnose minnow	N ([52],[75],[77])	S, N ([52],[75],[77])	N, F ([52],[53],[75])
Emerald shiner	S, N ([52],[75],[80])	S, N ([52],[75],[80])	
Lake sturgeon	N, F [81]	N, F [81]	
Largemouth bass	S, N ([52],[77],[78])	S ([52][77],[78])	
Logperch	S, N, F ([52],[75],[77],[79])	S, N ([52][75],[77])	C ([52],[75])
Pumpkinseed	S, N, F ([52],[77],[78])	S, N, F ([52],[77],[78])	F, C ([52],[76],[78])
Rock bass	S, F ([74],[77],[78])	S, N, F ([74],[52],[77],[78])	F [52]
Smallmouth bass	S, N ([52],[74],[75],[77],[78])	S, N ([52],[74],[75],[77])	N, C ([52],[75],[76],[78])
Walleye	S, N, F ([77],[83])	S, N ([52],[75],[77],[83])	S, C, F ([52],[77])
White sucker	S, N, F ([75],[77],[83])	S, N, F ([75],[77],[80],[83])	C, F ([52],[75])
Yellow perch	N, F ([76],[77])	N ([52],[77],[78],[82])	

Note: S = Spawning; N = Nursery; F = Feeding; C = Cover; [] = References

The information presented in Table 13 identifies fish species that may find the habitat in the Ottawa River nearshore zone near NPD desirable at various life stages (i.e., nursery) or for different functions (i.e., spawning, feeding, cover). All of the species listed in this table are common in the Ottawa River. When this information is paired with physicochemical data (e.g.,

water quality, contaminant load, temperature) and other ecological data (e.g., food availability, benthic invertebrates) included in the definition of fish habitat, a holistic picture of fish habitat is presented. This fish habitat study can be replicated post-construction-phase at NPD, and the current (i.e., baseline) fish habitat description, particularly littoral zone physical habitat adjacent to NPD, can then be compared to monitoring data to demonstrate any effects (or, lack thereof) to fish habitat.

5. Overall Conclusions

The results for non-radiological parameters are typical of what has been observed for Ottawa River sediments in other studies (e.g., [6], [13], [14], [15]), while metal concentrations reflect local geology for the most part. Overall, the Ottawa River benthic invertebrate community near NPD is healthy and typical of what is observed in many large, soft-bottomed, oligotrophic river systems (e.g., [8], [24], [33], [34]). Fish habitat in the Ottawa River near NPD was assessed and described, and it was determined that the sandy littoral zone near NPD likely provides habitat for a number of species; however this sandy littoral zone is not unique to NPD as much of the littoral zone of the Allumette Lake portion of the Ottawa River is dominated by shallow sandy substrate.

When considered holistically, the sediment, benthic invertebrate community, and fish habitat results presented in this report provide an overview of baseline conditions in the Ottawa River prior to decommissioning of the NPD site. The data contained in this report can be compared against future monitoring data (if necessary) to determine if any changes have occurred.

River systems are naturally subject to constant change, resulting in large part from large variability in flows [84]. These changes can include changes in channel, substrate and habitat available to invertebrates and fish, among many others. It is important that such large-scale changes also be considered when this data is used for monitoring.

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Appendix A Raw Ottawa River Sediment Data

Table 14: Raw chemistry results for sediment samples along Transect 1.

Analyte	Unit	NPD-1-1		NPD-1-2		NPD-1-3		NPD-1-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	18.1	10.7	19.4	10.6	ND	9.96	25.9	10.7
Aluminum	mg/kg	2760	8.26	4140	9.38	2230	8.48	4770	8.99
Antimony	mg/kg	ND	0.401	ND	0.455	ND	0.411	ND	0.436
Arsenic	mg/kg	0.687	0.607	1.15	0.69	ND	0.623	1.48	0.661
Barium	mg/kg	30.9	0.121	35.4	0.138	16.7	0.125	40.3	0.132
Beryllium	mg/kg	0.226	0.121	0.332	0.138	0.174	0.125	0.386	0.132
Boron	mg/kg	1.28	1.21	ND	1.38	ND	1.25	ND	1.32
Cadmium	mg/kg	0.185	0.121	0.267	0.138	ND	0.125	0.302	0.132
Calcium	mg/kg	1120	9.71	1880	11	712	9.97	2000	10.6
Chromium	mg/kg	6.16	0.182	9.92	0.207	6.94	0.187	11.6	0.198
Cobalt	mg/kg	2.38	0.182	3.52	0.207	1.82	0.187	4.05	0.198
Copper	mg/kg	4.60	0.364	6.72	0.414	4.72	0.374	7.7	0.397
Iron	mg/kg	5340	9.71	8350	11	4120	9.97	9690	10.6
Lead	mg/kg	ND	0.401	ND	0.455	ND	0.411	0.775	0.436
Magnesium	mg/kg	1910	10.3	2830	11.7	1560	10.6	3360	11.2
Manganese	mg/kg	77.9	0.243	135	0.276	55	0.249	169	0.264
Molybdenum	mg/kg	ND	0.243	ND	0.276	ND	0.249	ND	0.264
Nickel	mg/kg	5.01	0.182	7.28	0.207	3.98	0.187	8.01	0.198
Phosphorous	mg/kg	331	6.07	577	6.9	200	6.23	582	6.61
Potassium	mg/kg	740	7.77	874	8.83	492	7.98	928	8.46
Selenium	mg/kg	2.44	0.607	2.17	0.69	0.963	0.623	2.17	0.661
Silica	mg/kg	1990	3.90	2890	4.42	1530	4	2710	4.24
Silicon	mg/kg	922	1.82	1330	2.07	710	1.87	1250	1.98
Silver	mg/kg	ND	0.121	ND	0.138	ND	0.125	ND	0.132
Sodium	mg/kg	45.9	8.50	60.6	9.65	36.7	8.72	67.6	9.25
Strontium	mg/kg	3.45	0.121	5.94	0.138	2.23	0.125	6.15	0.132
Sulfur	mg/kg	34.0	3.04	55.1	3.45	20	3.12	59.3	3.31
Thallium	mg/kg	ND	0.607	1.99	0.69	0.912	0.623	1.8	0.661
Tin	mg/kg	0.436	0.364	1.28	0.414	0.426	0.374	ND	0.397
Titanium	mg/kg	467	0.121	618	0.138	258	0.125	710	0.132
Uranium	mg/kg	ND	1.21	ND	1.38	ND	1.25	ND	1.32
Vanadium	mg/kg	10.8	0.121	14.7	0.138	7.23	0.125	17.6	0.132
Zinc	mg/kg	18.8	0.486	28.3	0.552	13.9	0.499	36.1	0.529
Lithium	mg/kg	7.34	0.530	7.15	0.526	5.45	0.517	6.42	0.551
Aroclor-1016	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1221	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1232	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1242	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1248	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1254	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
Aroclor-1260	µg/kg	ND	1.44	ND	1.55	ND	1.45	ND	1.58
pH		6.85	0.01	6.66	0.01	6.88	0.01	6.66	0.01
Moisture Content	%	24.6		29		24.7		31.5	
4cmx	µg/kg	6.17		7.7		6.72		7.38	
Decachlorobiphenyl	µg/kg	8.05		9.82		9.15		9.62	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

Table 15: Raw chemistry results for sediment samples along Transect 2.

Analyte	Unit	NPD-2-1		NPD-2-2		NPD-2-3		NPD-2-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	70.3	16.2	64.1	15.5	29.5	11.3	15.1	11.4
Aluminum	mg/kg	10200	13.8	10000	12.9	4660	9.86	4990	9.79
Antimony	mg/kg	ND	0.672	ND	0.628	ND	0.478	ND	0.475
Arsenic	mg/kg	5.52	1.02	6.2	0.952	1.53	0.725	1.95	0.72
Barium	mg/kg	80.7	0.204	82.6	0.19	39.9	0.145	42.1	0.144
Beryllium	mg/kg	0.703	0.204	0.784	0.19	0.392	0.145	0.415	0.144
Boron	mg/kg	ND	2.04	ND	1.9	ND	1.45	ND	1.44
Cadmium	mg/kg	1.11	0.204	0.911	0.19	0.373	0.145	0.41	0.144
Calcium	mg/kg	4250	16.3	3710	15.2	2510	11.6	2510	11.5
Chromium	mg/kg	27.7	0.305	26.5	0.286	12.2	0.217	12.6	0.216
Cobalt	mg/kg	9.75	0.305	10.2	0.286	4.66	0.217	4.42	0.216
Copper	mg/kg	17.2	0.611	16.9	0.571	6.9	0.435	8.04	0.432
Iron	mg/kg	17600	16.3	18600	15.2	10300	11.6	11600	11.5
Lead	mg/kg	9.94	0.672	7.67	0.628	1.34	0.478	1.22	0.475
Magnesium	mg/kg	5450	17.3	6480	16.2	3330	12.3	3510	12.2
Manganese	mg/kg	383	0.407	383	0.381	194	0.29	170	0.288
Molybdenum	mg/kg	0.525	0.407	0.496	0.381	0.314	0.29	ND	0.288
Nickel	mg/kg	20.6	0.305	19.5	0.286	8.15	0.217	8.38	0.216
Phosphorous	mg/kg	1310	13	1460	12.2	910	9.28	978	9.21
Potassium	mg/kg	1.67	1.02	3.71	0.952	1.73	0.725	3.43	0.72
Selenium	mg/kg	5050	6.53	4760	6.11	3040	4.65	3120	4.62
Silica	mg/kg	2330	3.05	2210	2.86	1410	2.17	1440	2.16
Silicon	mg/kg	ND	0.204	ND	0.19	ND	0.145	ND	0.144
Silver	mg/kg	170	14.3	157	13.3	71.2	10.1	68.1	10.1
Sodium	mg/kg	14.6	0.204	12.4	0.19	7.77	0.145	7.09	0.144
Strontium	mg/kg	528	5.09	236	4.76	53.9	3.62	75	3.6
Sulfur	mg/kg	3.01	1.02	3.61	0.952	1.39	0.725	2.31	0.72
Thallium	mg/kg	ND	0.611	ND	0.571	ND	0.435	0.741	0.432
Tin	mg/kg	1020	0.204	1170	0.19	668	0.145	734	0.144
Titanium	mg/kg	ND	2.04	ND	1.9	2.4	1.45	ND	1.44
Uranium	mg/kg	28.6	0.204	33	0.19	18.7	0.145	21.1	0.144
Vanadium	mg/kg	106	0.814	103	0.762	36.1	0.58	38.7	0.576
Zinc	mg/kg	1090	50.9	821	47.6	780	36.2	785	36
Lithium	mg/kg	15.9	0.803	20.1	0.778	8.47	0.572	9.22	0.517
Aroclor-1016	µg/kg	ND	2.28	ND	2.18	ND		ND	1.59
Aroclor-1221	µg/kg	ND	2.28	ND	2.18	ND		ND	1.59
Aroclor-1232	µg/kg	ND	2.28	ND	2.18	ND		ND	1.59
Aroclor-1242	µg/kg	ND	2.28	ND	2.18	ND		ND	1.59
Aroclor-1248	µg/kg	ND	2.28	ND	2.18	ND		ND	1.59
Aroclor-1254	µg/kg	ND	2.28	ND	2.18	11.1		ND	1.59
Aroclor-1260	µg/kg	ND	2.28	ND	2.18	4.68		ND	1.59
pH		5.99	0.01	6.29	0.01	6.5		6.29	0.01
Moisture Content	%	51.7		49.4		32.1		30.2	
4cmx	µg/kg	10.7		10		7.08		7.54	
Decachlorobiphenyl	µg/kg	13.7		13.8		9.46		9.51	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

Table 16: Raw chemistry results for sediment samples along Transect 3.

Analyte	Unit	NPD-3-1		NPD-3-2		NPD-3-3		NPD-3-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	50.5	14.2	69.3	13.7	46.4	14.3	25.5	12
Aluminum	mg/kg	9580	12	15400	13.5	8260	11.5	7400	9.78
Antimony	mg/kg	ND	0.581	ND	0.654	ND	0.56	ND	0.475
Arsenic	mg/kg	3.94	0.881	5.65	0.99	4.58	0.848	3.03	0.719
Barium	mg/kg	79.6	0.176	124	0.198	64.5	0.17	61.2	0.144
Beryllium	mg/kg	0.728	0.176	0.946	0.198	0.637	0.17	0.615	0.144
Boron	mg/kg	ND	1.76	2	1.98	ND	1.7	ND	1.44
Cadmium	mg/kg	0.905	0.176	0.999	0.198	0.72	0.17	0.612	0.144
Calcium	mg/kg	3560	14.1	4440	15.8	3080	13.6	2560	11.5
Chromium	mg/kg	26	0.264	42.8	0.297	21.5	0.254	18.7	0.216
Cobalt	mg/kg	8.75	0.264	11.5	0.297	7.87	0.254	7.07	0.216
Copper	mg/kg	24.6	0.529	25.8	0.594	13.9	0.509	10.4	0.431
Iron	mg/kg	18000	14.1	21700	15.8	16700	13.6	15900	11.5
Lead	mg/kg	6.09	0.581	7.65	0.654	5.5	0.56	2.39	0.475
Magnesium	mg/kg	6640	15	7210	16.8	5180	14.4	5250	12.2
Manganese	mg/kg	370	0.352	453	0.396	341	0.339	315	0.288
Molybdenum	mg/kg	ND	0.352	0.483	0.396	0.374	0.339	ND	0.288
Nickel	mg/kg	17.3	0.264	28.1	0.297	15.1	0.254	13.1	0.216
Phosphorous	mg/kg	1670	11.3	2010	12.7	1220	10.9	1270	9.2
Potassium	mg/kg	2.47	0.881	5.47	0.99	1.46	0.848	2.34	0.719
Selenium	mg/kg	4690	5.65	5590	6.35	3940	5.44	3560	4.61
Silica	mg/kg	2170	2.64	2580	2.97	1830	2.54	1650	2.16
Silicon	mg/kg	ND	0.176	ND	0.198	ND	0.17	ND	0.144
Silver	mg/kg	153	12.3	215	13.9	124	11.9	84.7	10.1
Sodium	mg/kg	12.4	0.176	18.7	0.198	10.3	0.17	8.22	0.144
Strontium	mg/kg	270	4.4	702	4.95	166	4.24	93.1	3.59
Sulfur	mg/kg	3.23	0.881	2.94	0.99	2.27	0.848	2.42	0.719
Thallium	mg/kg	ND	0.529	ND	0.594	ND	0.509	ND	0.431
Tin	mg/kg	1120	0.176	1260	0.198	989	0.17	1110	0.144
Titanium	mg/kg	ND	1.76	ND	1.98	ND	1.7	ND	1.44
Uranium	mg/kg	34.2	0.176	39.3	0.198	27	0.17	27.2	0.144
Vanadium	mg/kg	91.6	0.705	100	0.792	82.3	0.678	68.6	0.575
Zinc	mg/kg	812	44	920	49.5	837	42.4	703	35.9
Lithium	mg/kg	13.5	0.662	20.5	0.775	12.5	0.72	11.5	0.588
Aroclor-1016	µg/kg	ND	2.03	ND	2.17	ND	2.02	ND	1.71
Aroclor-1221	µg/kg	ND	2.03	ND	2.17	ND	2.02	ND	1.71
Aroclor-1232	µg/kg	ND	2.03	ND	2.17	ND	2.02	ND	1.71
Aroclor-1242	µg/kg	ND	2.03	ND	2.17	ND	2.02	ND	1.71
Aroclor-1248	µg/kg	ND	2.03	ND	2.17	ND	2.02	ND	1.71
Aroclor-1254	µg/kg	ND	2.03	6.35	2.17	3.79	2.02	15.2	1.71
Aroclor-1260	µg/kg	ND	2.03	ND	2.17	ND	2.02	5.88	1.71
pH		6.36	0.01	6.2	0.01	6.32	0.01	6.34	0.01
Moisture Content	%	45.6		50.1		46.1		36.3	
4cmx	µg/kg	8.51		8.54		8.25		7.43	
Decachlorobiphenyl	µg/kg	11.2		11.3		10.6		9.87	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

Table 17: Raw chemistry results for sediment samples along Transect 4.

Analyte	Unit	NPD-4-1		NPD-4-2		NPD-4-3		NPD-4-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	ND	9.48	126	18.8	32.4	12.6	17.4	11.4
Aluminum	mg/kg	1250	9.05	19100	15.7	7020	11	6290	9.65
Antimony	mg/kg	ND	0.439	ND	0.763	0.867	0.533	ND	0.468
Arsenic	mg/kg	ND	0.666	16.9	1.16	5.12	0.808	3.35	0.71
Barium	mg/kg	10.5	0.133	153	0.231	59.7	0.162	52.2	0.142
Beryllium	mg/kg	ND	0.133	1.11	0.231	1.21	0.162	1.33	0.142
Boron	mg/kg	ND	1.33	2.94	2.31	ND	1.62	ND	1.42
Cadmium	mg/kg	0.223	0.133	1.76	0.231	ND	0.162	ND	0.142
Calcium	mg/kg	1770	10.7	5560	18.5	3120	12.9	2940	11.4
Chromium	mg/kg	3.17	0.2	56.7	0.347	18.4	0.242	17.2	0.213
Cobalt	mg/kg	1.49	0.2	16.6	0.347	7.98	0.242	7.61	0.213
Copper	mg/kg	1.92	0.399	40.9	0.693	11.5	0.485	9.47	0.426
Iron	mg/kg	2340	10.7	27400	18.5	14300	12.9	14100	11.4
Lead	mg/kg	1.01	0.439	29.1	0.763	8.25	0.533	5.06	0.468
Magnesium	mg/kg	584	11.3	8280	19.6	3830	13.7	4270	12.1
Manganese	mg/kg	57	0.266	723	0.462	299	0.323	229	0.284
Molybdenum	mg/kg	ND	0.266	1.15	0.462	ND	0.323	ND	0.284
Nickel	mg/kg	2.73	0.2	41.3	0.347	14.5	0.242	11.6	0.213
Phosphorous	mg/kg	660	6.66	2300	14.8	964	10.3	1100	9.08
Potassium	mg/kg	173	8.52	6.7	1.16	ND	0.808	ND	0.71
Selenium	mg/kg	1.58	0.666	7590	7.41	6450	5.18	6210	4.55
Silica	mg/kg	1500	4.27	3510	3.47	2970	2.42	2860	2.13
Silicon	mg/kg	695	2	ND	0.231	ND	0.162	ND	0.142
Silver	mg/kg	ND	0.133	316	16.2	165	11.3	124	9.93
Sodium	mg/kg	51.3	9.32	25.5	0.231	9.03	0.162	7.64	0.142
Strontium	mg/kg	3.82	0.133	1360	5.78	211	4.04	91.7	3.55
Sulfur	mg/kg	70.3	3.33	3.54	1.16	ND	0.808	0.862	0.71
Thallium	mg/kg	1.16	0.666	ND	0.693	792	0.162	932	0.142
Tin	mg/kg	ND	0.399	1270	0.231	22.9	0.162	25	0.142
Titanium	mg/kg	166	0.133	ND	2.31	73.6	0.646	59	0.568
Uranium	mg/kg	ND	1.33	45	0.231	862	40.4	757	35.5
Vanadium	mg/kg	4.3	0.133	169	0.924	ND	0.485	ND	0.426
Zinc	mg/kg	11.9	0.533	1150	57.8	ND	1.62	ND	1.42
Lithium	mg/kg	2.17	0.516	27.7	0.896	8.06	0.62	9.17	0.564
Aroclor-1016	µg/kg	ND	1.55	ND	2.6	ND	1.89	ND	1.67
Aroclor-1221	µg/kg	ND	1.55	ND	2.6	ND	1.89	ND	1.67
Aroclor-1232	µg/kg	ND	1.55	ND	2.6	ND	1.89	ND	1.67
Aroclor-1242	µg/kg	ND	1.55	ND	2.6	ND	1.89	ND	1.67
Aroclor-1248	µg/kg	ND	1.55	ND	2.6	ND	1.89	ND	1.67
Aroclor-1254	µg/kg	ND	1.55	ND	2.6	25.8	1.89	31.7	1.67
Aroclor-1260	µg/kg	ND	1.55	ND	2.6	8.37	1.89	11.2	1.67
pH		6.74	0.01	6.67	0.01	6.49	0.01	6.3	0.01
Moisture Content	%	28.6		57.7		41.3		33.8	
4cmx	µg/kg	7.26		10.7		8.84		8.31	
Decachlorobiphenyl	µg/kg	9.65		15.3		10.9		10.3	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

Table 18: Raw chemistry results for sediment samples along Transect 5.

Analyte	Unit	NPD-5-1		NPD-5-2		NPD-5-3		NPD-5-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	34.5	11.5	22.7	13.2	27	13.1	ND	11.8
Aluminum	mg/kg	5900	10.8	6970	11.9	10000	11.2	9020	9.78
Antimony	mg/kg	ND	0.523	ND	0.578	ND	0.542	ND	0.475
Arsenic	mg/kg	4.83	0.793	7.18	0.875	3.76	0.821	4.45	0.719
Barium	mg/kg	45.7	0.159	57.9	0.175	76.4	0.164	69.5	0.144
Beryllium	mg/kg	0.897	0.159	1.12	0.175	1.99	0.164	1.89	0.144
Boron	mg/kg	ND	1.59	ND	1.75	ND	1.64	ND	1.44
Cadmium	mg/kg	ND	0.159	ND	0.175	ND	0.164	ND	0.144
Calcium	mg/kg	2650	12.7	3050	14	3880	13.1	2390	11.5
Chromium	mg/kg	16.2	0.238	18.7	0.263	26.1	0.246	22.2	0.216
Cobalt	mg/kg	6.54	0.238	7.99	0.263	11.4	0.246	11	0.216
Copper	mg/kg	9.75	0.476	11.3	0.525	16.3	0.492	12.3	0.432
Iron	mg/kg	11800	12.7	14600	14	21200	13.1	20800	11.5
Lead	mg/kg	8.22	0.523	9.6	0.578	7.94	0.542	6.64	0.475
Magnesium	mg/kg	2860	13.5	3720	14.9	6870	14	6320	12.2
Manganese	mg/kg	393	0.317	385	0.35	404	0.328	347	0.288
Molybdenum	mg/kg	ND	0.317	ND	0.35	ND	0.328	ND	0.288
Nickel	mg/kg	12.6	0.238	14.9	0.263	17.7	0.246	16.4	0.216
Phosphorous	mg/kg	734	7.93	846	8.75	1690	10.5	525	7.19
Potassium	mg/kg	805	10.1	949	11.2	ND	0.821	1530	9.21
Selenium	mg/kg	ND	0.793	ND	0.875	7470	5.27	6570	4.62
Silica	mg/kg	6700	5.09	7350	5.62	3530	2.46	3100	2.16
Silicon	mg/kg	3080	2.38	3380	2.63	ND	0.164	ND	0.144
Silver	mg/kg	ND	0.159	ND	0.175	185	11.5	117	10.1
Sodium	mg/kg	202	11.1	222	12.3	10.9	0.164	6.44	0.144
Strontium	mg/kg	9.59	0.159	10.3	0.175	199	4.1	117	3.6
Sulfur	mg/kg	162	3.96	179	4.38	ND	0.821	ND	0.719
Thallium	mg/kg	ND	0.793	ND	0.875	1460	0.164	1420	0.144
Tin	mg/kg	614	0.159	750	0.175	39.1	0.164	34.6	0.144
Titanium	mg/kg	17.7	0.159	22.8	0.175	80.1	0.657	92.6	0.576
Uranium	mg/kg	62.6	0.634	70.2	0.7	1000	41	ND	3.6
Vanadium	mg/kg	ND	0.476	ND	2.63	ND	2.46	ND	2.16
Zinc	mg/kg	1.99	1.59	ND	1.75	ND	1.64	4	1.44
Lithium	mg/kg	8.4	0.592	11.2	0.699	12.9	0.688	7.02	0.562
Aroclor-1016	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
Aroclor-1221	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
Aroclor-1232	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
Aroclor-1242	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
Aroclor-1248	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
Aroclor-1254	µg/kg	ND	1.78	3.17	1.98	ND	2.01	9.58	1.73
Aroclor-1260	µg/kg	ND	1.78	ND	1.98	ND	2.01	ND	1.73
pH		6.51	0.01	6.49		6.38	0.01	6.35	0.01
Moisture Content	%	38.5		45.4		45		36	
4cmx	µg/kg	6.74		6.04		10.2		6.59	
Decachlorobiphenyl	µg/kg	8.2		7.95		12.2		8.05	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

Table 19: Raw chemistry results for sediment samples along Transect 6.

Analyte	Unit	NPD-6-1		NPD-6-2		NPD-6-3		NPD-6-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	47.3	13	46.1	15.1	27.9	12.4	33.5	12.3
Aluminum	mg/kg	5730	12.3	7450	12.5	9610	11.4	12500	11.6
Antimony	mg/kg	ND	0.599	1.4	0.606	0.889	0.551	ND	0.561
Arsenic	mg/kg	4.33	0.907	3.55	0.918	3.14	0.835	2.54	0.849
Barium	mg/kg	51.9	0.181	65.1	0.184	72.9	0.167	94.8	0.17
Beryllium	mg/kg	0.994	0.181	1.13	0.184	1.23	0.167	1.48	0.17
Boron	mg/kg	ND	1.81	ND	1.84	ND	1.67	ND	1.7
Cadmium	mg/kg	0.231	0.181	0.486	0.184	ND	0.167	ND	0.17
Calcium	mg/kg	3310	14.5	3330	14.7	2980	13.4	3680	13.6
Chromium	mg/kg	14.9	0.272	19.3	0.275	27.3	0.251	36.9	0.255
Cobalt	mg/kg	6.95	0.272	8.08	0.275	8.56	0.251	9.66	0.255
Copper	mg/kg	11.9	0.544	14.8	0.551	11.8	0.501	14.4	0.51
Iron	mg/kg	11400	14.5	13200	14.7	15400	13.4	16400	13.6
Lead	mg/kg	8.57	0.599	12.6	0.606	6.29	0.551	6.9	0.561
Magnesium	mg/kg	3120	15.4	3950	15.6	4220	14.2	5090	14.4
Manganese	mg/kg	269	0.363	262	0.367	332	0.334	254	0.34
Molybdenum	mg/kg	ND	0.363	ND	0.367	ND	0.334	ND	0.34
Nickel	mg/kg	11.9	0.272	15.8	0.275	17.9	0.251	22.6	0.255
Phosphorous	mg/kg	771	9.07	781	9.18	681	8.35	698	8.49
Potassium	mg/kg	810	11.6	949	11.7	1270	10.7	1610	10.9
Selenium	mg/kg	ND	0.907	ND	0.918	ND	0.835	ND	0.849
Silica	mg/kg	6980	5.82	7590	5.89	7390	5.36	7460	5.45
Silicon	mg/kg	3220	2.72	3500	2.75	3400	2.51	3430	2.55
Silver	mg/kg	ND	0.181	ND	0.184	ND	0.167	ND	0.17
Sodium	mg/kg	162	12.7	188	12.8	221	11.7	289	11.9
Strontium	mg/kg	10	0.181	10.4	0.184	11	0.167	14.6	0.17
Sulfur	mg/kg	409	4.53	397	4.59	129	4.18	244	4.25
Thallium	mg/kg	ND	0.907	ND	0.918	ND	0.835	ND	0.849
Tin	mg/kg	673	0.181	729	0.184	795	0.167	959	0.17
Titanium	mg/kg	17.9	0.181	23.5	0.184	25.2	0.167	31.4	0.17
Uranium	mg/kg	69.1	0.726	82.2	0.734	51.7	0.668	59.8	0.68
Vanadium	mg/kg	ND	0.544	ND	0.551	ND	0.501	11.3	0.51
Zinc	mg/kg	3.55	1.81	ND	1.84	3.82	1.67	2.16	1.7
Lithium	mg/kg	3.84	0.677	7.4	0.734	10.9	0.696	16.8	0.7
Aroclor-1016	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
Aroclor-1221	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
Aroclor-1232	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
Aroclor-1242	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
Aroclor-1248	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
Aroclor-1254	µg/kg	ND	2.08	4.52	2.14	ND	1.9	ND	1.94
Aroclor-1260	µg/kg	ND	2.08	ND	2.14	ND	1.9	ND	1.94
pH		6.33	0.01	6.65		6.49	0.01	6.51	0.01
Moisture Content	%	47		48.3		42.8		43.2	
4cmx	µg/kg	10.4		7.28		7.11		9.03	
Decachlorobiphenyl	µg/kg	12.6		8.6		8.47		9.15	

Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

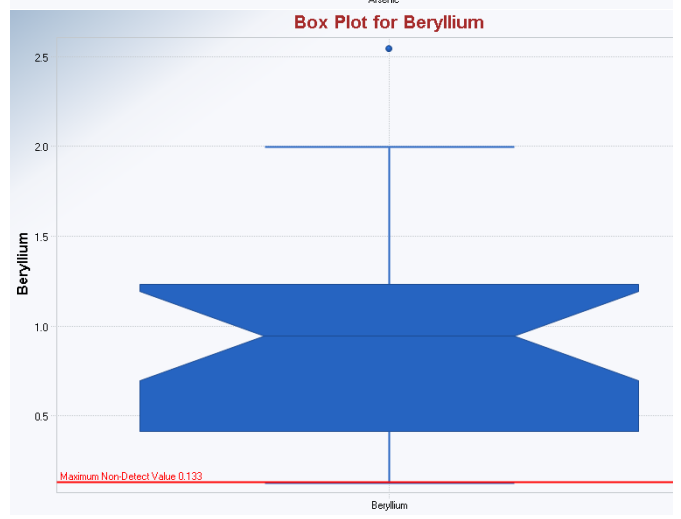
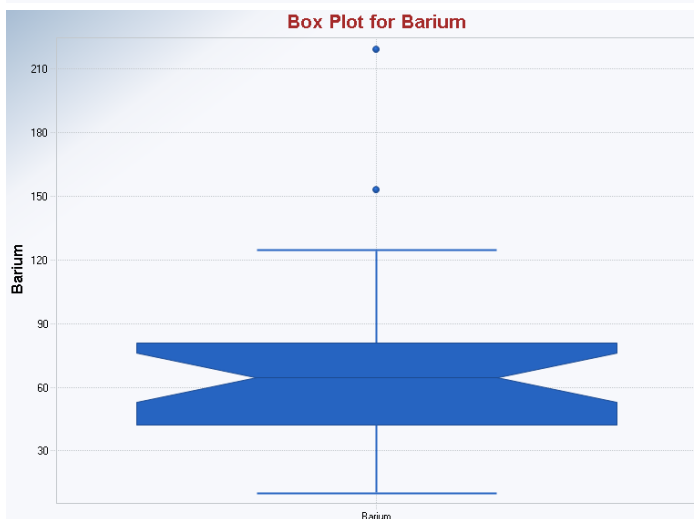
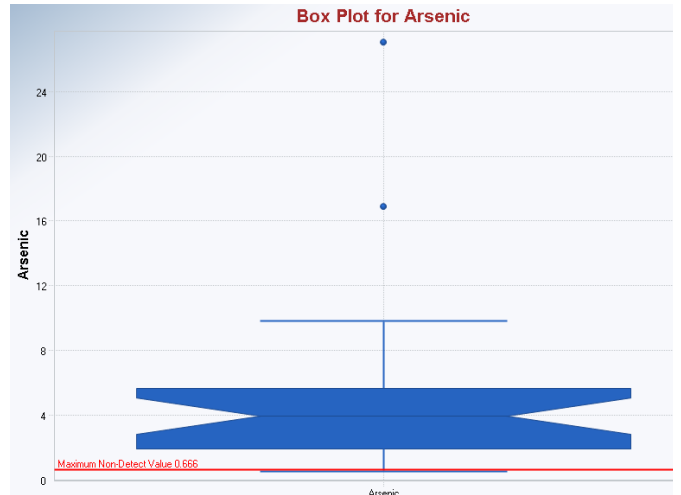
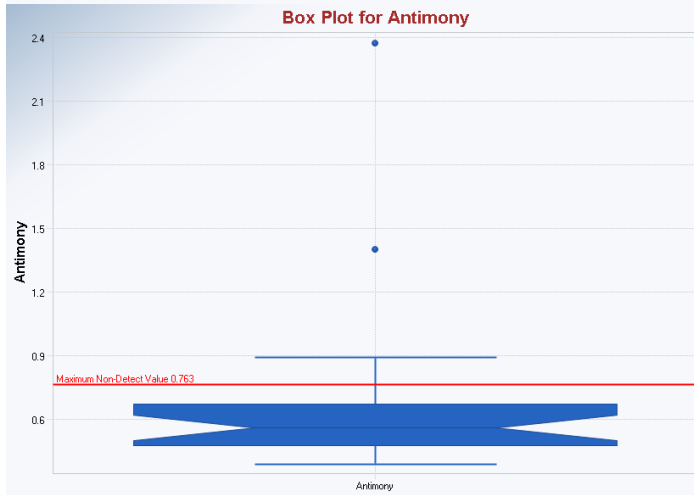
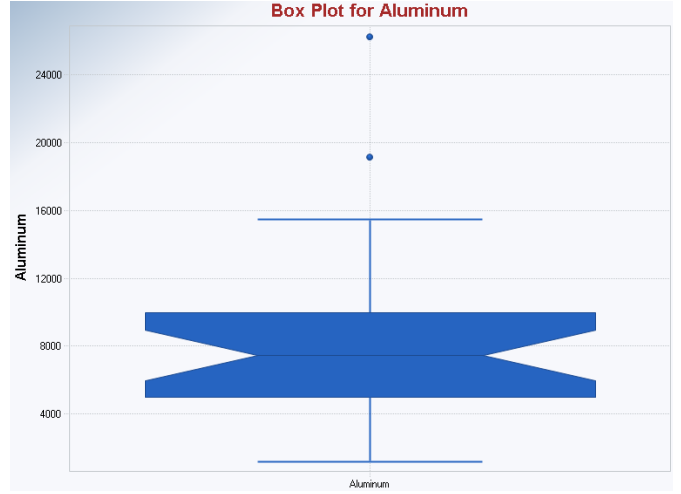
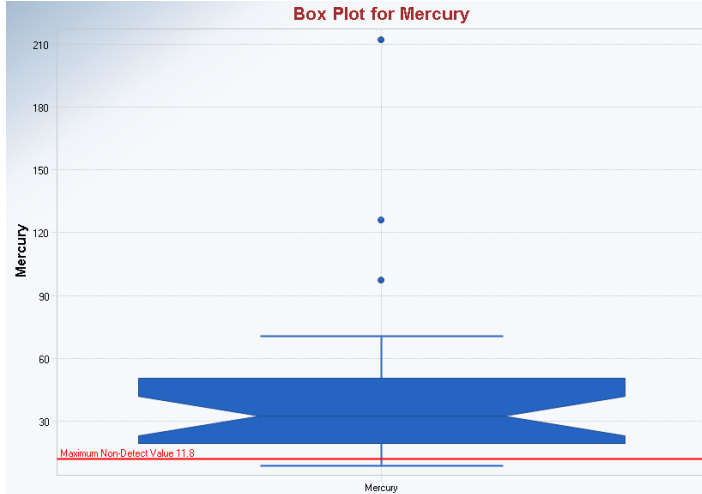
Table 20: Raw chemistry results for sediment samples along Transect 7.

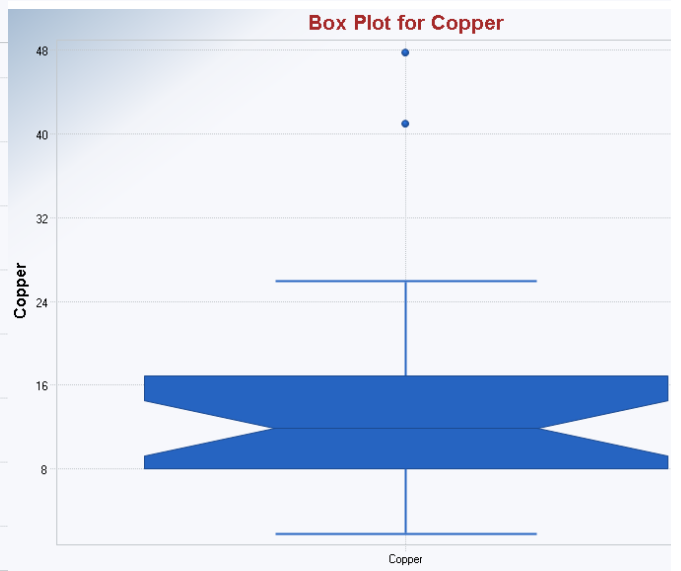
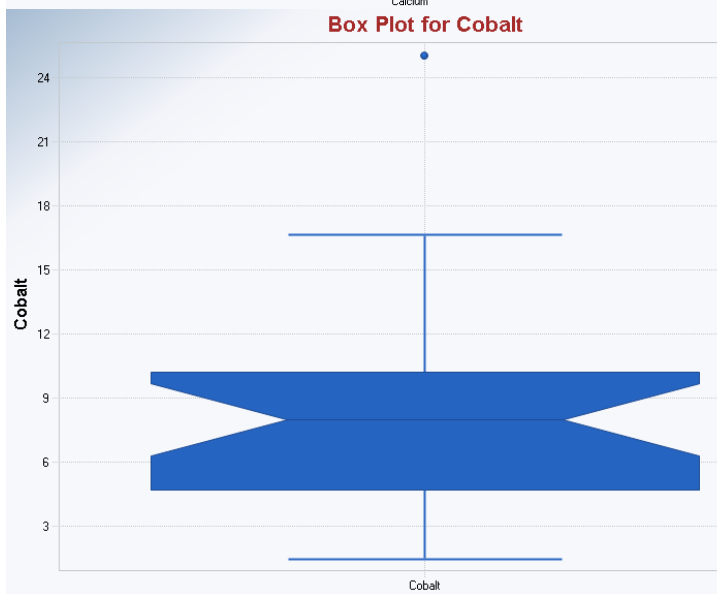
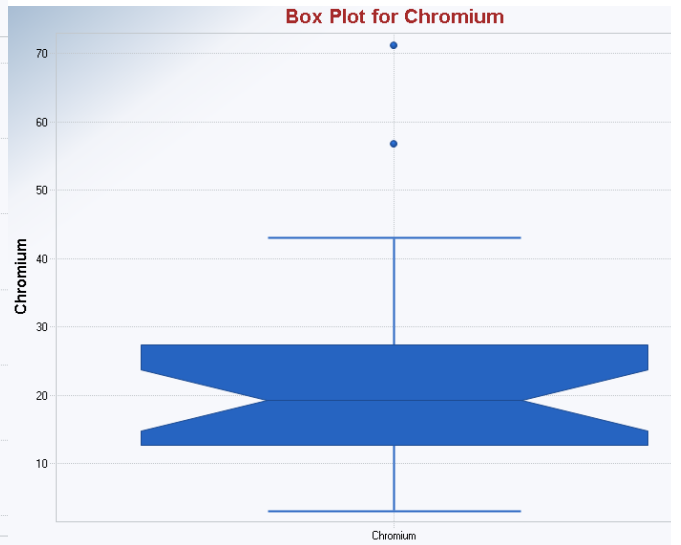
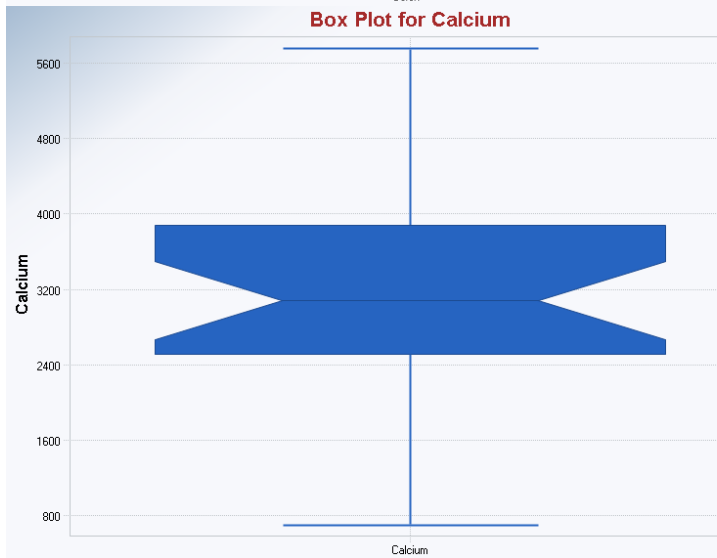
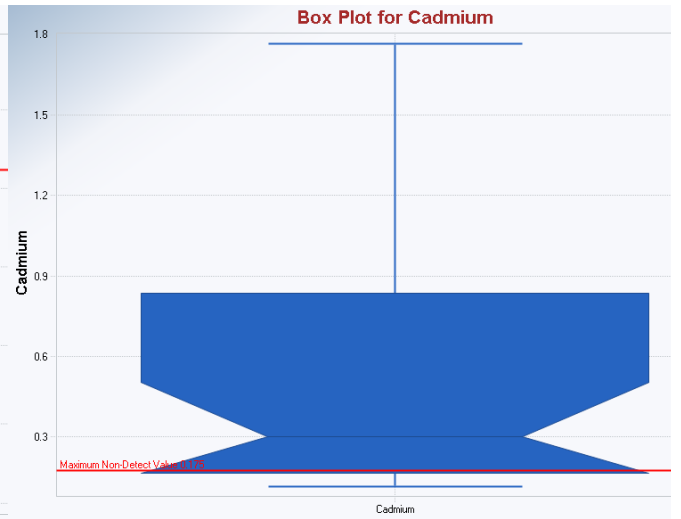
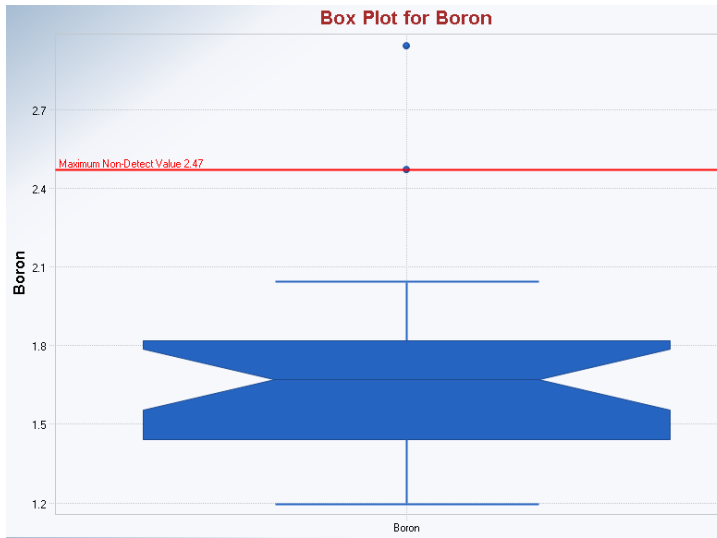
Analyte	Unit	NPD-7-1		NPD-7-2		NPD-7-3		NPD-7-4	
		Result	DL	Result	DL	Result	DL	Result	DL
Mercury	µg/kg	ND	9.1	48	14.4	97.3	14.4	212	18.9
Aluminum	mg/kg	2230	8.13	7450	12.4	11400	11.6	26200	16.8
Antimony	mg/kg	ND	0.394	0.689	0.6	ND	0.565	2.37	0.815
Arsenic	mg/kg	1.11	0.598	5.8	0.909	9.76	0.856	27	1.24
Barium	mg/kg	16.7	0.12	66.4	0.182	88.2	0.171	219	0.247
Beryllium	mg/kg	0.395	0.12	1.16	0.182	1.71	0.171	2.54	0.247
Boron	mg/kg	ND	1.2	ND	1.82	ND	1.71	ND	2.47
Cadmium	mg/kg	ND	0.12	0.474	0.182	0.897	0.171	0.836	0.247
Calcium	mg/kg	1600	9.56	4130	14.6	4100	13.7	5740	19.8
Chromium	mg/kg	6.65	0.179	22.4	0.273	34.2	0.257	71.1	0.371
Cobalt	mg/kg	2.52	0.179	7.32	0.273	12.3	0.257	25	0.371
Copper	mg/kg	2.47	0.359	15.2	0.546	23.1	0.514	47.7	0.741
Iron	mg/kg	4570	9.56	14800	14.6	21200	13.7	39600	19.8
Lead	mg/kg	1.91	0.394	8.94	0.6	18.1	0.565	49.9	0.815
Magnesium	mg/kg	1140	10.2	3550	15.5	5190	14.6	9730	21
Manganese	mg/kg	68	0.239	248	0.364	345	0.342	1420	0.494
Molybdenum	mg/kg	ND	0.239	ND	0.364	ND	0.342	0.809	0.494
Nickel	mg/kg	4.6	0.179	14.7	0.273	24.5	0.257	59.1	0.371
Phosphorous	mg/kg	457	5.98	774	9.09	1610	11	916	12.4
Potassium	mg/kg	332	7.65	1070	11.6	ND	0.856	3150	15.8
Selenium	mg/kg	ND	0.598	ND	0.909	8680	5.49	ND	1.24
Silica	mg/kg	3450	3.84	7500	5.84	4000	2.57	13900	7.93
Silicon	mg/kg	1590	1.79	3460	2.73	ND	0.171	6390	3.71
Silver	mg/kg	ND	0.12	ND	0.182	236	12	ND	0.247
Sodium	mg/kg	96.7	8.37	189	12.7	14.7	0.171	542	17.3
Strontium	mg/kg	6.13	0.12	14.8	0.182	792	4.28	28.9	0.247
Sulfur	mg/kg	69.2	2.99	693	4.55	0.935	0.856	1050	6.18
Thallium	mg/kg	ND	0.598	ND	0.909	1100	0.171	ND	1.24
Tin	mg/kg	272	0.12	777	0.182	34.4	0.171	1480	0.247
Titanium	mg/kg	7.9	0.12	25.5	0.182	130	0.685	65	0.247
Uranium	mg/kg	19.8	0.478	80.2	0.728	889	42.8	242	0.988
Vanadium	mg/kg	ND	0.359	ND	0.546	ND	2.57	ND	3.71
Zinc	mg/kg	ND	1.2	ND	1.82	ND	1.71	4.25	2.47
Lithium	mg/kg	3.78	0.473	12.1	0.781	16.5	0.708	31.5	0.966
Aroclor-1016	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1221	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1232	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1242	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1248	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1254	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
Aroclor-1260	µg/kg	ND	1.37	ND	2.25	ND	1.96	ND	2.8
pH		7.3	0.01	6.57	0.01	6.06	0.01	6.47	0.01
Moisture Content	%	21.1		50.7		44.9		60.5	
4cmx	µg/kg	5.78		9.55		10.5		9.19	
Decachlorobiphenyl	µg/kg	7.12		11.5		11.1		15.1	

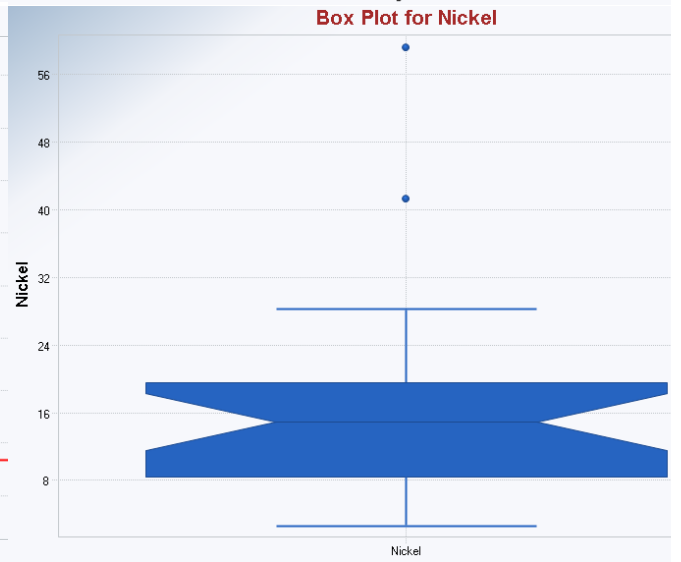
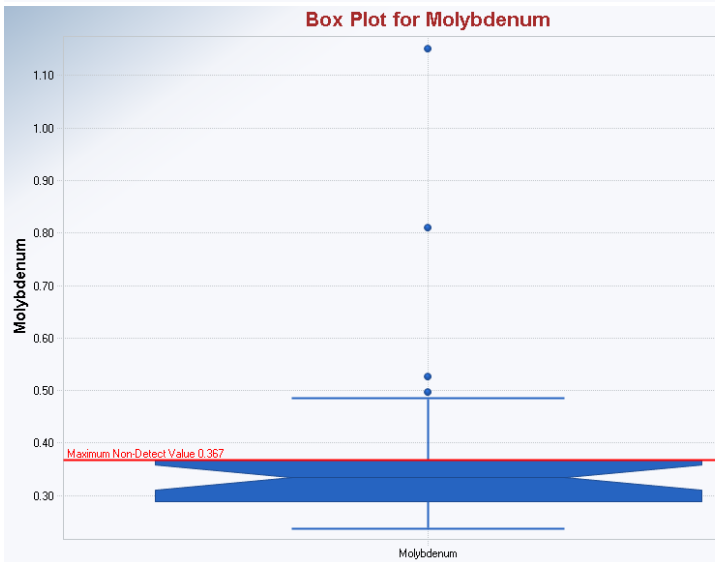
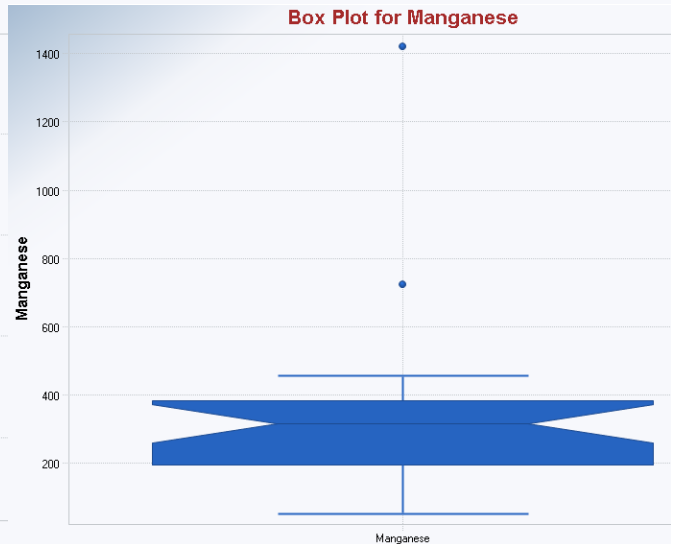
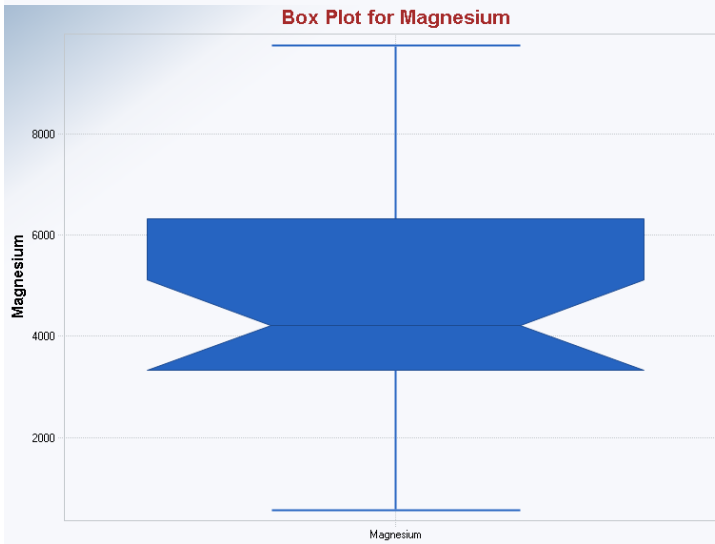
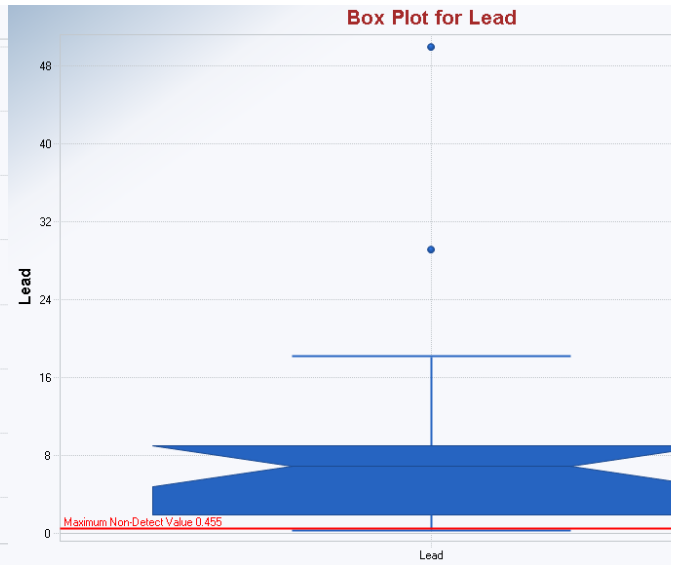
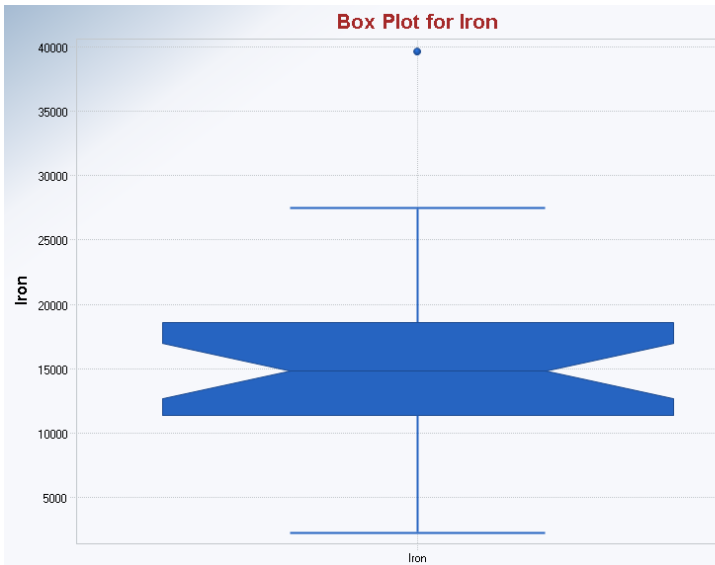
Note: DL = Detection Limit; ND = Non-detect (i.e., < DL); all values represent concentrations per dry mass.

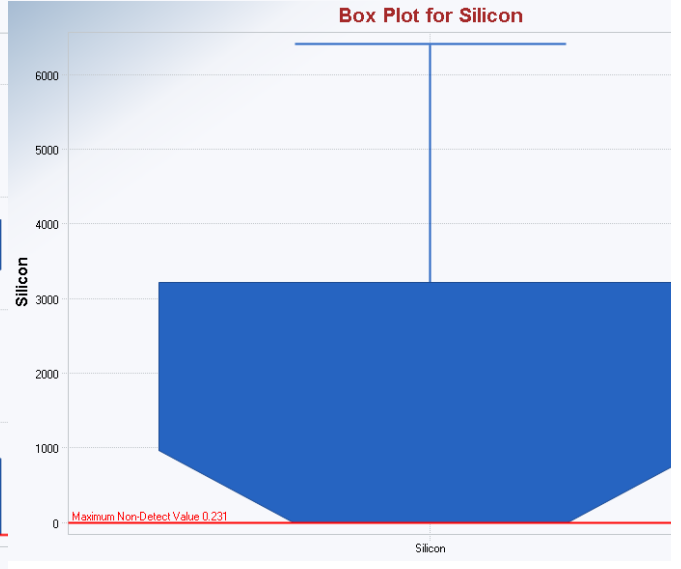
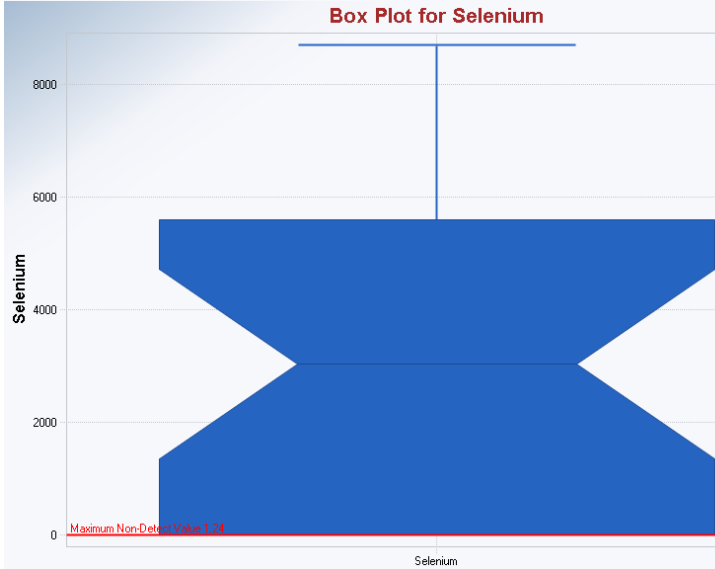
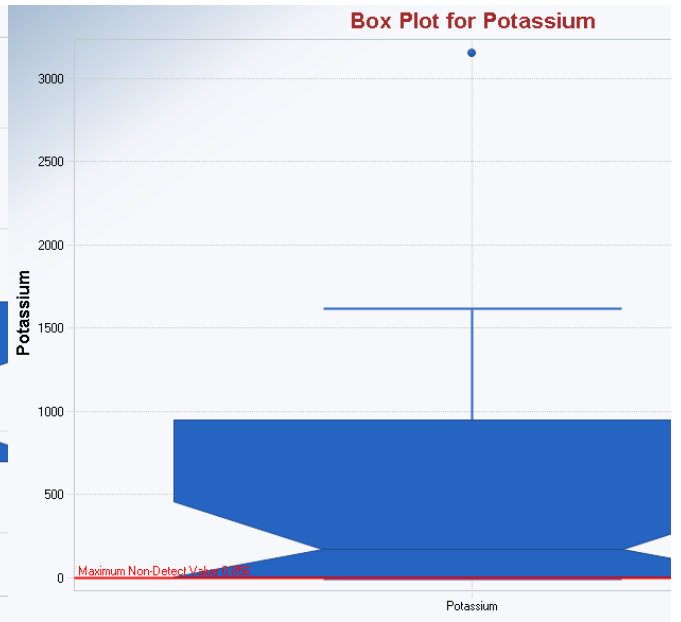
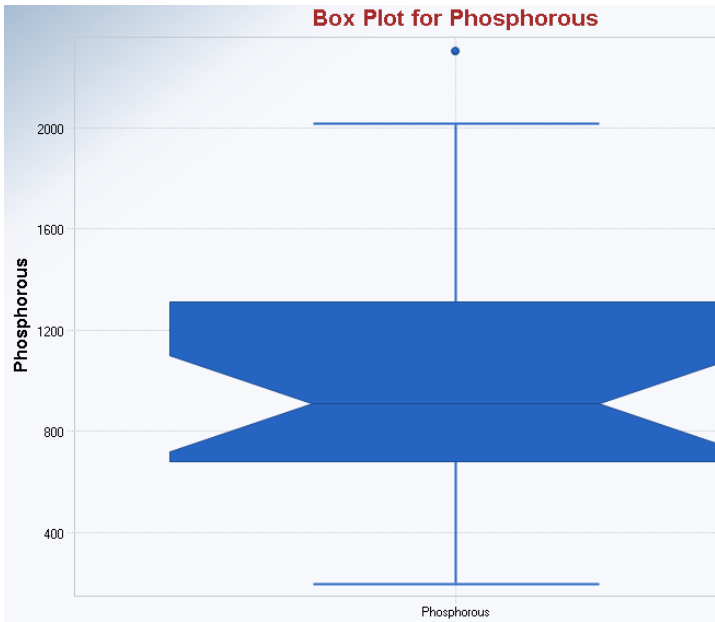
Appendix B Box Plots for Ottawa River Non-Radiological Sediment Data near NPD

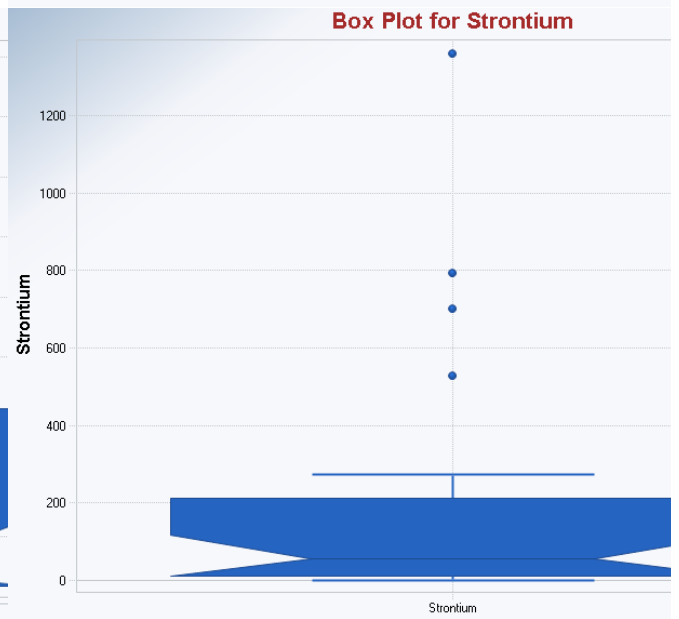
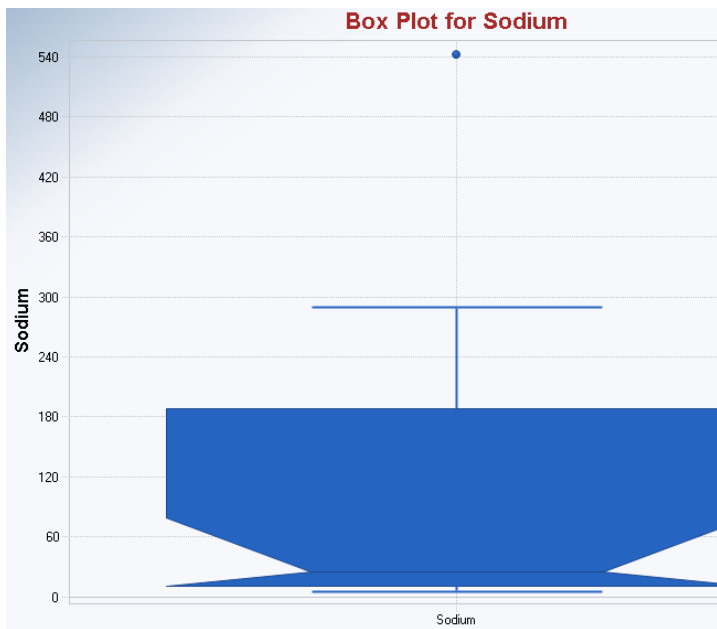
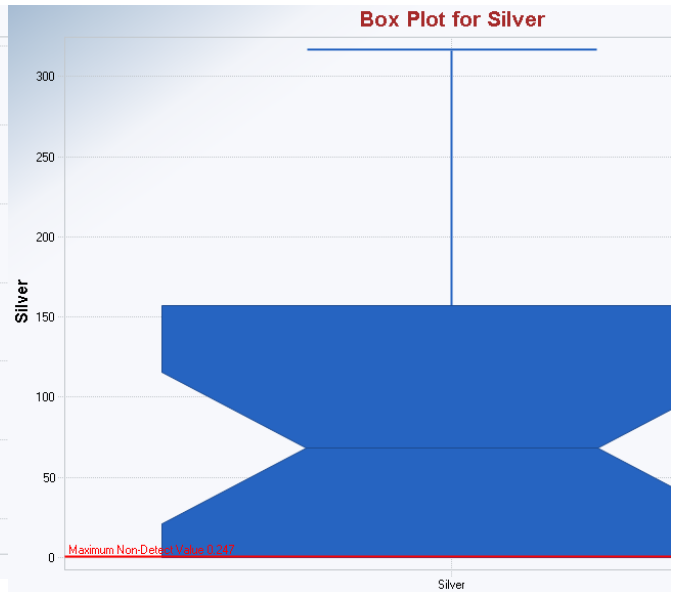
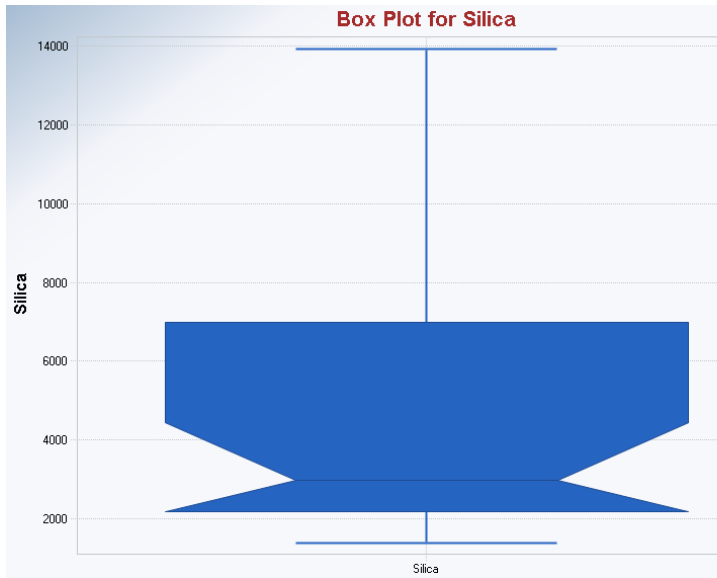
Note: Units are in shown in the data tables above; red lines represent maximum detection limit.

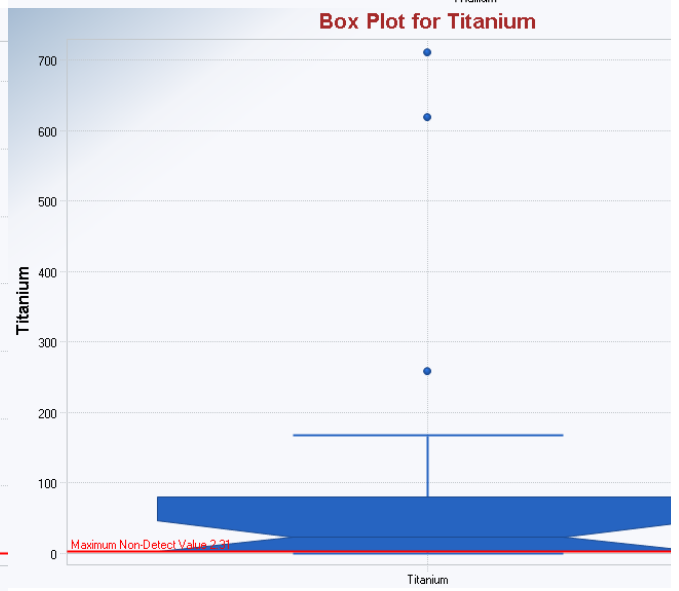
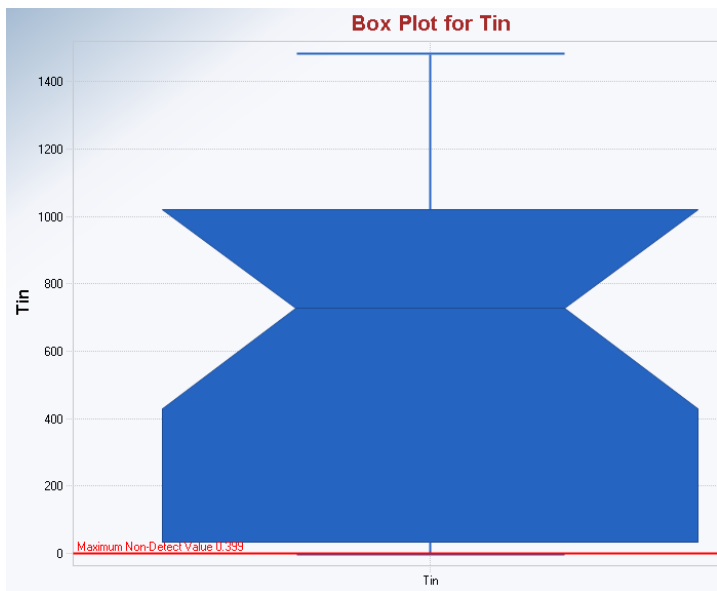
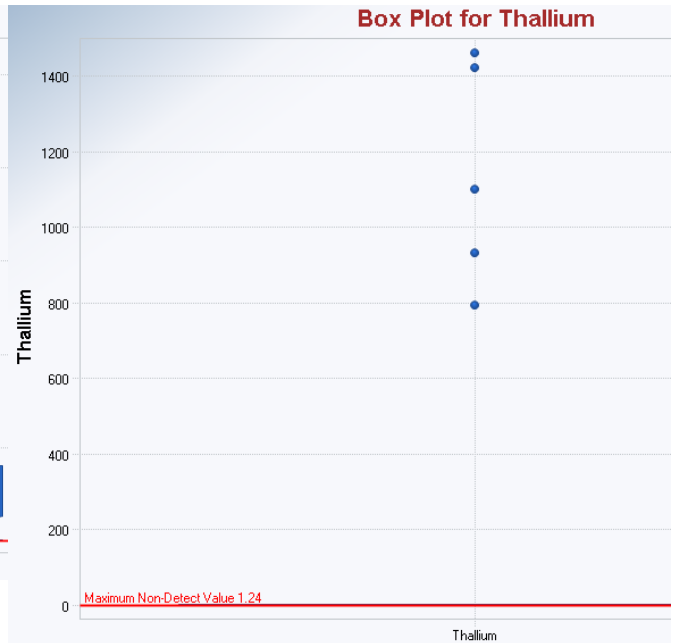
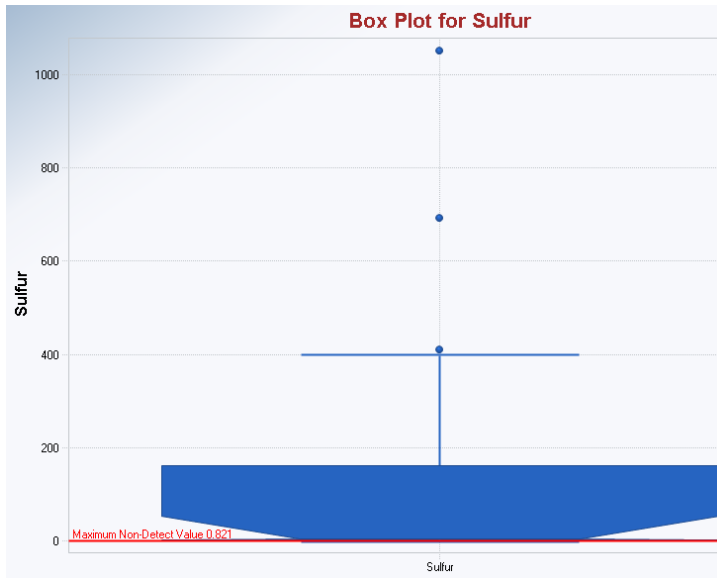


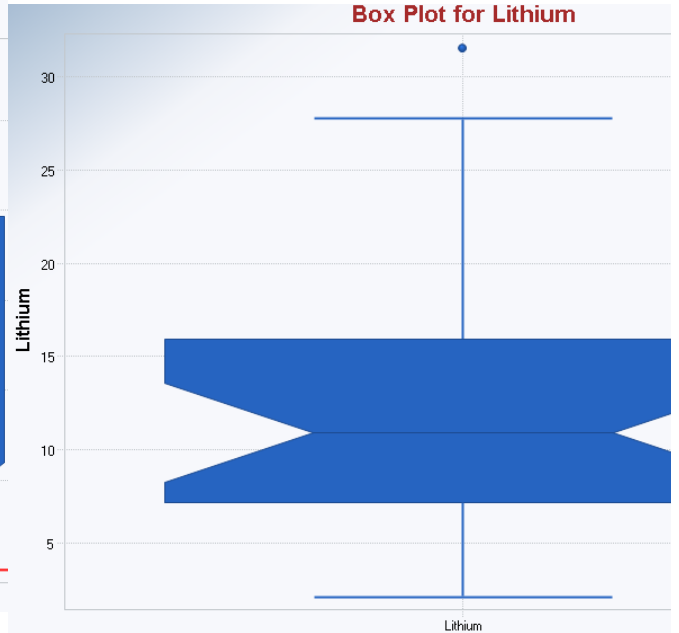
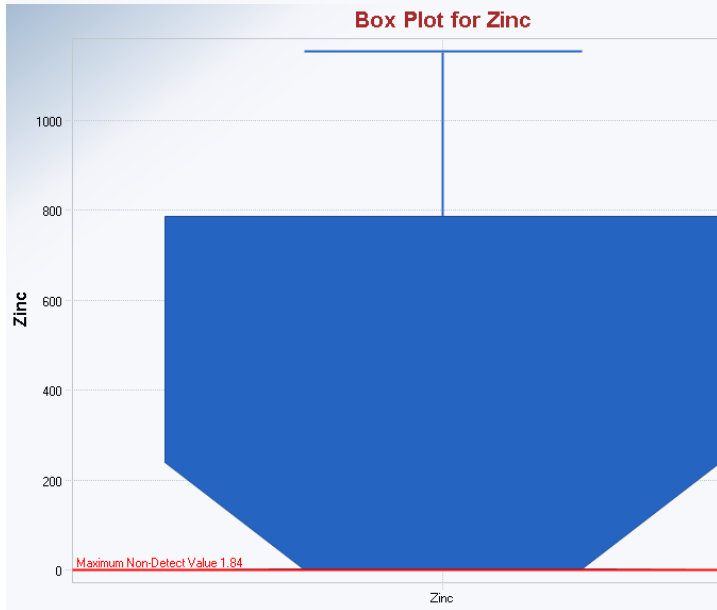
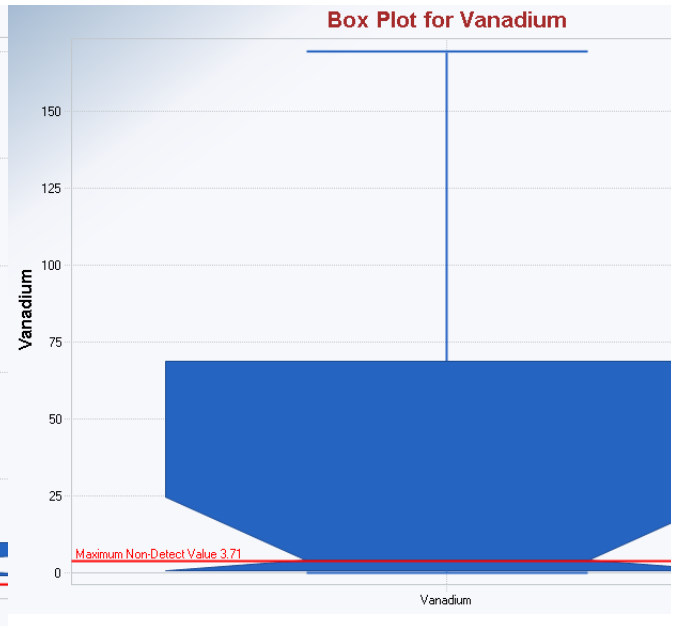
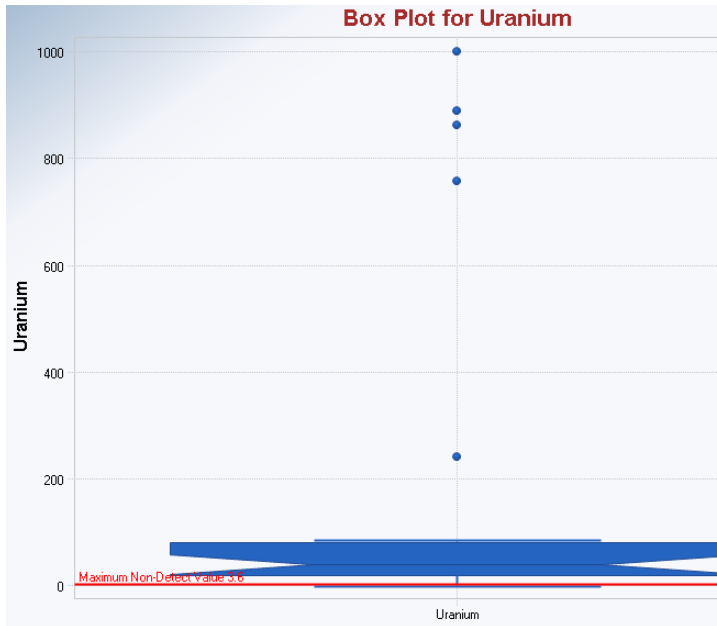


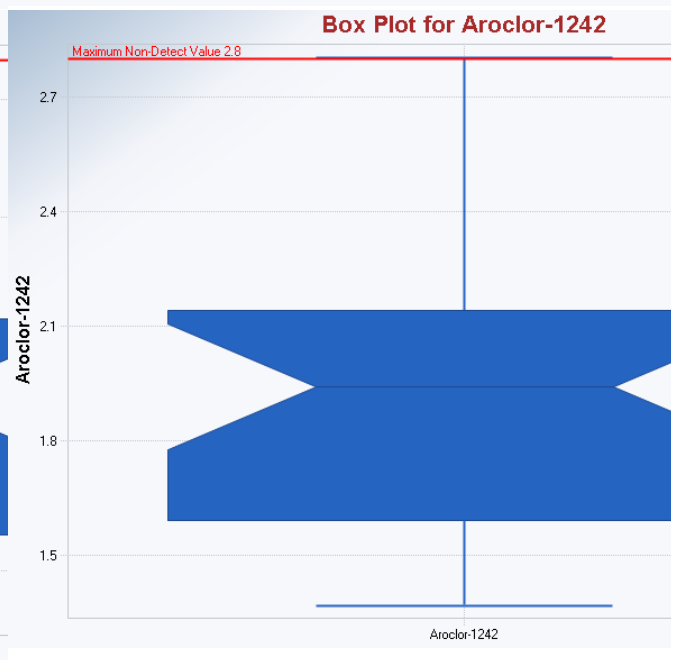
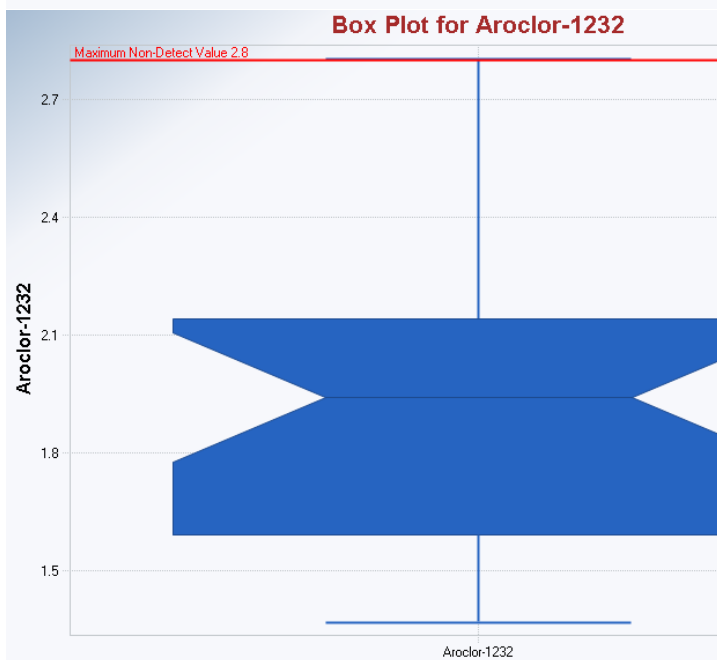
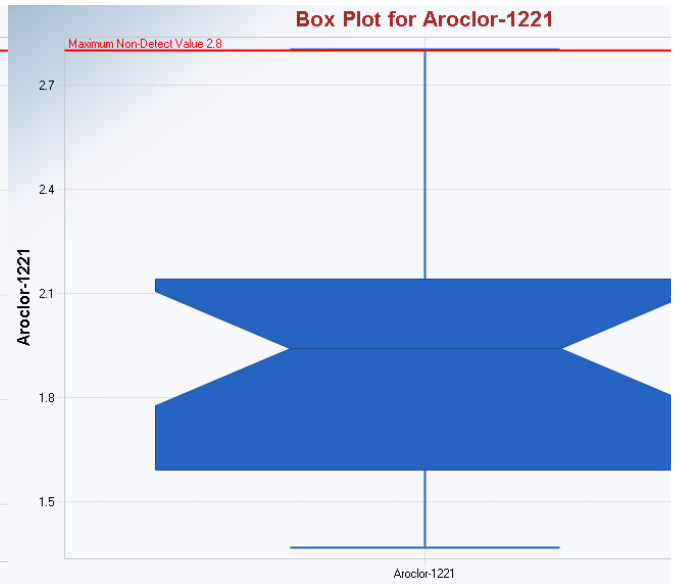
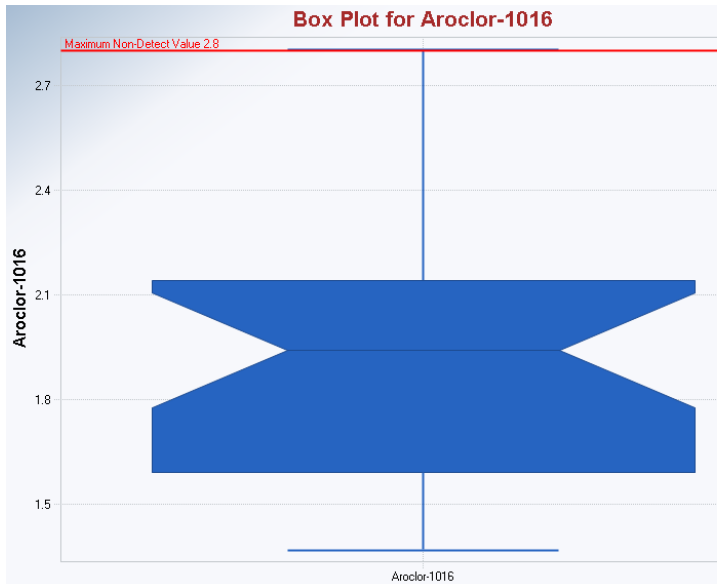


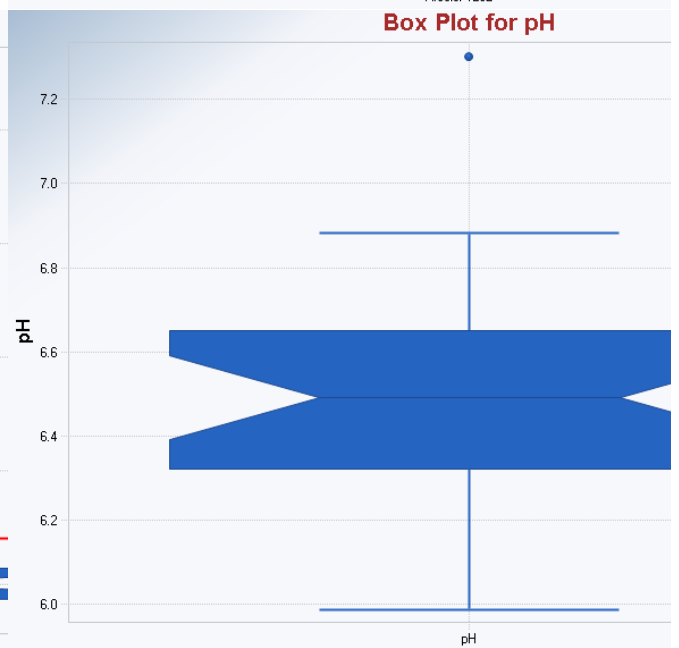
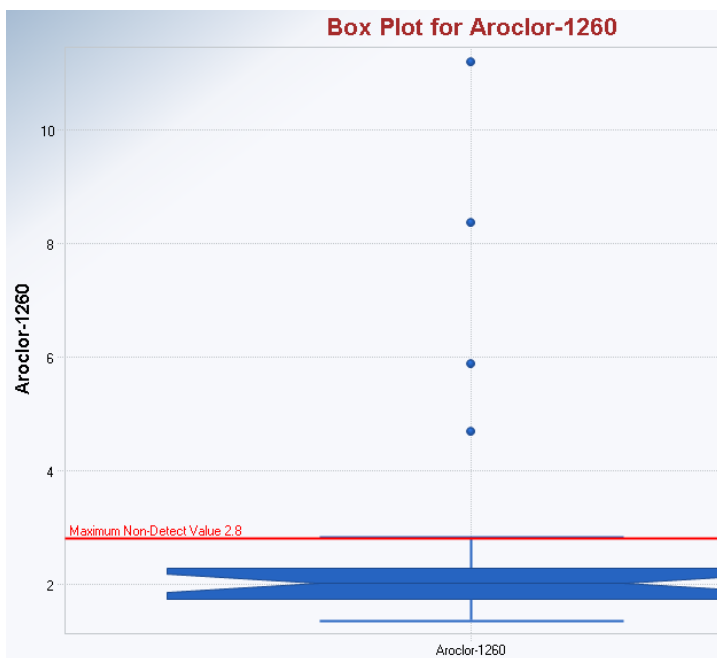
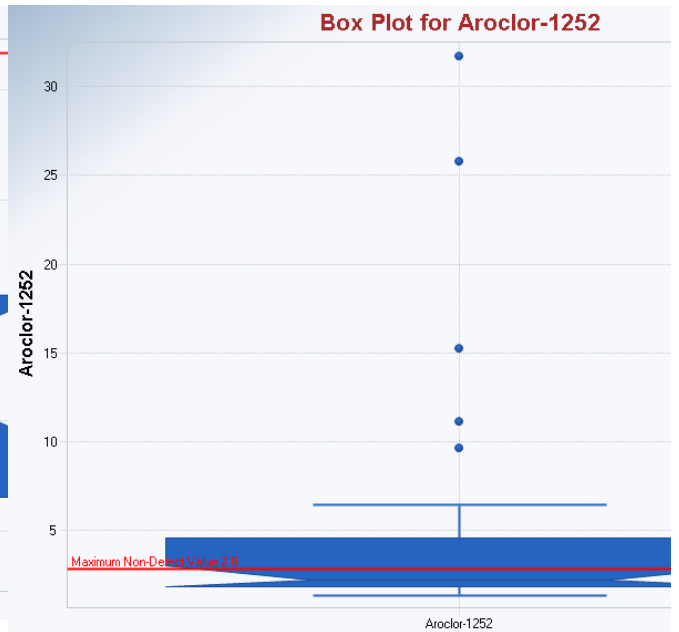
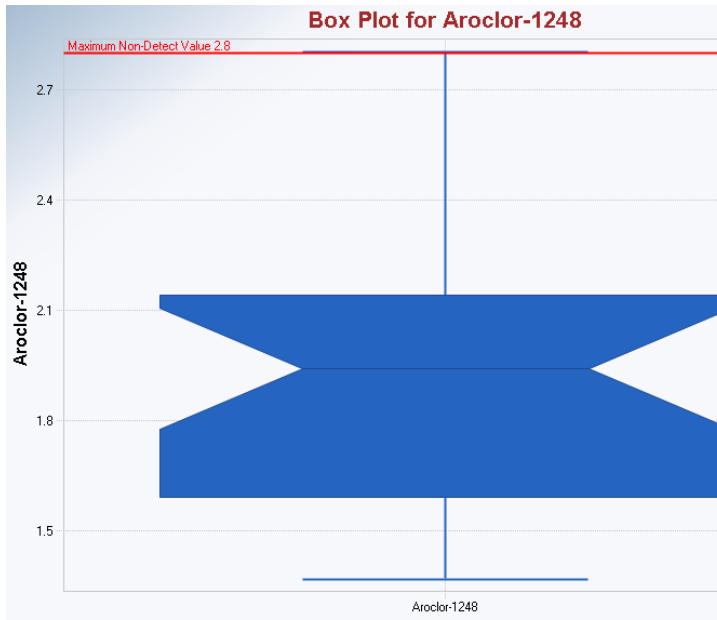


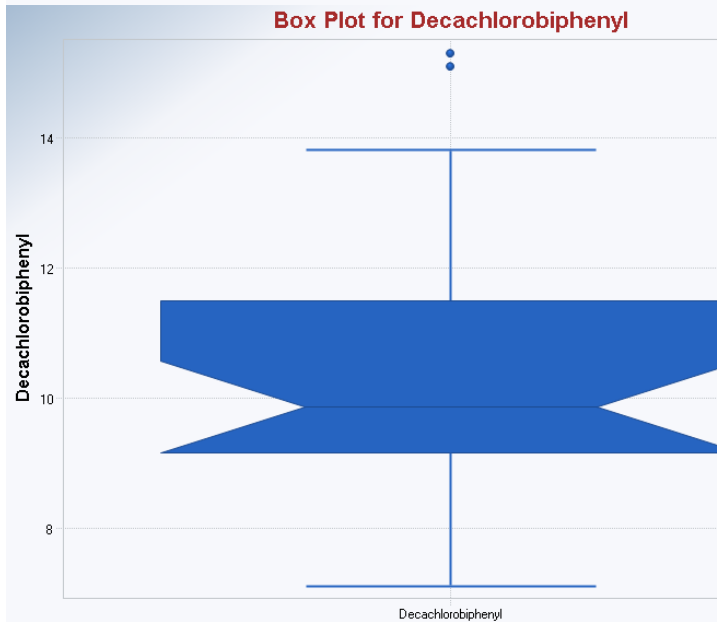
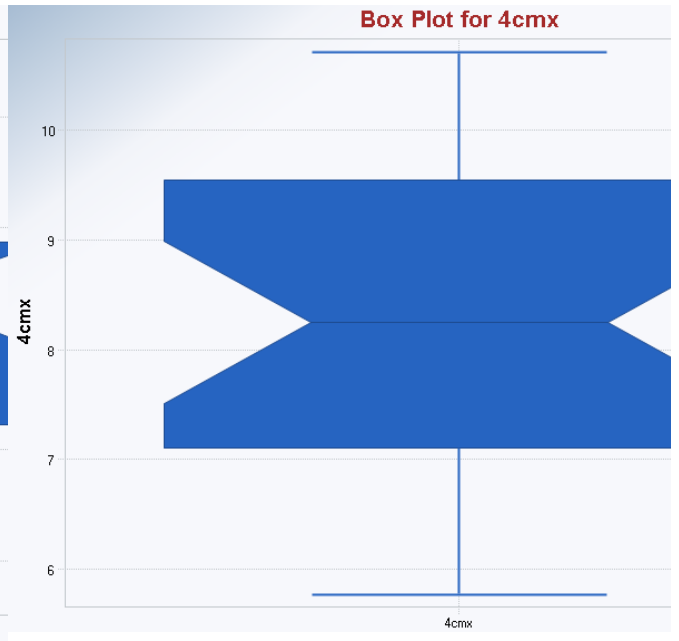
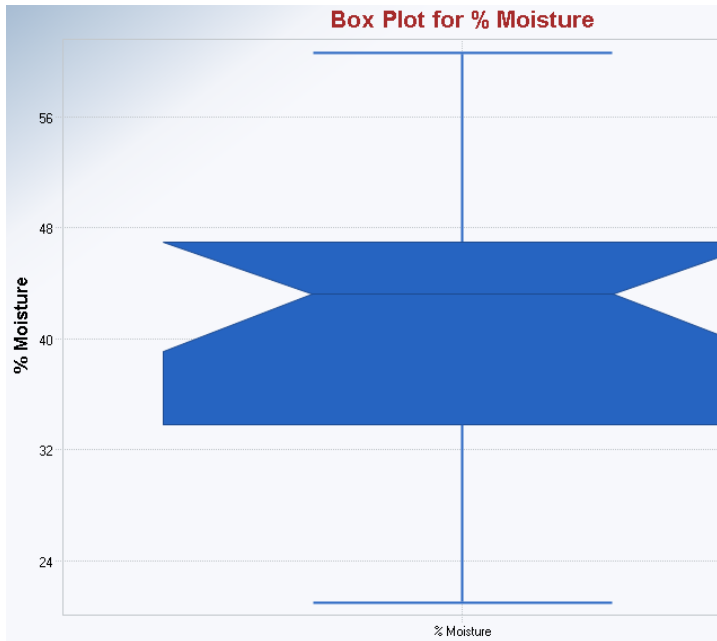












Appendix C Raw Ottawa River Sediment Radiochemistry Data**Table 21: Raw radiochemistry results for sediment samples along Transect 1.**

Analyte	Unit	NPD-1-1			NPD-1-2			NPD-1-3			NPD-1-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	0.327	0.162	0.125	0.286	0.166	0.144	0.368	0.259	0.191	0.267	0.186	0.217
Am-241	pCi/g	ND		0.186	ND		0.137	ND		0.0833	ND		0.19
Sb-124	pCi/g	ND		0.0656	ND		0.0995	ND		0.106	ND		0.135
Sb-125	pCi/g	ND		0.0831	ND		0.101	ND		0.104	ND		0.131
Ba-133	pCi/g	ND		0.0374	ND		0.0426	ND		0.0523	ND		0.0553
Ba-140	pCi/g	ND		0.536	ND		0.63	ND		0.701	ND		0.982
Be-7	pCi/g	ND		0.362	ND		0.376	ND		0.48	ND		0.597
Bi-212	pCi/g	ND		0.513	ND		0.73	ND		0.778	1.12	0.686	0.561
Bi-214	pCi/g	0.0983	0.0914	0.0676	0.262	0.0961	0.0818	0.309	0.120	0.156	0.246	0.128	0.112
Ce-139	pCi/g	ND		0.0312	ND		0.0301	ND		0.0344	ND		0.036
Ce-141	pCi/g	ND		0.0854	ND		0.0797	ND		0.0905	ND		0.105
Ce-144	pCi/g	ND		0.204	ND		0.205	ND		0.224	ND		0.222
Cs-134	pCi/g	ND		0.0355	ND		0.0521	ND		0.0626	ND		0.0658
Cs-136	pCi/g	ND		0.250	ND		0.257	ND		0.357	ND		0.373
Cs-137	pCi/g	ND		0.0356	0.0845	0.0536	0.0397	ND		0.0563	0.131	0.0502	0.0465
Cr-51	pCi/g	ND		0.483	ND		0.544	ND		0.678	ND		0.717
Co-56	pCi/g	ND		0.0441	ND		0.0486	ND		0.0693	ND		0.0735
Co-57	pCi/g	ND		0.0259	ND		0.0245	ND		0.0279	ND		0.0299
Co-58	pCi/g	ND		0.0371	ND		0.0519	ND		0.0584	ND		0.0632
Co-60	pCi/g	ND		0.0375	ND		0.0437	ND		0.0514	ND		0.0762
Eu-152	pCi/g	ND		0.0842	ND		0.111	ND		0.13	ND		0.112
Eu-154	pCi/g	ND		0.121	ND		0.142	ND		0.204	ND		0.203
Eu-155	pCi/g	ND		0.106	ND		0.1	ND		0.108	ND		0.131
Ir-192	pCi/g	ND		0.0373	ND		0.0403	ND		0.0454	ND		0.0526
Fe-59	pCi/g	ND		0.109	ND		0.124	ND		0.141	ND		0.214
Pb-210	pCi/g	ND		6.79	ND		3.09	ND		0.708	ND		4.55
Pb-212	pCi/g	0.324	0.0688	0.0543	0.312	0.0803	0.0613	0.352	0.100	0.0691	0.399	0.0780	0.065
Pb-214	pCi/g	0.340	0.0799	0.115	0.278	0.100	0.0733	0.258	0.104	0.145	0.221	0.126	0.0987
Mn-54	pCi/g	ND		0.0341	ND		0.0482	ND		0.0553	ND		0.0688
Hg-203	pCi/g	ND		0.0455	ND		0.0505	ND		0.059	ND		0.0584
Nd-147	pCi/g	ND		1.30	ND		1.56	ND		1.73	ND		2.18
Np-239	pCi/g	ND		0.236	ND		0.233	ND		0.272	ND		0.307
Nb-94	pCi/g	ND		0.0303	ND		0.0359	ND		0.0476	ND		0.0532
Nb-95	pCi/g	ND		0.0427	ND		0.0612	ND		0.0587	ND		0.0763
K-40	pCi/g	18.5	0.996	0.278	17.2	1.19	0.336	16.4	1.43	0.452	15.3	1.53	0.524
Pm-144	pCi/g	ND		0.0323	ND		0.039	ND		0.0473	ND		0.0579
Pm-146	pCi/g	ND		0.0408	ND		0.0456	ND		0.049	ND		0.0678
Ra-228	pCi/g	0.327	0.162	0.125	0.286	0.166	0.144	0.368	0.259	0.191	0.267	0.186	0.217
Ru-106	pCi/g	ND		0.311	ND		0.314	ND		0.484	ND		0.457
Ag-110m	pCi/g	ND		0.0487	ND		0.0566	ND		0.0744	ND		0.0742
Na-22	pCi/g	ND		0.0433	ND		0.0398	ND		0.0734	ND		0.0726
Tl-208	pCi/g	0.0775	0.0333	0.0316	0.0714	0.0465	0.0358	0.0957	0.0511	0.0453	0.178	0.0552	0.048
Th-234	pCi/g	ND		1.51	ND		1.3	ND		0.837	ND		1.71
Sn-113	pCi/g	ND		0.0426	ND		0.0512	ND		0.0639	ND		0.069
U-235	pCi/g	ND		0.200	ND		0.182	ND		0.219	ND		0.241
U-238	pCi/g	ND		1.51	ND		1.3	ND		0.837	ND		1.71
Y-88	pCi/g	ND		0.0291	ND		0.0504	ND		0.0567	ND		0.0589
Zn-65	pCi/g	ND		0.0827	ND		0.0945	ND		0.139	ND		0.148
Zr-95	pCi/g	ND		0.0766	ND		0.102	ND		0.13	ND		0.133
Gross Alpha	pCi/g	3.98	2.76	3.94	7.01	3.06	3.5	ND		2.61	4.29	2.36	2.91
Gross Beta	pCi/g	13.2	2.60	3.46	19.6	2.18	2.18	17.1	2.39	2.82	18.6	2.30	2.41
H-3	Bq/g	ND		0.121	ND		0.138	ND		0.191	ND		0.19
C-14	Bq/g	ND		0.0362	ND		0.0964	ND		0.0383	ND		0.0366

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

Table 22: Raw radiochemistry results for sediment samples along Transect 2.

Analyte	Unit	NPD-2-1			NPD-2-2			NPD-2-3			NPD-2-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	0.699	0.311	0.236	0.51	0.240	0.204	0.427	0.220	0.175	0.538	0.227	0.163
Am-241	pCi/g	ND		0.0727	ND		0.0645	ND		0.282	ND		0.22
Sb-124	pCi/g	ND		0.199	ND		0.143	ND		0.144	ND		0.123
Sb-125	pCi/g	ND		0.132	ND		0.11	ND		0.0981	ND		0.0959
Ba-133	pCi/g	ND		0.0531	ND		0.0485	ND		0.0495	ND		0.0477
Ba-140	pCi/g	ND		1.03	ND		0.827	ND		0.76	ND		0.761
Be-7	pCi/g	ND		0.614	ND		0.609	ND		0.448	ND		0.439
Bi-212	pCi/g	ND		1.06	ND		0.705	0.683	0.507	0.642	ND		0.747
Bi-214	pCi/g	0.389	0.131	0.233	0.485	0.155	0.0948	0.285	0.118	0.0805	0.327	0.110	0.0809
Ce-139	pCi/g	ND		0.0376	ND		0.0365	ND		0.036	ND		0.0339
Ce-141	pCi/g	ND		0.112	ND		0.0863	ND		0.102	ND		0.0884
Ce-144	pCi/g	ND		0.248	ND		0.211	ND		0.234	ND		0.207
Cs-134	pCi/g	ND		0.0843	ND		0.07	ND		0.0527	ND		0.0539
Cs-136	pCi/g	ND		0.438	ND		0.369	ND		0.392	ND		0.336
Cs-137	pCi/g	0.373	0.0955	0.0663	0.509	0.0820	0.0437	0.221	0.0456	0.0386	0.158	0.0553	0.0371
Cr-51	pCi/g	ND		0.851	ND		0.655	ND		0.667	ND		0.618
Co-56	pCi/g	ND		0.0728	ND		0.0649	ND		0.0646	ND		0.0554
Co-57	pCi/g	ND		0.0275	ND		0.0285	ND		0.027	ND		0.0295
Co-58	pCi/g	ND		0.0854	ND		0.0673	ND		0.0532	ND		0.054
Co-60	pCi/g	ND		0.0736	ND		0.0555	ND		0.0529	ND		0.0574
Eu-152	pCi/g	ND		0.137	ND		0.12	ND		0.119	ND		0.113
Eu-154	pCi/g	ND		0.233	ND		0.23	ND		0.176	ND		0.175
Eu-155	pCi/g	ND		0.129	ND		0.111	ND		0.119	ND		0.119
Ir-192	pCi/g	ND		0.0497	ND		0.0527	ND		0.0454	ND		0.0411
Fe-59	pCi/g	ND		0.225	ND		0.163	ND		0.169	ND		0.161
Pb-210	pCi/g	1.37	0.720	0.601	0.969	0.591	0.477	ND		11.5	ND		9.24
Pb-212	pCi/g	0.49	0.0819	0.0705	0.662	0.0804	0.0691	0.519	0.0727	0.0632	0.462	0.0827	0.0675
Pb-214	pCi/g	0.356	0.133	0.114	0.577	0.114	0.194	0.419	0.117	0.162	0.496	0.123	0.175
Mn-54	pCi/g	ND		0.0649	ND		0.0546	ND		0.0528	ND		0.0455
Hg-203	pCi/g	ND		0.0721	ND		0.062	ND		0.0582	ND		0.052
Nd-147	pCi/g	ND		2.55	ND		2.03	ND		1.61	ND		1.85
Np-239	pCi/g	ND		0.307	ND		0.262	ND		0.272	ND		0.303
Nb-94	pCi/g	ND		0.0655	ND		0.0493	ND		0.0371	ND		0.0415
Nb-95	pCi/g	ND		0.0959	ND		0.0671	ND		0.0624	ND		0.0642
K-40	pCi/g	16.5	1.75	0.627	16.7	1.47	0.634	18	1.38	0.43	18.5	1.44	0.486
Pm-144	pCi/g	ND		0.0623	ND		0.0521	ND		0.0434	ND		0.0397
Pm-146	pCi/g	ND		0.0623	ND		0.059	ND		0.0528	ND		0.0476
Ra-228	pCi/g	0.699	0.311	0.236	0.51	0.240	0.204	0.427	0.220	0.175	0.538	0.227	0.163
Ru-106	pCi/g	ND		0.51	ND		0.491	ND		0.354	ND		0.382
Ag-110m	pCi/g	ND		0.0844	ND		0.0696	ND		0.0756	ND		0.0601
Na-22	pCi/g	ND		0.0824	ND		0.0816	ND		0.0623	ND		0.0621
Tl-208	pCi/g	0.141	0.0645	0.0722	0.194	0.0739	0.0426	0.144	0.0508	0.0475	0.0821	0.0496	0.0446
Th-234	pCi/g	1.17	0.847	0.702	ND		0.642	ND		2.26	ND		1.88
Sn-113	pCi/g	ND		0.0772	ND		0.0583	ND		0.0596	ND		0.0516
U-235	pCi/g	ND		0.246	ND		0.191	ND		0.227	ND		0.227
U-238	pCi/g	1.17	0.847	0.702	ND		0.642	ND		2.26	ND		1.88
Y-88	pCi/g	ND		0.0741	ND		0.0554	ND		0.0504	ND		0.0608
Zn-65	pCi/g	ND		0.174	ND		0.14	ND		0.134	ND		0.126
Zr-95	pCi/g	ND		0.145	ND		0.104	ND		0.117	ND		0.118
Gross Alpha	pCi/g	10.6	3.62	4.08	12	3.42	2.49	8.04	3.14	3.82	6.95	3.11	3.99
Gross Beta	pCi/g	93.6	4.45	2.78	32.3	2.90	2.81	45.6	3.33	2.92	21.5	2.75	3.44
H-3	Bq/g	ND		0.177	ND		0.172	ND		0.172	ND		0.197
C-14	Bq/g	ND		0.0364	ND		0.0353	ND		0.0366	ND		0.0344

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

Table 23: Raw radiochemistry results for sediment samples along Transect 3.

Analyte	Unit	NPD-3-1			NPD-3-2			NPD-3-3			NPD-3-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	0.514	0.199	0.17	0.829	0.331	0.317	0.814	0.248	0.235	0.442	0.225	0.227
Am-241	pCi/g	ND		0.122	ND		0.124	ND		0.219	ND		0.0574
Sb-124	pCi/g	ND		0.107	ND		0.117	ND		0.131	ND		0.132
Sb-125	pCi/g	ND		0.101	ND		0.177	ND		0.157	ND		0.118
Ba-133	pCi/g	ND		0.0452	ND		0.0704	ND		0.0696	ND		0.0517
Ba-140	pCi/g	ND		0.859	ND		1.23	ND		1.21	ND		0.708
Be-7	pCi/g	ND		0.419	ND		0.747	ND		0.703	ND		0.602
Bi-212	pCi/g	0.774	0.656	0.499	ND		1.3	1.05	0.607	0.764	1.32	0.642	0.608
Bi-214	pCi/g	0.404	0.118	0.0877	0.35	0.159	0.143	0.404	0.146	0.118	0.293	0.120	0.096
Ce-139	pCi/g	ND		0.036	ND		0.0495	ND		0.0495	ND		0.0343
Ce-141	pCi/g	ND		0.0925	ND		0.122	ND		0.114	ND		0.094
Ce-144	pCi/g	ND		0.219	ND		0.32	ND		0.274	ND		0.203
Cs-134	pCi/g	ND		0.0592	ND		0.0922	ND		0.0743	ND		0.0711
Cs-136	pCi/g	ND		0.297	ND		0.523	ND		0.504	ND		0.388
Cs-137	pCi/g	0.364	0.0691	0.0443	0.39	0.101	0.0749	0.459	0.0889	0.0542	0.354	0.0644	0.0552
Cr-51	pCi/g	ND		0.613	ND		0.936	ND		0.916	ND		0.745
Co-56	pCi/g	ND		0.0597	ND		0.109	ND		0.0921	ND		0.0695
Co-57	pCi/g	ND		0.0268	ND		0.039	ND		0.0383	ND		0.0272
Co-58	pCi/g	ND		0.0511	ND		0.0727	ND		0.0822	ND		0.0649
Co-60	pCi/g	ND		0.0465	ND		0.0706	ND		0.0773	ND		0.0519
Eu-152	pCi/g	ND		0.111	ND		0.16	ND		0.159	ND		0.105
Eu-154	pCi/g	ND		0.142	ND		0.256	ND		0.236	ND		0.199
Eu-155	pCi/g	ND		0.113	ND		0.142	ND		0.137	ND		0.105
Ir-192	pCi/g	ND		0.0446	ND		0.0689	ND		0.0579	ND		0.05
Fe-59	pCi/g	ND		0.147	ND		0.29	ND		0.225	ND		0.17
Pb-210	pCi/g	ND		2.31	ND		0.903	ND		5.2	ND		0.502
Pb-212	pCi/g	0.508	0.0894	0.0743	0.755	0.118	0.0926	0.383	0.128	0.0933	0.476	0.0707	0.0585
Pb-214	pCi/g	0.529	0.112	0.171	0.535	0.139	0.134	0.259	0.164	0.125	0.38	0.122	0.0953
Mn-54	pCi/g	ND		0.0457	ND		0.0851	ND		0.0801	ND		0.0567
Hg-203	pCi/g	ND		0.0536	ND		0.0857	ND		0.0775	ND		0.0591
Nd-147	pCi/g	ND		1.92	ND		2.72	ND		2.67	ND		2.06
Np-239	pCi/g	ND		0.263	ND		0.394	ND		0.373	ND		0.27
Nb-94	pCi/g	ND		0.0414	ND		0.0732	ND		0.0662	ND		0.0399
Nb-95	pCi/g	ND		0.0554	ND		0.101	ND		0.081	ND		0.0772
K-40	pCi/g	17.9	1.30	0.341	15.7	1.76	0.962	16.6	1.89	0.81	17.4	1.52	0.511
Pm-144	pCi/g	ND		0.0451	ND		0.0794	ND		0.0587	ND		0.0542
Pm-146	pCi/g	ND		0.0565	ND		0.0671	ND		0.078	ND		0.0595
Ra-228	pCi/g	0.514	0.199	0.17	0.829	0.331	0.317	0.814	0.248	0.235	0.442	0.225	0.227
Ru-106	pCi/g	ND		0.388	ND		0.641	ND		0.612	ND		0.499
Ag-110m	pCi/g	ND		0.0601	ND		0.107	ND		0.101	ND		0.073
Na-22	pCi/g	ND		0.05	ND		0.0892	ND		0.0838	ND		0.0714
Tl-208	pCi/g	0.173	0.0500	0.0387	0.284	0.0975	0.0598	0.143	0.0732	0.0591	0.0975	0.0682	0.0487
Th-234	pCi/g	ND		1.27	ND		1.15	ND		1.86	ND		0.625
Sn-113	pCi/g	ND		0.0528	ND		0.0847	ND		0.0809	ND		0.0636
U-235	pCi/g	ND		0.217	ND		0.324	ND		0.262	ND		0.223
U-238	pCi/g	ND		1.27	ND		1.15	ND		1.86	ND		0.625
Y-88	pCi/g	ND		0.0395	ND		0.0847	ND		0.0928	ND		0.0605
Zn-65	pCi/g	ND		0.113	ND		0.19	ND		0.175	ND		0.15
Zr-95	pCi/g	ND		0.0769	ND		0.171	ND		0.184	ND		0.116
Gross Alpha	pCi/g	16	4.93	4	8.37	3.16	3.79	6.29	2.94	3.96	6.45	2.34	2.27
Gross Beta	pCi/g	24.5	2.96	2.69	24.6	2.93	3.25	23.9	2.97	3.57	25.1	2.55	2.54
H-3	Bq/g	ND		0.172	ND		0.212	ND		0.168	ND		0.211
C-14	Bq/g	ND		0.0347	ND		0.0398	ND		0.039	ND		0.0361

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

Table 24: Raw radiochemistry results for sediment samples along Transect 4.

Analyte	Unit	NPD-4-1			NPD-4-2			NPD-4-3			NPD-4-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	0.309	0.154	0.234	0.974	0.261	0.24	0.605	0.291	0.398	0.732	0.251	0.335
Am-241	pCi/g	ND		0.0456	ND		0.334	ND		0.255	ND		0.194
Sb-124	pCi/g	ND		0.108	ND		0.139	ND		0.165	ND		0.11
Sb-125	pCi/g	ND		0.0916	ND		0.176	ND		0.124	ND		0.0961
Ba-133	pCi/g	ND		0.0331	ND		0.0695	ND		0.0513	ND		0.0409
Ba-140	pCi/g	ND		0.6	ND		1.03	ND		0.859	ND		0.714
Be-7	pCi/g	ND		0.352	ND		0.745	ND		0.569	ND		0.423
Bi-212	pCi/g	0.566	0.491	0.483	ND		1.08	0.735	0.544	0.627	1.35	0.528	0.458
Bi-214	pCi/g	0.156	0.0943	0.0718	0.351	0.135	0.115	0.348	0.118	0.104	0.277	0.0978	0.0771
Ce-139	pCi/g	ND		0.0266	ND		0.0449	ND		0.0353	ND		0.0306
Ce-141	pCi/g	ND		0.0673	ND		0.131	ND		0.0987	ND		0.0904
Ce-144	pCi/g	ND		0.149	ND		0.29	ND		0.241	ND		0.209
Cs-134	pCi/g	ND		0.0434	ND		0.0652	ND		0.0557	ND		0.0496
Cs-136	pCi/g	ND		0.266	ND		0.5	ND		0.37	ND		0.238
Cs-137	pCi/g	0.0741	0.0537	0.038	0.822	0.112	0.0596	0.407	0.0800	0.0415	0.377	0.0601	0.0413
Cr-51	pCi/g	ND		0.461	ND		0.918	ND		0.697	ND		0.54
Co-56	pCi/g	ND		0.0522	ND		0.0893	ND		0.0664	ND		0.0518
Co-57	pCi/g	ND		0.0199	ND		0.0368	ND		0.0319	ND		0.0256
Co-58	pCi/g	ND		0.0495	ND		0.0771	ND		0.0673	ND		0.0523
Co-60	pCi/g	ND		0.0417	ND		0.0648	ND		0.062	ND		0.0479
Eu-152	pCi/g	ND		0.0861	ND		0.157	ND		0.134	ND		0.104
Eu-154	pCi/g	ND		0.157	ND		0.178	ND		0.186	ND		0.153
Eu-155	pCi/g	ND		0.071	ND		0.167	ND		0.13	ND		0.107
Ir-192	pCi/g	ND		0.0356	ND		0.0645	ND		0.0544	ND		0.0471
Fe-59	pCi/g	ND		0.15	ND		0.228	ND		0.193	ND		0.154
Pb-210	pCi/g	0.858	0.493	0.331	ND		16.9	ND		9.83	ND		6.78
Pb-212	pCi/g	0.252	0.0521	0.0483	0.899	0.104	0.0895	0.485	0.103	0.0809	1	0.0681	0.056
Pb-214	pCi/g	0.357	0.0818	0.0626	0.458	0.122	0.115	0.373	0.136	0.0819	0.37	0.100	0.078
Mn-54	pCi/g	ND		0.0408	ND		0.0742	ND		0.0571	ND		0.0471
Hg-203	pCi/g	ND		0.0391	ND		0.0767	ND		0.06	ND		0.0503
Nd-147	pCi/g	ND		1.5	ND		2.6	ND		2	ND		1.74
Np-239	pCi/g	ND		0.21	ND		0.385	ND		0.304	ND		0.288
Nb-94	pCi/g	ND		0.0304	ND		0.0558	ND		0.0493	ND		0.0383
Nb-95	pCi/g	ND		0.0545	ND		0.0801	ND		0.0738	ND		0.0563
K-40	pCi/g	16.5	1.15	0.0573	17.7	1.65	0.583	18.9	1.54	0.472	17.6	1.29	0.331
Pm-144	pCi/g	ND		0.043	ND		0.0644	ND		0.05	ND		0.0415
Pm-146	pCi/g	ND		0.0445	ND		0.0673	ND		0.0578	ND		0.0487
Ra-228	pCi/g	0.309	0.154	0.234	0.974	0.261	0.24	0.605	0.291	0.398	0.732	0.251	0.335
Ru-106	pCi/g	ND		0.324	ND		0.652	ND		0.429	ND		0.325
Ag-110m	pCi/g	ND		0.059	ND		0.0811	ND		0.0787	ND		0.0613
Na-22	pCi/g	ND		0.0565	ND		0.0616	ND		0.0665	ND		0.0552
Tl-208	pCi/g	0.0646	0.0430	0.0304	0.29	0.0767	0.0632	0.163	0.0571	0.0402	0.166	0.0515	0.0385
Th-234	pCi/g	ND		0.599	ND		2.78	ND		2.08	ND		1.41
Sn-113	pCi/g	ND		0.0429	ND		0.0834	ND		0.0646	ND		0.0505
U-235	pCi/g	ND		0.149	ND		0.307	ND		0.243	ND		0.209
U-238	pCi/g	ND		0.599	ND		2.78	ND		2.08	ND		1.41
Y-88	pCi/g	ND		0.0334	ND		0.0586	ND		0.0645	ND		0.0378
Zn-65	pCi/g	ND		0.119	ND		0.174	ND		0.153	ND		0.109
Zr-95	pCi/g	ND		0.0882	ND		0.171	ND		0.118	ND		0.0902
Gross Alpha	pCi/g	4.38	3.11	3.84	14.2	4.36	3.96	9.43	3.54	3.93	7.13	3.13	3.91
Gross Beta	pCi/g	16.9	3.06	2.76	24.2	3.24	3.25	21.6	2.86	2.9	21.8	2.61	2.41
H-3	Bq/g	ND		0.174	ND		0.22	ND		0.194	ND		0.157
C-14	Bq/g	ND		0.0376	ND		0.0372	ND		0.0357	ND		0.0358

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

Table 25: Raw radiochemistry results for sediment samples along Transect 5.

Analyte	Unit	NPD-5-1			NPD-5-2			NPD-5-3			NPD-5-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	0.369	0.175	0.166	0.787	0.212	0.144	0.412	0.183	0.143	0.523	0.225	0.148
Am-241	pCi/g	ND		0.179	ND		0.259	ND		0.0915	ND		0.237
Sb-124	pCi/g	ND		0.147	ND		0.109	ND		0.124	ND		0.125
Sb-125	pCi/g	ND		0.1	ND		0.102	ND		0.107	ND		0.107
Ba-133	pCi/g	ND		0.0471	ND		0.0459	ND		0.0448	ND		0.048
Ba-140	pCi/g	ND		0.804	ND		0.768	ND		0.691	ND		0.7
Be-7	pCi/g	ND		0.467	ND		0.492	ND		0.448	ND		0.469
Bi-212	pCi/g	0.59	0.370	0.459	ND		0.555	0.939	0.665	0.513	ND		0.523
Bi-214	pCi/g	0.394	0.118	0.0865	0.462	0.118	0.0781	0.233	0.0907	0.0852	0.306	0.113	0.0756
Ce-139	pCi/g	ND		0.0329	ND		0.0353	ND		0.0294	ND		0.0378
Ce-141	pCi/g	ND		0.09	ND		0.102	ND		0.0751	ND		0.0988
Ce-144	pCi/g	ND		0.228	ND		0.244	ND		0.183	ND		0.251
Cs-134	pCi/g	ND		0.0571	ND		0.0503	ND		0.0456	ND		0.0451
Cs-136	pCi/g	ND		0.327	ND		0.302	ND		0.314	ND		0.28
Cs-137	pCi/g	0.290	0.0682	0.0475	0.488	0.0615	0.0468	0.222	0.0525	0.0403	0.355	0.0535	0.0433
Cr-51	pCi/g	ND		0.595	ND		0.617	ND		0.583	ND		0.638
Co-56	pCi/g	ND		0.0537	ND		0.0621	ND		0.0503	ND		0.0509
Co-57	pCi/g	ND		0.0279	ND		0.0277	ND		0.0236	ND		0.0335
Co-58	pCi/g	ND		0.0434	ND		0.0476	ND		0.0524	ND		0.0505
Co-60	pCi/g	ND		0.0506	ND		0.0554	ND		0.0446	ND		0.0481
Eu-152	pCi/g	ND		0.109	ND		0.11	ND		0.0994	ND		0.11
Eu-154	pCi/g	ND		0.175	ND		0.155	ND		0.144	ND		0.143
Eu-155	pCi/g	ND		0.112	ND		0.134	ND		0.105	ND		0.138
Ir-192	pCi/g	ND		0.0407	ND		0.0479	ND		0.047	ND		0.0471
Fe-59	pCi/g	ND		0.12	ND		0.144	ND		0.148	ND		0.128
Pb-210	pCi/g	ND		4.7	ND		9.58	ND		1.38	ND		8.34
Pb-212	pCi/g	0.468	0.0721	0.0589	0.685	0.0775	0.0611	0.418	0.0743	0.0658	0.509	0.0777	0.0665
Pb-214	pCi/g	0.362	0.110	0.0826	0.442	0.125	0.164	0.424	0.109	0.148	0.542	0.0946	0.087
Mn-54	pCi/g	ND		0.0431	ND		0.0512	ND		0.046	ND		0.0441
Hg-203	pCi/g	ND		0.0532	ND		0.055	ND		0.0533	ND		0.0608
Nd-147	pCi/g	ND		1.97	ND		1.8	ND		1.82	ND		1.68
Np-239	pCi/g	ND		0.266	ND		0.326	ND		0.246	ND		0.311
Nb-94	pCi/g	ND		0.0414	ND		0.0378	ND		0.0394	ND		0.0375
Nb-95	pCi/g	ND		0.0576	ND		0.0625	ND		0.0516	ND		0.0574
K-40	pCi/g	17.7	1.43	0.478	17.9	1.13	0.388	18.4	1.23	0.407	18.7	1.12	0.376
Pm-144	pCi/g	ND		0.0387	ND		0.0402	ND		0.0397	ND		0.0443
Pm-146	pCi/g	ND		0.0541	ND		0.0521	ND		0.046	ND		0.0469
Ra-228	pCi/g	0.369	0.175	0.166	0.787	0.212	0.144	0.412	0.183	0.143	0.523	0.225	0.148
Ru-106	pCi/g	ND		0.378	ND		0.394	ND		0.323	ND		0.35
Ag-110m	pCi/g	ND		0.0557	ND		0.0614	ND		0.0514	ND		0.0614
Na-22	pCi/g	ND		0.0617	ND		0.0553	ND		0.0508	ND		0.0511
Tl-208	pCi/g	0.154	0.0555	0.0369	0.153	0.0506	0.0379	0.135	0.0501	0.0429	0.125	0.0454	0.0415
Th-234	pCi/g	ND		1.46	ND		2.03	ND		0.827	ND		1.82
Sn-113	pCi/g	ND		0.0481	ND		0.0541	ND		0.0527	ND		0.0549
U-235	pCi/g	ND		0.224	ND		0.247	ND		0.184	ND		0.269
U-238	pCi/g	ND		1.46	ND		2.03	ND		0.827	ND		1.82
Y-88	pCi/g	ND		0.047	ND		0.0564	ND		0.0471	ND		0.0424
Zn-65	pCi/g	ND		0.0845	ND		0.111	ND		0.117	ND		0.112
Zr-95	pCi/g	ND		0.116	ND		0.107	ND		0.1	ND		0.0964
Gross Alpha	pCi/g	9.72	3.97	3.89	8.02	3.60	3.87	7.23	3.00	3.94	6.47	3.90	3.64
Gross Beta	pCi/g	20.3	3.03	2.41	18.6	2.97	2.66	20.8	2.57	2.8	21.6	3.93	3.13
H-3	Bq/g	ND		0.169	ND		0.164	ND		0.166	ND		0.165
C-14	Bq/g	ND		0.0359	ND		0.0362	ND		0.0354	ND		0.0355

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

Table 26: Raw radiochemistry results for sediment samples along Transect 6.

Analyte	Unit	NPD-6-1			NPD-6-2			NPD-6-3			NPD-6-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	ND		0.294	0.262	0.183	0.21	0.375	0.168	0.168	0.798	0.208	0.167
Am-241	pCi/g	ND		0.0856	ND		0.162	ND		0.166	ND		0.143
Sb-124	pCi/g	ND		0.328	ND		0.13	ND		0.14	ND		0.0967
Sb-125	pCi/g	ND		0.178	ND		0.139	ND		0.12	ND		0.114
Ba-133	pCi/g	ND		0.0645	ND		0.0599	ND		0.0539	ND		0.0355
Ba-140	pCi/g	ND		1.38	ND		1.07	ND		0.794	ND		0.827
Be-7	pCi/g	ND		0.806	ND		0.621	ND		0.46	ND		0.389
Bi-212	pCi/g	ND		0.953	0.668	0.569	0.649	0.896	0.615	0.603	ND		0.61
Bi-214	pCi/g	0.301	0.166	0.148	0.368	0.139	0.099	0.392	0.106	0.0794	0.324	0.0823	0.0654
Ce-139	pCi/g	ND		0.0452	ND		0.0412	ND		0.0398	ND		0.0341
Ce-141	pCi/g	ND		0.121	ND		0.119	ND		0.0942	ND		0.0866
Ce-144	pCi/g	ND		0.262	ND		0.247	ND		0.224	ND		0.217
Cs-134	pCi/g	ND		0.0893	ND		0.0624	ND		0.0559	ND		0.0564
Cs-136	pCi/g	ND		0.566	ND		0.331	ND		0.367	ND		0.349
Cs-137	pCi/g	0.632	0.102	0.0736	0.635	0.0818	0.0545	0.104	0.0545	0.0418	ND		0.053
Cr-51	pCi/g	ND		0.993	ND		0.801	ND		0.704	ND		0.622
Co-56	pCi/g	ND		0.0936	ND		0.0684	ND		0.0568	ND		0.0495
Co-57	pCi/g	ND		0.0329	ND		0.0309	ND		0.0316	ND		0.0255
Co-58	pCi/g	ND		0.0899	ND		0.0651	ND		0.0451	ND		0.0619
Co-60	pCi/g	ND		0.0803	ND		0.0536	ND		0.0521	ND		0.0447
Eu-152	pCi/g	ND		0.155	ND		0.123	ND		0.116	ND		0.0967
Eu-154	pCi/g	ND		0.267	ND		0.175	ND		0.176	ND		0.14
Eu-155	pCi/g	ND		0.132	ND		0.123	ND		0.114	ND		0.105
Ir-192	pCi/g	ND		0.0751	ND		0.0498	ND		0.0519	ND		0.046
Fe-59	pCi/g	ND		0.271	ND		0.187	ND		0.143	ND		0.172
Pb-210	pCi/g	2.54	0.656	0.659	ND		4.09	ND		3.58	ND		2.91
Pb-212	pCi/g	0.509	0.0902	0.0819	0.511	0.0786	0.0686	0.439	0.0872	0.0666	0.603	0.0719	0.0545
Pb-214	pCi/g	0.453	0.167	0.126	0.452	0.146	0.0955	0.406	0.103	0.0904	0.553	0.0942	0.178
Mn-54	pCi/g	ND		0.0665	ND		0.063	ND		0.0452	ND		0.046
Hg-203	pCi/g	ND		0.0853	ND		0.0706	ND		0.0584	ND		0.0494
Nd-147	pCi/g	ND		2.74	ND		2.57	ND		1.8	ND		1.74
Np-239	pCi/g	ND		0.36	ND		0.334	ND		0.296	ND		0.248
Nb-94	pCi/g	ND		0.0666	ND		0.0516	ND		0.0449	ND		0.0379
Nb-95	pCi/g	ND		0.0993	ND		0.0682	ND		0.0677	ND		0.0593
K-40	pCi/g	15.8	1.81	0.744	19.3	1.42	0.441	18.4	1.34	0.458	16.9	1.26	0.259
Pm-144	pCi/g	ND		0.0611	ND		0.0525	ND		0.0502	ND		0.0419
Pm-146	pCi/g	ND		0.0848	ND		0.0655	ND		0.0464	ND		0.0555
Ra-228	pCi/g	ND		0.294	0.262	0.183	0.21	0.375	0.168	0.168	0.798	0.208	0.167
Ru-106	pCi/g	ND		0.575	ND		0.386	ND		0.377	ND		0.382
Ag-110m	pCi/g	ND		0.115	ND		0.071	ND		0.0564	ND		0.0515
Na-22	pCi/g	ND		0.094	ND		0.0571	ND		0.0619	ND		0.0486
Tl-208	pCi/g	0.142	0.0623	0.0725	0.138	0.0490	0.0505	0.236	0.0535	0.0372	0.197	0.0590	0.0412
Th-234	pCi/g	ND		0.847	ND		1.42	ND		1.39	ND		1.12
Sn-113	pCi/g	ND		0.091	ND		0.0752	ND		0.0536	ND		0.0493
U-235	pCi/g	ND		0.278	ND		0.264	ND		0.226	ND		0.202
U-238	pCi/g	ND		0.847	ND		1.42	ND		1.39	ND		1.12
Y-88	pCi/g	ND		0.0698	ND		0.0595	ND		0.0546	ND		0.0458
Zn-65	pCi/g	ND		0.182	ND		0.107	ND		0.114	ND		0.11
Zr-95	pCi/g	ND		0.164	ND		0.134	ND		0.11	ND		0.0997
Gross Alpha	pCi/g	6.00	2.92	3.92	16.2	4.15	3.83	7.44	3.24	3.27	9.52	3.74	3.88
Gross Beta	pCi/g	23.5	3.00	3.69	21.7	2.37	2.53	20.8	3.50	4.33	21.9	3.40	3.83
H-3	Bq/g	ND		0.171	ND		0.165	ND		0.171	ND		0.222
C-14	Bq/g	ND		0.0364	ND		0.0518	ND		0.0518	ND		0.074

Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

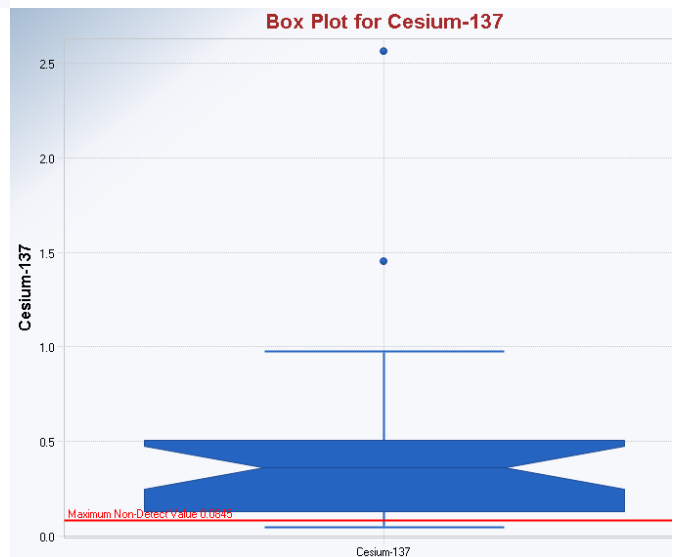
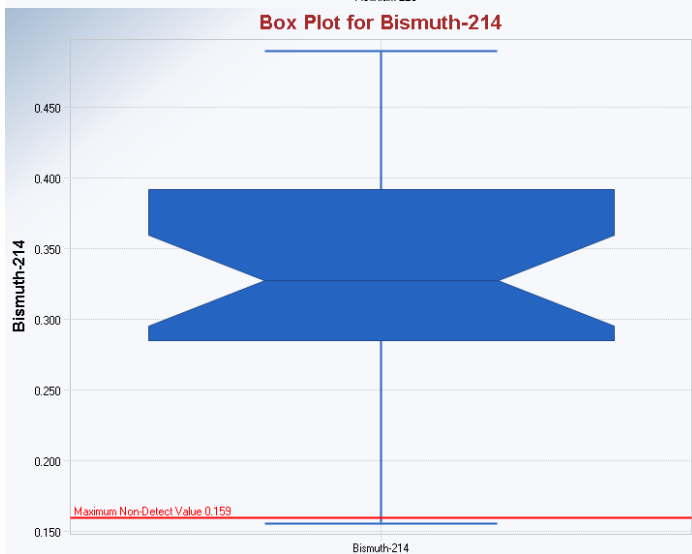
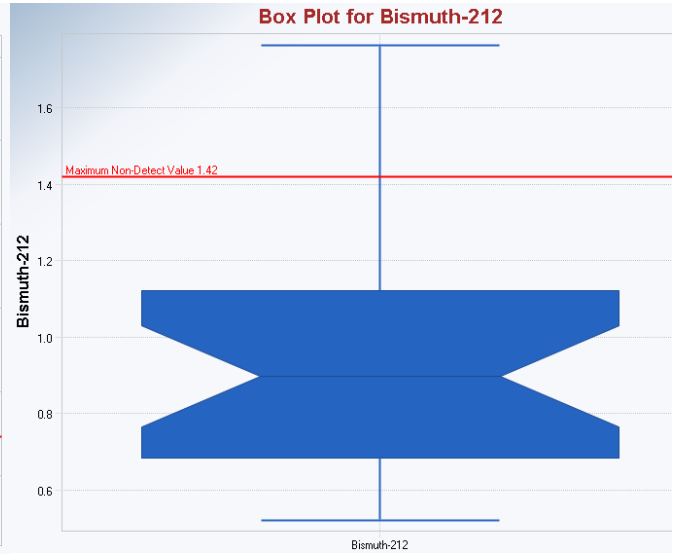
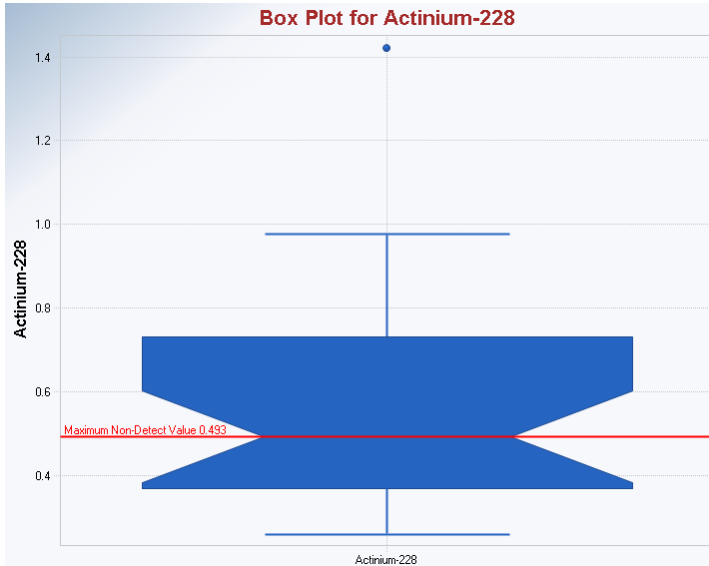
Table 27: Raw radiochemistry results for sediment samples along Transect 7.

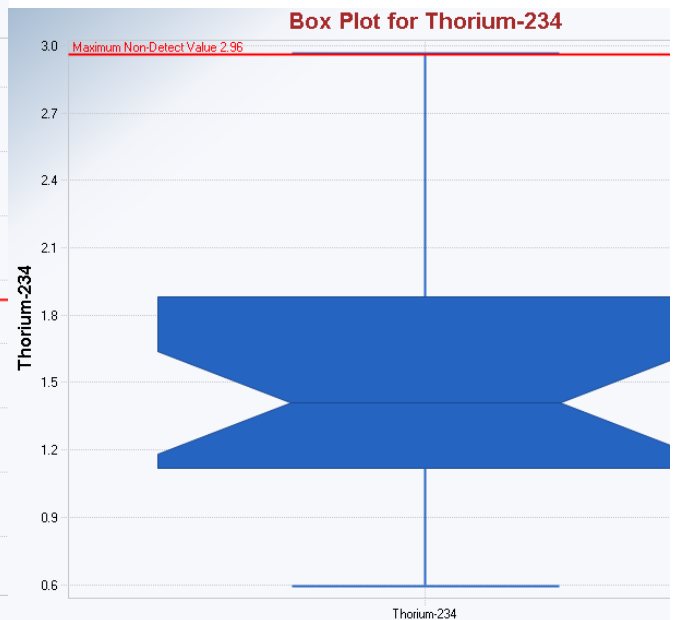
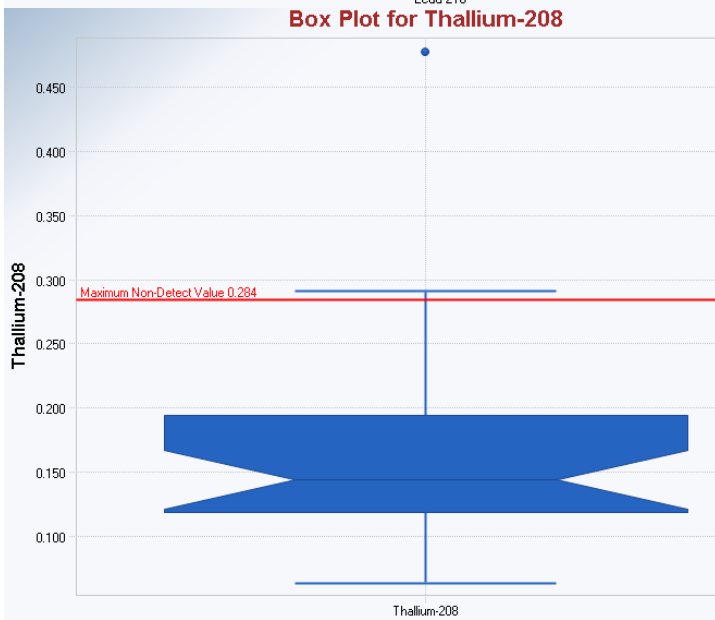
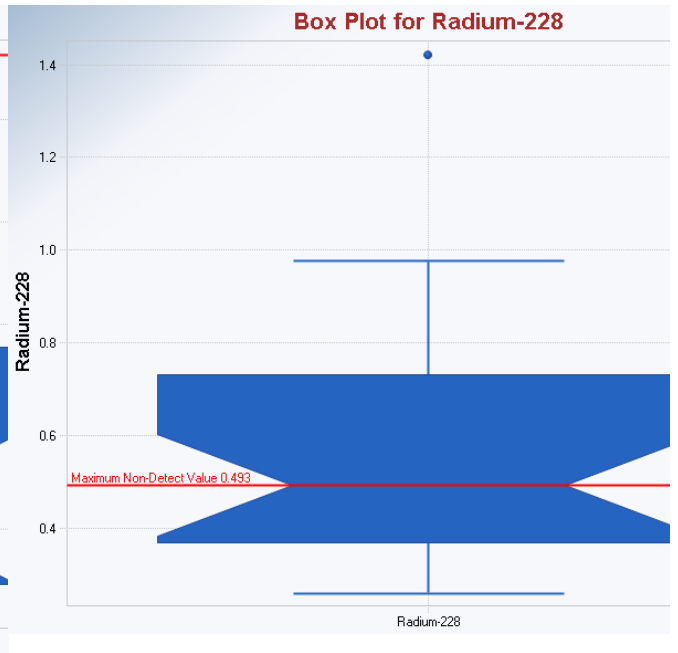
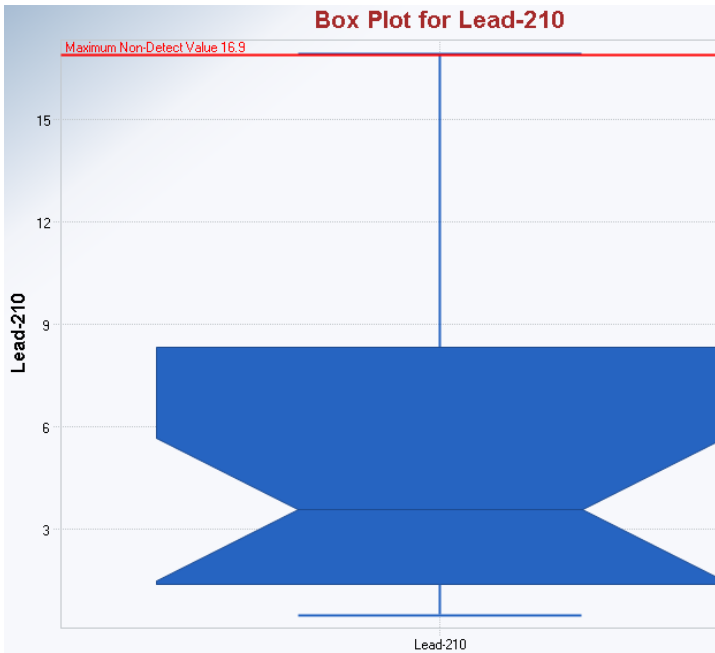
Analyte	Unit	NPD-7-1			NPD-7-2			NPD-7-3			NPD-7-4		
		Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA	Result	+/-	MDA
Ac-228	pCi/g	ND		0.369	0.422	0.377	0.304	ND		0.493	1.42	0.380	0.279
Am-241	pCi/g	ND		0.0903	ND		0.229	ND		0.358	ND		0.0997
Sb-124	pCi/g	ND		0.186	ND		0.27	ND		0.0627	ND		0.125
Sb-125	pCi/g	ND		0.116	ND		0.191	ND		0.153	ND		0.206
Ba-133	pCi/g	ND		0.0467	ND		0.0773	ND		0.0715	ND		0.0792
Ba-140	pCi/g	ND		1.01	ND		1.52	ND		1.13	ND		1.61
Be-7	pCi/g	ND		0.569	ND		0.968	ND		0.757	ND		0.998
Bi-212	pCi/g	1.02	0.851	0.816	1.76	0.872	0.882	ND		1.14	ND		1.42
Bi-214	pCi/g	0.342	0.155	0.10	0.285	0.134	0.162	0.489	0.126	0.105	ND		0.159
Ce-139	pCi/g	ND		0.0328	ND		0.0481	ND		0.0431	ND		0.0559
Ce-141	pCi/g	ND		0.096	ND		0.141	ND		0.147	ND		0.151
Ce-144	pCi/g	ND		0.255	ND		0.309	ND		0.316	ND		0.348
Cs-134	pCi/g	ND		0.0732	ND		0.0776	ND		0.0792	ND		0.102
Cs-136	pCi/g	ND		0.539	ND		0.584	ND		0.523	ND		0.626
Cs-137	pCi/g	ND		0.0826	1.45	0.147	0.0727	0.969	0.121	0.054	2.56	0.183	0.0818
Cr-51	pCi/g	ND		0.753	ND		1.12	ND		0.874	ND		1.25
Co-56	pCi/g	ND		0.0594	ND		0.0812	ND		0.088	ND		0.0873
Co-57	pCi/g	ND		0.0309	ND		0.0404	ND		0.0399	ND		0.0424
Co-58	pCi/g	ND		0.0471	ND		0.085	ND		0.0481	ND		0.0829
Co-60	pCi/g	ND		0.0609	ND		0.076	ND		0.0789	ND		0.102
Eu-152	pCi/g	ND		0.116	ND		0.191	ND		0.152	ND		0.208
Eu-154	pCi/g	ND		0.189	ND		0.26	ND		0.242	ND		0.259
Eu-155	pCi/g	ND		0.111	ND		0.16	ND		0.183	ND		0.16
Ir-192	pCi/g	ND		0.0492	ND		0.0802	ND		0.0738	ND		0.0779
Fe-59	pCi/g	ND		0.17	ND		0.237	ND		0.229	ND		0.3
Pb-210	pCi/g	ND		0.749	ND		6.19	ND		14.4	3.58	0.958	0.808
Pb-212	pCi/g	0.33	0.0887	0.0695	0.681	0.108	0.0919	0.672	0.105	0.0988	1.31	0.125	0.0986
Pb-214	pCi/g	0.44	0.132	0.192	0.4	0.197	0.15	0.359	0.170	0.118	0.663	0.171	0.276
Mn-54	pCi/g	ND		0.0558	ND		0.084	ND		0.0709	ND		0.0852
Hg-203	pCi/g	ND		0.0607	ND		0.086	ND		0.0813	ND		0.0933
Nd-147	pCi/g	ND		2.1	ND		3.7	ND		3.1	ND		3.82
Np-239	pCi/g	ND		0.293	ND		0.375	ND		0.4	ND		0.377
Nb-94	pCi/g	ND		0.0497	ND		0.0692	ND		0.0492	ND		0.069
Nb-95	pCi/g	ND		0.0758	ND		0.0839	ND		0.0647	ND		0.102
K-40	pCi/g	12.7	1.32	0.526	13.4	1.94	0.982	15.6	1.56	0.539	16.9	1.74	0.665
Pm-144	pCi/g	ND		0.0456	ND		0.0585	ND		0.0613	ND		0.0728
Pm-146	pCi/g	ND		0.0662	ND		0.0924	ND		0.0696	ND		0.112
Ra-228	pCi/g	ND		0.369	0.422	0.377	0.304	ND		0.493	1.42	0.380	0.279
Ru-106	pCi/g	ND		0.484	ND		0.631	ND		0.524	ND		0.652
Ag-110m	pCi/g	ND		0.0887	ND		0.0748	ND		0.0743	ND		0.113
Na-22	pCi/g	ND		0.0678	ND		0.0919	ND		0.0852	ND		0.0916
Tl-208	pCi/g	0.119	0.0562	0.0504	ND		0.0724	0.245	0.0637	0.0509	0.477	0.0879	0.0701
Th-234	pCi/g	ND		1.13	ND		1.88	ND		2.96	1.44	0.977	0.932
Sn-113	pCi/g	ND		0.0662	ND		0.101	ND		0.0822	ND		0.107
U-235	pCi/g	ND		0.251	ND		0.349	ND		0.312	ND		0.323
U-238	pCi/g	ND		1.13	ND		1.88	ND		2.96	1.44	0.977	0.932
Y-88	pCi/g	ND		0.0489	ND		0.0981	ND		0.0829	ND		0.12
Zn-65	pCi/g	ND		0.158	ND		0.212	ND		0.163	ND		0.194
Zr-95	pCi/g	ND		0.144	ND		0.126	ND		0.128	ND		0.192
Gross Alpha	pCi/g	5.28	2.66	3.42	11.9	3.51	3.94	14.2	4.40	3.61	13.1	4.04	3.84
Gross Beta	pCi/g	13.8	1.96	2.37	22	2.50	2.55	19.9	2.95	2.89	31.1	3.32	3.05
H-3	Bq/g	ND		0.162	ND		0.157	ND		0.17	ND		0.206
C-14	Bq/g	ND		0.0363	ND		0.0357	ND		0.036	ND		0.0364

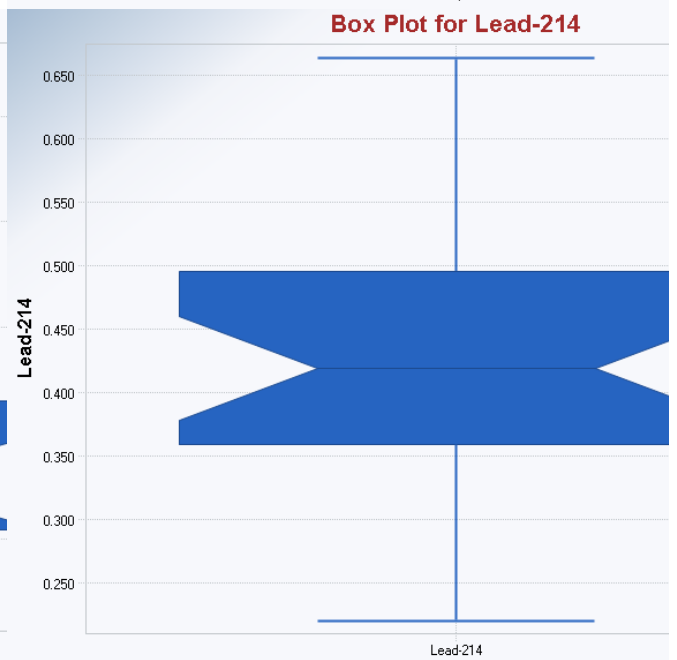
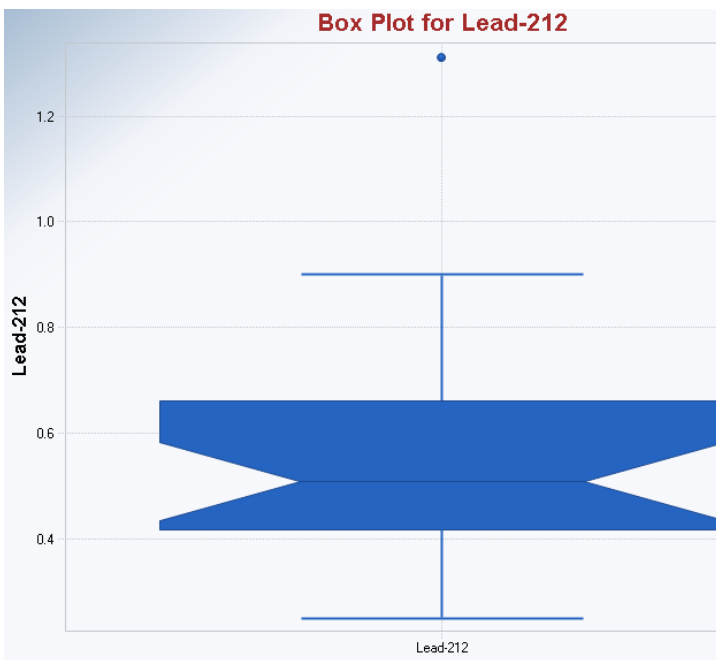
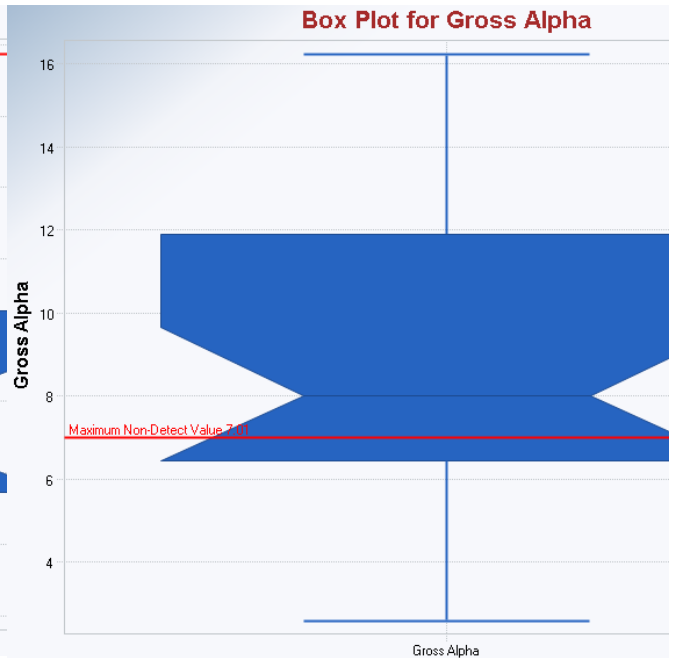
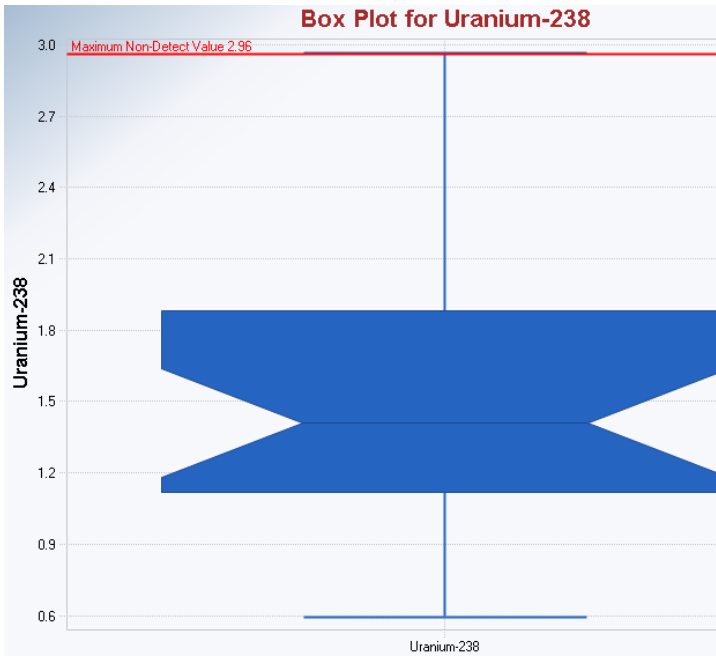
Note: MDA = Minimum Detectable Activity; ND = Non-detect (i.e., < MDA); all concentrations are per dry weight.

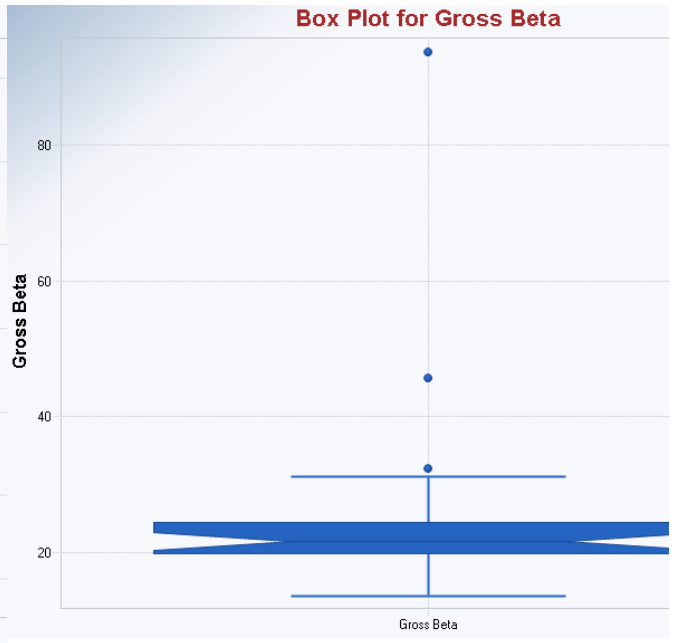
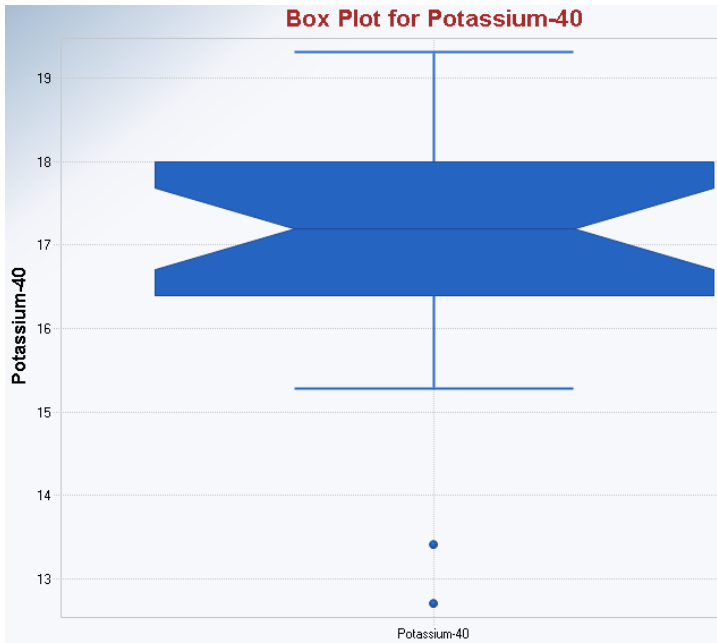
Appendix D Box Plots for Ottawa River Radiological Sediment Data near NPD

Note: Units are in shown in the data tables above; red lines represent maximum detection limit.









Sample ID	Amphipoda			Bivalvia		Coleoptera	Diptera			Ephemeroptera			Gastropoda			Hemiptera	Hirudinea	Hydrachnidia	Isopoda	Megaloptera		Odonata			Trichoptera						Nemata	Oligochaeta		Sample Biomass (g ; d.w.)
	Cragonyctidae	Gammaridae	Hyalellidae	Sphaeriidae	Unionidae	Elmidae	Ceratopogonidae	Chironomidea	Tipulidae	Baetidae	Caenidae	Ephemeridae	Hydrobiidae	Physidae	Valvatidae	Corixidae	Glossiphoniidae	Asellidae	Sialidae	Corydalidae	Gomphidae	Macromiidae	Gomphidae	Brachycentridae	Glossosomatidae	Heliopsychidae	Leptoceridae	Molannidae	Odontoceridae	Polycentropoda	Nemata	Naididae	Lumbriculidae	
NPD-1-18				12											2												4					12		0.0389
NPD-1-19				11				3	1						3												5					11		0.1251
NPD-1-20				20	1			5	1			2			1												2					11		0.0000
NPD-2-1																																		0.0316
NPD-2-2						8	2	55			3															2	1				4		0.0098	
NPD-2-3														2												1							0.0058	
NPD-2-4							1	26	1		4								2														0.0787	
NPD-2-5								13			5					1															2		0.0107	
NPD-2-6				1			1	5			3			2									1				1		1				0.0115	
NPD-2-7				3				14	1																	1					12		0.0208	
NPD-2-8				1				16																		2					19		0.0371	
NPD-2-9				5			1	7																		1					27		0.1447	
NPD-2-10				4	1			11	6							1															22		0.1157	
NPD-2-11				9				4	1		3								1							4	2				5		0.0156	
NPD-2-12				15			3	6																		4					7		0.0537	
NPD-2-13		4		8				19	12																	3					17	1	0.0277	
NPD-2-14	1			11		1		5	11																	3					18		0.0422	
NPD-2-15				12			1	6	3																	6					5		0.0276	
NPD-2-16				7				9	10		1	1														3			2		20		0.0464	

Sample ID	Amphipoda			Bivalvia		Coleoptera	Diptera			Ephemeroptera			Gastropoda			Hemiptera	Hirudinea	Hydrachnidia	Isopoda	Megaloptera			Odonata			Trichoptera							Nemata	Oligochaeta		Sample Biomass (g ; d.w.)
	Cragonyctidae	Gammaridae	Hyalellidae	Sphaeriidae	Unionidae	Elmidae	Ceratopogonidae	Chironomidea	Tipulidae	Baetidae	Caenidae	Ephemeridae	Hydrobiidae	Physidae	Valvatidae	Corixidae	Glossiphoniidae	Asellidae	Sialidae	Corydalidae	Gomphidae	Macromiidae	Gomphidae	Brachycentridae	Glossosomatidae	Heliopsychidae	Leptoceridae	Molannidae	Odontoceridae	Polycentropodida	Naididae	Lumbriculidae				
NPD-3-16				7				13			5	1																	1		11		0.0255			
NPD-3-17				20				8	2		2															2				24		0.0192				
NPD-3-18				8				5	2																	3		1	25		0.0073					
NPD-3-19				10							1																	1		6		0.0479				
NPD-3-20		2		20				8	28		2	1						1								2				21		0.0369				
NPD-4-1				1		1	3	32		1	6		1	1									1		1		1	1	2		0.1703					
NPD-4-2			1					3			1										1											0.0062				
NPD-4-3								3				4		2															1		0.0134					
NPD-4-4						3	5	31		1	1	2														2	1		2		0.0215					
NPD-4-5		1						11			7		1	3					1			1			2		3				0.0727					
NPD-4-6				3	2		2	5	1		3																				12.227					
NPD-4-7				6	2		1	12	1		1																1				14.304					
NPD-4-8				3	1		1	4			1																1		1		0.5675					
NPD-4-9					1		1	4			1																				0.0719					
NPD-4-10				1	1		2	4						1																	0.0382					
NPD-4-11				3				4	2		12																		8		0.0536					
NPD-4-12				5				5	21		6															1			10		0.0097					
NPD-4-13				6				5	4													1						1		1	0.0246					
NPD-4-14		1		5			4	8	12		12					1										2			13		0.0183					

Sample ID	Amphipoda			Bivalvia		Coleoptera	Diptera			Ephemeroptera			Gastropoda			Hemiptera	Hirudinea	Hydrachnidia	Isopoda	Megaloptera			Odonata			Trichoptera							Nemata	Oligochaeta		Sample Biomass (g ; d.w.)
	Cragonyctidae	Gammaridae	Hyalellidae	Sphaeriidae	Unionidae	Elmidae	Ceratopogonidae	Chironomidea	Tipulidae	Baetidae	Caenidae	Ephemeridae	Hydrobiidae	Physidae	Valvatidae	Corixidae	Glossiphoniidae	Asellidae	Sialidae	Corydalidae	Gomphidae	Macromiidae	Gomphidae	Brachycentridae	Glossosomatidae	Heliopsychidae	Leptoceridae	Molannidae	Odontoceridae	Polycentropodida		Naididae	Lumbriculidae			
NPD-4-15		1		6				15	40			5															1						13		0.0256	
NPD-4-16		6		16			1	9	16			3	1					2												1			17		0.0323	
NPD-4-17		82		11	1		1	65			1	1					24		1								2			23		24		8.5508		
NPD-4-18		3		17				14	24			5			2			1									3						13		0.0706	
NPD-4-19		1		17	2			13	25		1	3	2														2						11		0.0948	
NPD-4-20				23	1			4	8			4															1						9		0.0698	
NPD-5-1							1	21	2			16			8	1											1						4		0.0203	
NPD-5-2				2	2		1	51	16			12			8						2	1											1		0.1052	
NPD-5-3				2				43	10			13			7				1								1								0.0249	
NPD-5-4		1						11				7		1	3				1			1			2		3								0.0891	
NPD-5-5					2		1	15	2			17			12				1		1									1			1		14.607	
NPD-5-6				1	1			16				7															5		1				1		0.0359	
NPD-5-7				8	1			5	1			6															3						4		0.0035	
NPD-5-8				3				5				5			1																		1		0.0156	
NPD-5-9					1							2			1																				0.0976	
NPD-5-10				7	1			4	1			4															3						3		0.0095	
NPD-5-11	1			18	1			5	14			3																					9		0.0225	
NPD-5-12				12				2	12																		1						25		2.2450	
NPD-5-13				12				4	20																		2						11	3	0.0106	

Sample ID	Amphipoda			Bivalvia		Coleoptera	Diptera			Ephemeroptera			Gastropoda			Hemiptera	Hirudinea	Hydrachnidia	Isopoda	Megaloptera			Odonata			Trichoptera							Nemata		Oligochaeta		Sample Biomass (g ; d.w.)	
	Cragonyctidae	Gammaridae	Hyalellidae	Sphaeriidae	Unionidae	Elmidae	Ceratopogonidae	Chironomidea	Tipulidae	Baetidae	Caenidae	Ephemeridae	Hydrobiidae	Physidae	Valvatidae	Corixidae	Glossiphoniidae	Asellidae	Sialidae	Corydalidae	Gomphidae	Macromiidae	Gomphidae	Brachycentridae	Glossosomatidae	Heliopsychidae	Leptoceridae	Molannidae	Odontoceridae	Polycentropodida		Naididae	Lumbriculidae					
NPD-7-12				10				21			6	1	1																					2		2		0.0857
NPD-7-13		1		4				15	9		5																							20		0.0332		
NPD-7-14				6		2		13		1	2	1														3							5	8	0.1159			
NPD-7-15				7		2		19	2		3	1																								0.0139		
NPD-7-16				3		3		11					1																							0.0626		
NPD-7-17											1																						3		3		0.0254	
NPD-7-18				35				3			3			1												3							3		3		0.0059	
NPD-7-19				11				1																									1		8		0.0488	
NPD-7-20				8				2						1																				2		0.0206		
NPD-1-1				11				5			1	1																						2		1		0.0222

Appendix F Benthic Invertebrate Community Indices for all Samples

Sample ID	Total Count	Density (No./m ²)	Biomass (g/m ²) d.w.	S	%E	%P	%T	%EPT	HBI	D	'H
NPD-1-1	110	2110	0.426	4	0.00	0.00	0.91	0.91	4.51	0.929	0.194
NPD-1-2	167	3203	3.215	7	0.00	0.00	1.80	1.80	6.80	0.907	0.272
NPD-1-3	66	1266	2.708	8	1.52	0.00	3.03	4.55	2.69	0.653	0.833
NPD-1-4	83	1592	0.679	6	0.00	0.00	2.41	2.41	3.41	0.819	0.461
NPD-1-5	29	556	1.101	6	3.45	0.00	6.90	10.35	1.13	0.46	1.151
NPD-1-6	7	134	0.036	6	0.00	0.00	0.00	0.00	0.29	0.219	1.668
NPD-1-7	33	633	3.333	8	0.00	0.00	15.15	15.15	1.38	0.258	1.636
NPD-1-8	25	480	0.366	9	0.00	0.00	8.00	8.00	0.94	0.162	1.968
NPD-1-9	8	153	1.017	5	0.00	0.00	37.50	37.50	0.25	0.25	1.494
NPD-1-10	95	1822	0.731	9	1.05	0.00	4.21	5.26	4.08	0.341	1.434
NPD-1-11	40	767	0.568	7	0.00	0.00	2.50	2.50	1.52	0.258	1.571
NPD-1-12	0	0	0.000	0	-	-	-	-	-	-	-
NPD-1-13	18	345	0.056	7	0.00	0.00	11.11	11.11	0.72	0.289	1.488
NPD-1-14	1	19	0.006	1	0.00	0.00	0.00	0.00	0.05	-	-
NPD-1-15	1	19	0.230	1	0.00	0.00	100.00	100.00	0.02	-	-
NPD-1-16	70	1343	1.041	6	0.00	0.00	14.29	14.29	2.73	0.282	1.466
NPD-1-17	30	575	0.364	4	0.00	0.00	13.33	13.33	1.19	0.342	1.182
NPD-1-18	34	652	0.746	6	0.00	0.00	14.71	14.71	1.32	0.247	1.544
NPD-1-19	43	825	2.399	8	0.00	0.00	4.65	4.65	1.67	0.301	1.503
NPD-1-20	0	0	0.000	0	-	-	-	-	-	-	-
NPD-2-1	76	1458	0.606	7	3.95	0.00	3.95	7.90	2.88	0.555	1.002
NPD-2-2	3	58	0.188	2	0.00	0.00	33.33	33.33	0.12	0.556	0.637
NPD-2-3	34	652	0.111	5	11.76	0.00	0.00	11.76	1.26	0.604	0.831
NPD-2-4	21	403	1.509	4	23.81	0.00	0.00	23.81	0.64	0.451	1.008
NPD-2-5	15	288	0.205	8	20.00	0.00	13.33	33.33	0.52	0.191	1.859
NPD-2-6	32	614	0.221	5	0.00	0.00	3.13	3.13	1.30	0.365	1.174
NPD-2-7	38	729	0.399	4	0.00	0.00	5.26	5.26	1.65	0.431	0.962
NPD-2-8	41	786	0.712	5	0.00	0.00	2.44	2.44	1.82	0.479	1.015
NPD-2-9	45	863	2.775	6	0.00	0.00	0.00	0.00	1.83	0.325	1.347
NPD-2-10	29	556	2.219	8	10.34	0.00	20.69	31.03	0.99	0.182	1.864
NPD-2-11	35	671	0.299	5	0.00	0.00	11.43	11.43	1.29	0.274	1.446
NPD-2-12	64	1228	1.030	7	0.00	0.00	4.69	4.69	2.36	0.255	1.564
NPD-2-13	50	959	0.531	7	0.00	0.00	6.00	6.00	1.79	0.241	1.59
NPD-2-14	33	633	0.809	6	0.00	0.00	18.18	18.18	1.15	0.231	1.598
NPD-2-15	53	1017	0.529	8	1.89	0.00	9.43	11.32	1.95	0.23	1.687
NPD-2-16	67	1285	0.890	9	2.99	0.00	1.49	4.48	2.36	0.231	1.654
NPD-2-17	73	1400	0.543	8	1.37	0.00	6.85	8.22	2.32	0.246	1.623

Sample ID	Total Count	Density (No./m ²)	Biomass (g/m ²) d.w.	S	%E	%P	%T	%EPT	HBI	D	'H
NPD-2-18	57	1093	2.724	7	0.00	0.00	7.02	7.02	2.05	0.195	1.773
NPD-2-19	71	1362	1.143	8	0.00	0.00	7.04	7.04	2.64	0.184	1.839
NPD-2-20	53	1017	4.534	11	0.00	0.00	13.21	13.21	1.92	0.146	2.092
NPD-3-1	9	173	2.445	5	11.11	0.00	0.00	11.11	0.36	0.284	1.427
NPD-3-2	52	997	0.153	8	1.92	0.00	7.69	9.61	1.96	0.244	1.603
NPD-3-3	12	230	0.349	4	0.00	0.00	8.33	8.33	0.49	0.319	1.237
NPD-3-4	1	19	0.006	1	0.00	0.00	0.00	0.00	0.04	-	-
NPD-3-5	8	153	0.113	4	0.00	0.00	0.00	0.00	0.30	0.281	1.321
NPD-3-6	21	403	1.063	5	0.00	0.00	4.76	4.76	0.80	0.447	1.074
NPD-3-7	25	480	2.190	8	4.00	0.00	12.00	16.00	0.82	0.462	1.272
NPD-3-8	18	345	0.880	7	5.56	0.00	5.56	11.12	0.65	0.346	1.457
NPD-3-9	16	307	0.451	6	12.50	0.00	6.25	18.75	0.58	0.266	1.511
NPD-3-10	12	230	0.115	3	0.00	0.00	0.00	0.00	0.45	0.708	0.566
NPD-3-11	48	921	0.585	7	22.92	0.00	4.17	27.09	1.55	0.238	1.626
NPD-3-12	10	192	0.829	5	0.00	0.00	10.00	10.00	0.40	0.28	1.419
NPD-3-13	10	192	0.113	4	50.00	0.00	0.00	50.00	0.27	0.36	1.168
NPD-3-14	18	345	0.761	5	0.00	0.00	11.11	11.11	0.64	0.346	1.268
NPD-3-15	38	729	0.364	6	13.16	0.00	2.63	15.79	1.39	0.254	1.496
NPD-3-16	62	1189	0.489	6	3.23	0.00	3.23	6.46	2.38	0.313	1.354
NPD-3-17	44	844	0.368	6	0.00	0.00	6.82	6.82	1.84	0.376	1.288
NPD-3-18	18	345	0.140	4	5.56	0.00	5.56	11.12	0.70	0.426	1.014
NPD-3-19	88	1688	0.919	9	2.27	0.00	2.27	4.54	2.79	0.236	1.643
NPD-3-20	53	1017	0.708	14	13.21	0.00	7.55	20.76	1.85	0.386	1.587
NPD-4-1	6	115	3.266	4	16.67	0.00	0.00	16.67	0.23	0.333	1.243
NPD-4-2	10	192	0.119	4	0.00	0.00	0.00	0.00	0.41	0.3	1.28
NPD-4-3	48	921	0.257	9	4.17	0.00	10.42	14.59	1.82	0.438	1.331
NPD-4-4	30	575	0.412	9	23.33	0.00	16.67	40.00	0.93	0.218	1.802
NPD-4-5	16	307	1.394	6	18.75	0.00	0.00	18.75	0.53	0.203	1.684
NPD-4-6	24	460	234.512	7	4.17	0.00	4.17	8.34	0.89	0.326	1.43
NPD-4-7	13	249	274.358	7	7.69	0.00	7.69	15.38	0.45	0.208	1.748
NPD-4-8	7	134	10.885	4	14.29	0.00	0.00	14.29	0.26	0.388	1.154
NPD-4-9	9	173	1.379	5	0.00	0.00	0.00	0.00	0.36	0.284	1.472
NPD-4-10	29	556	0.733	5	41.38	0.00	0.00	41.38	0.90	0.282	1.413
NPD-4-11	48	921	1.028	6	12.50	0.00	2.08	14.58	1.37	0.273	1.5
NPD-4-12	18	345	0.186	6	0.00	0.00	5.56	5.56	0.59	0.247	1.538
NPD-4-13	58	1112	0.472	9	20.69	0.00	3.45	24.12	1.72	0.169	1.912
NPD-4-14	81	1554	0.351	7	6.17	0.00	1.23	7.40	2.32	0.314	1.428
NPD-4-15	72	1381	0.491	10	4.17	0.00	1.39	5.56	2.51	0.18	1.887

Sample ID	Total Count	Density (No./m ²)	Biomass (g/m ²) d.w.	S	%E	%P	%T	%EPT	HBI	D	'H
NPD-4-16	246	4718	0.620	12	0.81	0.00	10.16	10.97	9.81	0.229	1.713
NPD-4-17	84	1611	164.004	9	5.95	0.00	3.57	9.52	2.65	0.19	1.837
NPD-4-18	77	1477	1.354	10	5.19	0.00	2.60	7.79	2.43	0.207	1.801
NPD-4-19	50	959	1.818	7	8.00	0.00	2.00	10.00	1.69	0.283	1.52
NPD-4-20	55	1055	1.339	8	29.09	0.00	1.82	30.91	1.86	0.269	1.547
NPD-5-1	98	1880	0.389	10	12.24	0.00	2.04	14.28	3.33	0.334	1.486
NPD-5-2	77	1477	2.018	7	16.88	0.00	1.30	18.18	2.65	0.367	1.316
NPD-5-3	30	575	0.478	9	23.33	0.00	16.67	40.00	0.93	0.218	1.802
NPD-5-4	53	1017	1.709	10	32.08	0.00	1.89	33.97	1.77	0.239	1.68
NPD-5-5	39	748	280.155	7	17.95	0.00	15.38	33.33	1.36	0.326	1.402
NPD-5-6	30	575	0.689	7	20.00	0.00	10.00	30.00	1.01	0.194	1.751
NPD-5-7	15	288	0.067	5	33.33	0.00	0.00	33.33	0.50	0.271	1.415
NPD-5-8	4	77	0.299	3	50.00	0.00	0.00	50.00	0.12	0.375	1.04
NPD-5-9	23	441	1.872	7	17.39	0.00	13.04	30.43	0.76	0.191	1.775
NPD-5-10	51	978	0.182	7	5.88	0.00	0.00	5.88	1.65	0.245	1.577
NPD-5-11	52	997	0.432	5	0.00	0.00	1.92	1.92	1.94	0.34	1.23
NPD-5-12	53	1017	43.059	6	0.00	0.00	3.77	3.77	1.67	0.257	1.522
NPD-5-13	52	997	0.203	7	5.77	0.00	7.69	13.46	1.93	0.219	1.68
NPD-5-14	16	307	0.786	5	0.00	0.00	0.00	0.00	0.57	0.227	1.527
NPD-5-15	27	518	0.244	7	11.11	0.00	3.70	14.81	0.77	0.331	1.477
NPD-5-16	11	211	0.058	5	9.09	0.00	0.00	9.09	0.43	0.355	1.295
NPD-5-17	14	269	0.284	5	0.00	0.00	7.14	7.14	0.57	0.347	1.27
NPD-5-18	17	326	0.311	5	0.00	0.00	5.88	5.88	0.69	0.287	1.375
NPD-5-19	32	614	0.293	8	12.50	0.00	3.13	15.63	1.18	0.221	1.707
NPD-5-20	34	652	0.299	6	0.00	0.00	0.00	0.00	1.32	0.175	1.768
NPD-6-1	81	1554	0.623	13	12.35	0.00	4.94	17.29	3.01	0.233	1.865
NPD-6-2	10	192	0.815	7	10.00	0.00	10.00	20.00	0.29	0.16	1.887
NPD-6-3	60	1151	3.548	8	18.33	0.00	0.00	18.33	1.91	0.218	1.729
NPD-6-4	52	997	599.927	9	21.15	0.00	3.85	25.00	1.76	0.246	1.742
NPD-6-5	4	77	0.470	3	50.00	0.00	0.00	50.00	0.10	0.375	1.04
NPD-6-6	29	556	18.894	6	34.48	0.00	0.00	34.48	0.85	0.246	1.569
NPD-6-7	23	441	0.410	5	56.52	0.00	4.35	60.87	0.60	0.388	1.193
NPD-6-8	26	499	6.464	9	30.77	0.00	3.85	34.62	0.68	0.178	1.936
NPD-6-9	27	518	0.341	6	14.81	0.00	0.00	14.81	0.81	0.226	1.609
NPD-6-10	20	384	0.666	5	10.00	0.00	0.00	10.00	0.79	0.28	1.419
NPD-6-11	1	19	0.044	1	0.00	0.00	0.00	0.00	0.04	-	-
NPD-6-12	0	0	0.000	0	-	-	-	-	-	-	-
NPD-6-13	35	671	0.140	6	28.57	0.00	0.00	28.57	0.86	0.29	1.445

Sample ID	Total Count	Density (No./m ²)	Biomass (g/m ²) d.w.	S	%E	%P	%T	%EPT	HBI	D	'H
NPD-6-14	20	384	0.159	5	40.00	0.00	10.00	50.00	0.51	0.275	1.415
NPD-6-15	25	480	0.148	4	36.00	0.00	0.00	36.00	0.88	0.318	1.207
NPD-6-16	20	384	0.437	5	30.00	0.00	10.00	40.00	0.65	0.247	1.493
NPD-6-17	22	422	0.363	5	18.18	0.00	9.09	27.27	0.68	0.27	1.417
NPD-6-18	17	326	0.320	6	5.88	0.00	0.00	5.88	0.72	0.329	1.425
NPD-6-19	11	211	0.412	4	36.36	0.00	27.27	63.63	0.22	0.289	1.295
NPD-6-20	21	403	1.063	10	9.52	0.00	14.29	23.81	0.68	0.129	2.174
NPD-7-1	31	595	0.378	8	9.68	0.00	0.00	9.68	1.18	0.222	1.772
NPD-7-2	18	537	11.427	6	5.56	0.00	5.56	3.71	0.72	0.284	1.475
NPD-7-3	28	537	1.496	6	0.00	0.00	0.00	0.00	1.13	0.401	1.222
NPD-7-4	13	249	1.976	6	0.00	0.00	23.08	23.08	0.45	0.278	1.525
NPD-7-5	28	537	4.126	4	0.00	0.00	0.00	0.00	1.11	0.355	1.158
NPD-7-6	96	1841	2.833	13	6.25	0.00	3.13	9.38	3.33	0.189	1.959
NPD-7-7	60	1151	6.437	9	3.33	0.00	0.00	3.33	2.42	0.265	1.664
NPD-7-8	57	1093	10.219	10	12.28	0.00	0.00	12.28	2.15	0.236	1.709
NPD-7-9	58	1112	1.072	9	10.34	0.00	6.90	17.24	2.05	0.193	1.837
NPD-7-10	74	1419	0.901	5	6.76	0.00	0.00	6.76	2.88	0.468	1.101
NPD-7-11	43	825	0.368	7	13.95	0.00	4.65	18.60	1.59	0.318	1.424
NPD-7-12	55	1055	1.644	7	9.09	0.00	1.82	10.91	2.04	0.248	1.573
NPD-7-13	33	633	0.637	9	9.09	0.00	9.09	18.18	1.22	0.186	1.888
NPD-7-14	34	652	2.223	6	8.82	0.00	0.00	8.82	1.21	0.37	1.302
NPD-7-15	18	345	0.267	4	0.00	0.00	0.00	0.00	0.68	0.432	1.059
NPD-7-16	6	115	1.201	3	16.67	0.00	50.00	66.67	0.22	0.388	1.004
NPD-7-17	53	1017	0.487	7	5.66	0.00	11.32	16.98	1.80	0.489	1.169
NPD-7-18	22	422	0.113	4	0.00	0.00	4.55	4.55	0.85	0.424	0.996
NPD-7-19	14	269	0.936	4	0.00	0.00	0.00	0.00	0.51	0.432	1.072
NPD-7-20	21	403	0.395	6	4.67	0.00	9.52	14.19	0.77	0.347	1.339

Note:

S = Taxa Richness

%E = % Ephemeroptera

%P = % Plecoptera

%T = % Trichoptera

%EPT = % Ephemeroptera + % Plecoptera + % Trichoptera

HBI = Hilsenhoff Biotic Index

D = Simpson's Index

H = Shannon-Wiener Index