



Norman Wells Operations 2017 Water Use Report

Water Licence S13L1-007

Imperial Oil Resources N.W.T. Limited
Bag 5000, 750 Mackenzie Drive,
Norman Wells, Northwest Territories
X0E 0V0, Canada

Switch Board: (867) 587-3100



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GLOSSARY

Term	Description
Acute Lethality	An effluent is deemed acutely lethal if the undiluted (100%) effluent kills 50% or more of the fish or <i>Daphnia magna</i> in the test. Biological test method: Acute Lethality Test Using Rainbow Trout Report EPS 1/RM/9 July 1990 (with May 1996 and May 2007 amendments) and Acute Lethality of Effluents to <i>Daphnia magna</i> EPS 1/RM/14 Second Edition December 2000, or as may be amended from time to time.
Average Concentration	The running average of any four consecutive analytical results submitted to the Board in accordance with the sampling and analysis requirements specified in the “Surveillance Network Program”.
Bathymetric Survey	A survey used to measure the topography on the bottom of a waterbody. Imperial conducts these surveys on the Mackenzie River to help identify and understand what changes have occurred on the River bottom.
Central Processing Facility (CPF)	The plant where oil, gas, and produced water, are collected from the oilfield and separated.
Exceedance	Results are above the maximum concentrations listed in Water Licence S13L1-007
Flowline	A line that is used to transport fluids from a well to a production facility or vice versa, and includes intrafield export and all gathering lines
Phenols	Any of a family of organic compounds characterized by a hydroxyl (-OH) group attached to a carbon atom that is part of an aromatic ring. Phenols are widely used in household products such as cleaners and mouthwash. They are commonly found in nature and can be obtained from essential oils of plants. Phenols can also be obtained from the distillation of coal tar or crude petroleum. (Source: www.britannica.com).
Produced Water	Water extracted from the reservoir as a mixture with oil and gas
SNP Station S13L1-007-1	The Surveillance Network Station for the Central Processing Facility intake water from the Mackenzie River.

SNP Station S13L1-007-2	The Surveillance Network Station for the Central Processing Facility cooling flow return line to the Mackenzie River.
Surface Water Run-Off Facilities	The Refinery Impounding Basin, Battery 3 Impounding Basin (also known as LT 11), Refinery Water Flood Basin, CPF Impounding Area (also known as LT 2), Miscellaneous Mainland Impounding Areas, Miscellaneous Bear Island Impounding Areas, Miscellaneous Goose Island Impounding Areas, and associated ditches provided for the collection, storage, and discharge of surface run-off waters from the Norman Wells Operation.
Surveillance Network Program	A series of network of devices or sampling points designed to test environmental conditions for comparison against baseline data obtained from a point or area designated as a control. This is a method of tracking and identifying the spread of deleterious substances in the environment.
Waste	Waste as defined by Section 2 of the <i>Northwest Territories Waters Act</i>
Waterflood	The injections of water into the Norman Wells oilfield reservoir for pressure maintenance and enhanced oil production
Water Intake	The wetwell pump and associated facilities installed in the Mackenzie River and the water line to the Central Processing Facility.

ACRONYMS

A&R	Abandonment and Reclamation; Abandonment and Restoration
CPF	Central Processing Facility
ERP	Emergency Response Plan
G.I.T	Goose Island Terminal
INAC	Indigenous and Northern Affairs Canada
n/a	Not applicable
NEB	National Energy Board
NWO	Norman Wells Operations
SCARP	Spill Contingency and Response Plan
SLWB	Sahtu Land and Water Board
SNP	Surveillance Network Program
SWROF	Surface Water Run-off Facilities
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
WMP	Waste Management Plan

1 INTRODUCTION

As required by Licence S13L1-007 (Part B: Item 11), the Licensee shall file an Annual Report with the Board not later than March 31st for the previous calendar year. Details on the licence requirements and corresponding applicable section(s) within the report can be found below.

Licence Requirement	Section of Report
a) The monthly and annual quantities in cubic meters of freshwater obtained from all sources	Section 3
b) The monthly and annual quantities in cubic meters of each and all Waste discharged	Water Discharges – Section 3, 4 & 5
c) The monthly and annual quantity in cubic meters of Waste discharged to the Mackenzie River at SNP station S13L1-007-2	Section 3
d) The monthly and annual quantities in cubic meters of freshwater and produced water injected to the Waterflood	Section 4
e) The monthly and annual quantities in cubic meters of Waters contained and discharged from the Surface Water Run-off Facilities	Section 5
f) The monthly and annual quantity in cubic meters of Produced Water recovered from the oilfield reservoir	Section 4
g) Tabular summaries of all data generated under the Surveillance Network Program (SNP)	Appendix A & B
h) A list of unauthorized discharges, identification of waterbodies affected and the current status of mitigation measures	Section 7
i) An annual drilling schedule for the upcoming year to the Board	Section 8
j) The annual amounts in cubic meters of water and Waste generated from all drilling activities	Section 8
k) A summary of measures taken to minimize net water withdrawals from the hydrological cycle as required in Part D, Item 4 of the licence	Section 3, 4 & 5
l) Details on the handling, storage, treatment and disposal of Waste from the Norman Wells Proven Area	Section 9
m) A review of spill training and communication exercises of the previous year, including the success and failure, as well as recommendations for improvement	Section 10
n) A general schedule for any planned oil spill exercises for the following year	Section 10
o) A summary of any Modification(s) and / or major maintenance work carried out as per Part G of the licence	Section 11
p) Any other details on Water(s) use or Waste(s) disposal requested by the Board no later than March 31 st of the following calendar year reported	Section 6
q) A summary of all spills and Unauthorized Discharges and follow up actions taken that occurred during the previous calendar year	Section 7

2 SITE SUMMARY

Imperial Oil Resources N.W.T. Limited (Imperial) is an upstream oil and gas facility located approximately 700 km northwest of Yellowknife, Northwest Territories (NT). Operations include a central processing facility, which receives production from the mainland (along the north-eastern shore of the Mackenzie River), natural islands (Bear and Goose Island), and six artificial islands.

Imperial holds a Type A Water Licence S13L1-007 which was issued by the Sahtu Land and Water Board (SLWB) on March 5, 2015 and valid for 10 years. The licence serves to regulate the use of water and the deposits of waste as it relates to Imperial's site. Imperial also holds a National Energy Board Operations Authorization 1210-001 (OA) issued December 31, 2014 and valid for 10 years. This authorization serves to regulate the oil and gas activity on Imperial's federally regulated site.

A key piece of Imperial's Norman Wells Operations and the Type A licence is the Surveillance Network Program (SNP). The SNP is detailed in Annex A of the licence and sets out the requirements for the three branches of the SNP program including but not limited to sampling expectations, water quality release limits and reporting. The three branches of the SNP are listed below:

- Freshwater – Mackenzie River water
- Surface Water – Snow and rainwater
- Groundwater – Below surface water

For more information on the SNP please refer to the Water Licence S13L1-007, Annex A. All other conditions are described above in Section 1.

In November 2016, Imperial was notified of Enbridge's Line 21 being temporarily suspended due to a slope instability concern at a Mackenzie River pipeline crossing near the Fort Simpson, N.W.T. area. Line 21 is the only available crude oil transport option and is planned to remain out of service until a repair can be complete. As a result in late November 2016, Imperial initiated efforts to reduce crude oil production to ensure that storage tanks would not exceed capacity. During this time, options for long term operations were being evaluated and in February/early March 2017, Imperial safely completed a temporary shutdown of the Norman Wells Operation until a repair to Enbridge's Line 21 can be executed.

The Imperial Norman Wells Operation remained in a temporary shutdown state for the remainder of 2017. Ongoing startup activities are taking place and being communicated with the NEB as Imperial works toward a potential startup near the end of 2018.

All submissions to the SLWB under the Water Licence S13L1-007 are available on the SLWB's [Public Registry](#).

3 SURVEILLANCE NETWORK PROGRAM (SNP) - FRESHWATER

The Surveillance Network Program (SNP) - Freshwater covers the testing and analysis of the river water entering and leaving the Central Processing Facility (CPF). There are two sampling locations, referred to as SNP Stations, included in this SNP program. The stations are S13L-007-1 (CPF Inlet) and S13L1-007-2 (CPF Outlet). The CPF Inlet is the point at which the freshwater from the Mackenzie River enters the facility and CPF Outlet (or effluent) is the last point before return back to the Mackenzie River. This is described in more detail in Section 3.3.

A summary of information on that program for the 2017 year is described in the sections below.

3.1 Mackenzie River Withdrawal and Return Volumes

In 2017, Imperial withdrew approximately 215 thousand m^3 of water from the Mackenzie River (maximum licence allowable limit is 3.5 million m^3). All of this water was used for cooling in the Central Processing Facility (CPF) (Figure A). Once the water was used for cooling, an estimated 177 thousand m^3 was discharged back to the Mackenzie River and an estimated 38 thousand m^3 was injected into the production reservoir to maintain reservoir pressure.

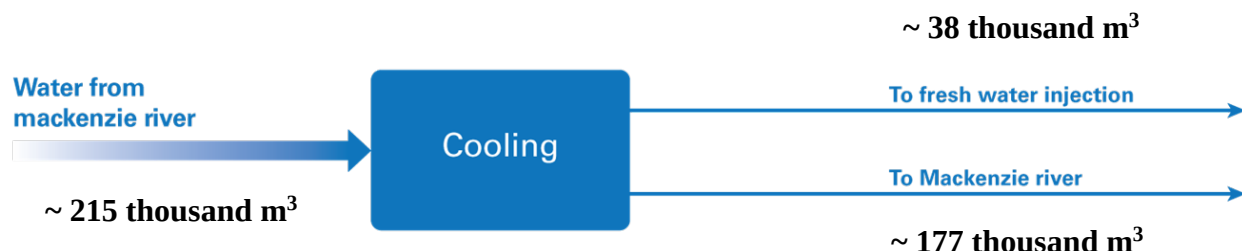


Figure A: Mackenzie River Water Uses

Details on the monthly quantities of freshwater withdrawn and discharged to the Mackenzie River can be found below in Table A. All injection volumes can be found in Table C. Figure B depicts the volume of water withdrawn from and returned to the Mackenzie River each year over a five year period. Freshwater intake and demand for cooling water will generally decline over time as production volumes decline.

Table A: 2017 CPF Inlet and CPF Outlet Volumes

Month	CPF Inlet (S13L1-007-1) (m ³)	CPF Outlet (S13L1-007-2) (m ³)
Jan	118,022	95,814
Feb	97,008	81,269
Mar	0	0
Apr	0	0
May	0	0
June	0	0
July	0	0
Aug	0	0
Sep	0	0
Oct	0	0
Nov	0	0
Dec	0	0
Total	215,030	177,083

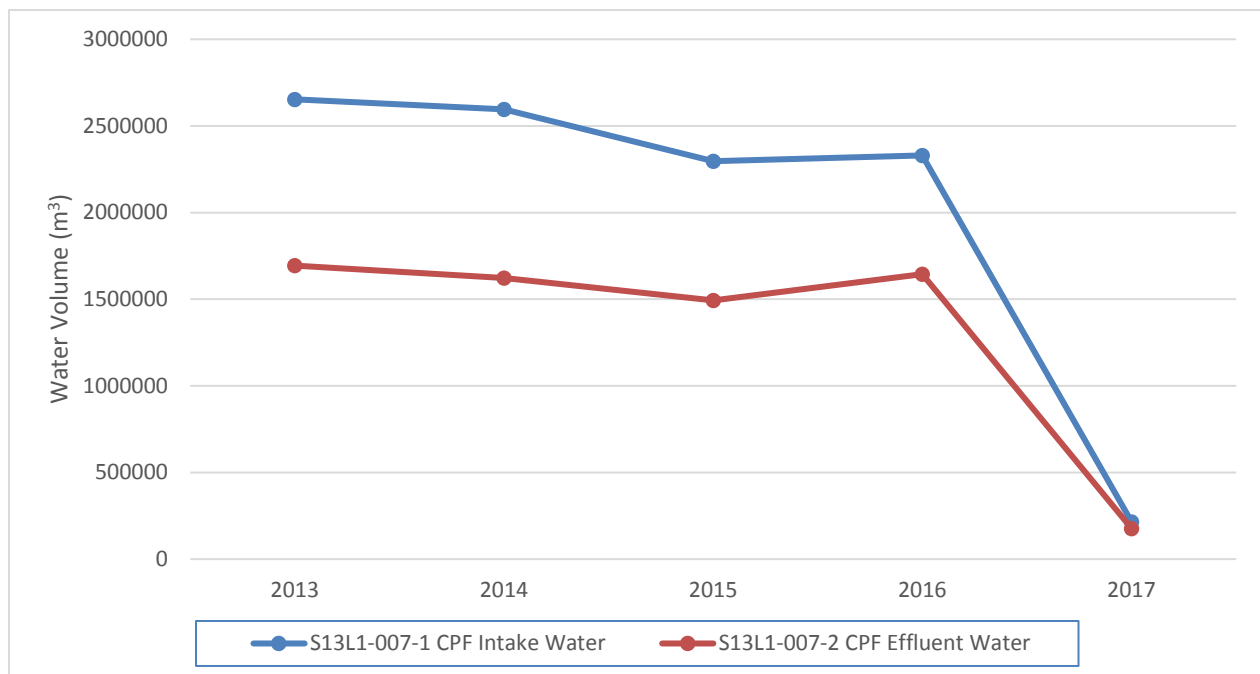


Figure B: Mackenzie River Withdrawal and Return Volumes (2013 – 2017)

3.2 Volumes of Water Withdrawn from Other Sources

In 2017, Imperial did not withdraw any water from other sources.

3.3 Freshwater Cooling Loop Explained

As water enters the CPF facility it is tested as per licence conditions at the CPF Inlet (Figure C). After testing, chlorine is added to kill bacteria in the piping and prevent damage to the equipment. This is the same type of chlorine used to disinfect drinking water systems. No other chemicals are added to the cooling water.

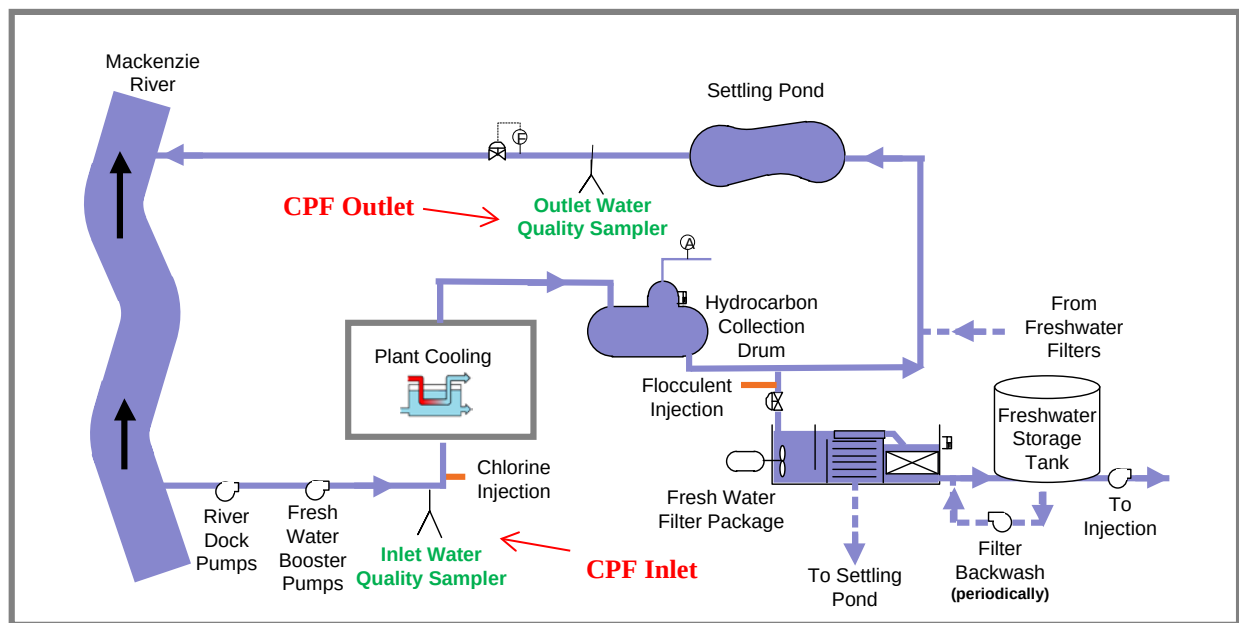


Figure C: Freshwater Cooling Loop Flow Diagram

Once a water sample has been taken and chlorine is added, the water then flows through heat exchangers within the plant for the sole purposes of cooling. The Mackenzie River water does not come into contact with any process fluids during cooling. There is no chance for the water to become contaminated because the water and oil is separated by a steel barrier (Figure D). After cooling, the water passes through the hydrocarbon collection drum. This hydrocarbon collection drum is engineer designed with sensors that can detect light hydrocarbons. It is also equipped with automatic shut in valves as a preventative measure in the unlikely event that light hydrocarbons were to be detected in the freshwater (e.g. exchanger failure).

Once the water has passed through the hydrocarbon collection drum it either goes to the field for injection into the reservoir or to the settling pond where it is returned to the Mackenzie River. As the water is released from the settling pond it is tested as per licence conditions at a testing location is referred to as the CPF Outlet (Figure C).

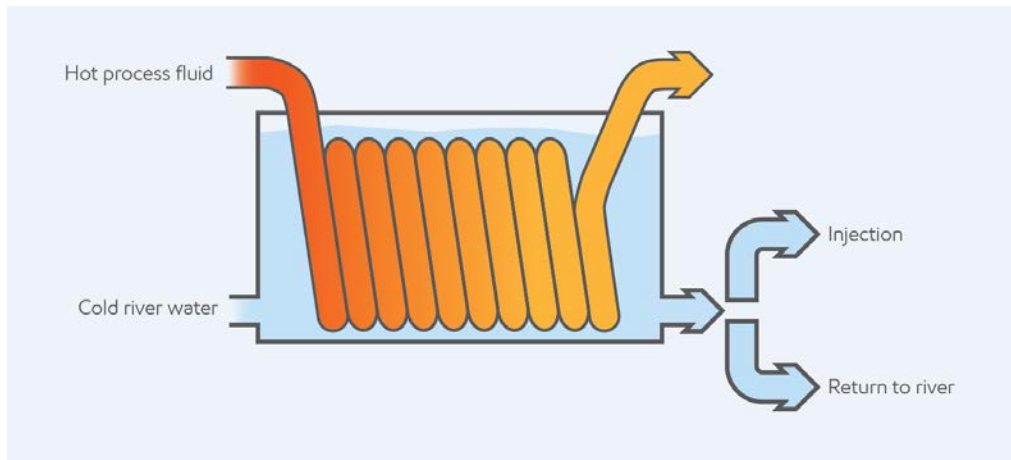


Figure D: Simple Heat Exchanger

3.4 SNP – Freshwater Data Summary

All water results are reported to the SLWB as per licence conditions in the Monthly Water Use Report and are provided annually in this report (Appendix A).

In 2017, there were no exceedances of any of the water licence requirements.

4 FRESHWATER AND PRODUCED WATER INJECTION

In order to maintain a constant pressure in the reservoir, all volumes removed from the producing reservoir must be replaced. Pressure is maintained by injecting fluid (such as produced water or freshwater) into the reservoir through injection wells. This is referred to as a waterflood. Without water injection the reservoir pressure would fall and production would quickly decline.

Water that is generated with the production of oil is called produced water and is re-injected into the reservoir. The volume of produced water is not enough to replace the amount of oil recovered; therefore, freshwater is used to supplement injection volumes required. The total volume of water injected in 2017 was approximately 148 thousand m³ and was made up of both freshwater and produced water (Table B).

Table B: 2017 Freshwater and Produced Water Injection Volumes

Month	Freshwater Injection (m ³)	Produced Water Injection (m ³)	Total Water Injection (m ³)
Jan	22,208	62,027	84,235
Feb	15,739	48,471	64,209
Mar	0	0	0
Apr	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
Aug	0	0	0
Sep	0	0	0
Oct	0	0	0
Nov	0	0	0
Dec	0	0	0
Total	37,947	110,498	148,444

As waterfloods mature, the produced water to oil ratio from the wells typically increase resulting in increased produced water volumes with time. As a result, the volume of produced water injection increases and the demand for freshwater injection decreases. This is visually highlighted in Figure E.

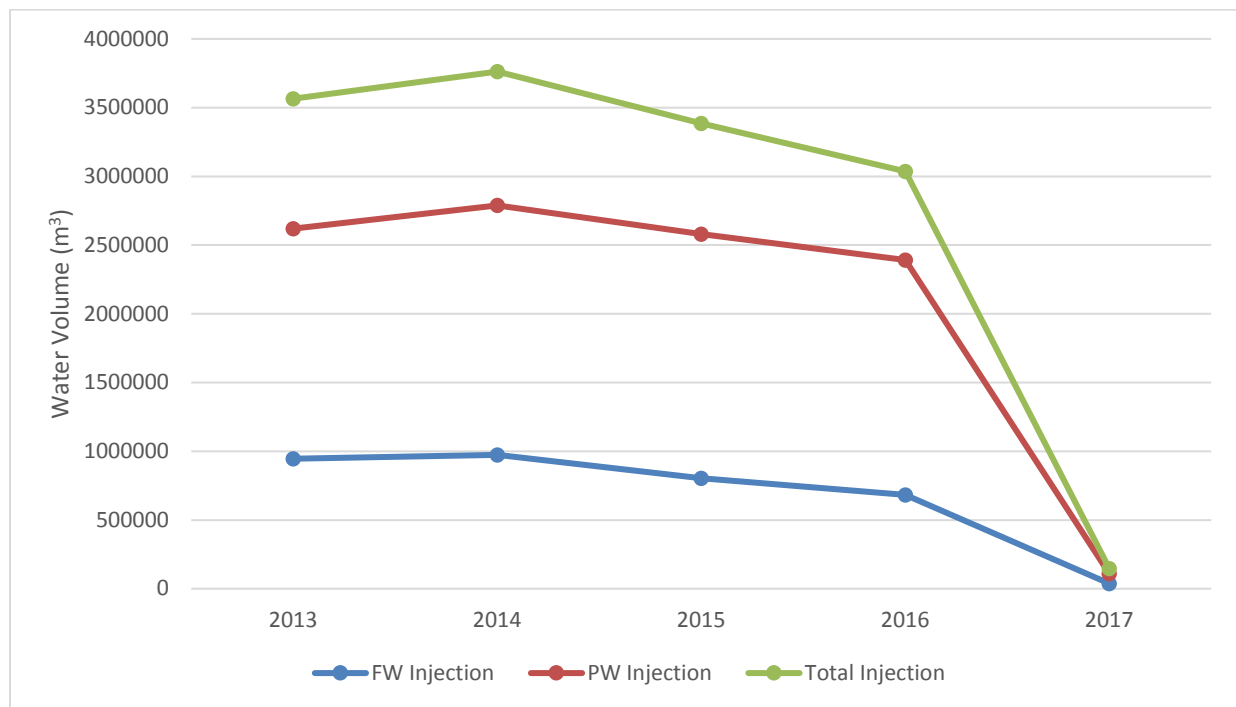


Figure E: Freshwater and Produced Water Injection Volumes (2013 - 2017)

5 SURVEILLANCE NETWORK PROGRAM (SNP) – SURFACE WATER

The Surveillance Network Program (SNP) – Surface Water covers the testing and analysis of surface water run-off facilities. The major elements of the program include:

- collecting representative samples from surface water runoff facilities for field testing and/or laboratory analysis; and
- performing controlled releases of surface water from runoff facilities that meets the guidelines in the Water Licence.

5.1 Surface Water Runoff Facilities (SWROF) Release Volumes

In 2017, 12,638 m³ of surface water was released from impound basins back to the environment (Table C).

Another 1,709 m³ of surface water was released back to the environment from ditches and bunkers on Goose Island and the Mainland (Table C).

Table C: 2017 SWROF Release Volumes

Month	CPF Impound	Mainland/ Bear Island/ Goose Island	LT 11 Impound	Refinery Impound	Refinery Water Flood Impound	Drilling Sumps	Other SWROF
Jan	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0
May	580	190	660	6,516	0	0	0
June	0	985	0	0	0	0	0
July	0	492	0	1,476	294	0	0
Aug	0	0	0	1,590	70	0	0
Sep	254	42	0	1,198	0	0	0
Oct	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0
Total	834	1,709	660	10,780	364	0	0

5.2 SNP – Surface Water Data Summary

There were no exceedances of water quality or uncontrolled releases in 2017.

All water results are reported to the SLWB as per licence conditions in the Monthly Water Use Report and are provided annually in this report (Appendix B).

6 SURVEILLANCE NETWORK PROGRAM (SNP) - GROUNDWATER

A summary of the 2017 Imperial Norman Wells Operation Groundwater Monitoring program and the results can be found in Appendix C.

7 REPORTABLE RELEASES

7.1 Incident Prevention and Reduction

Imperial's integrity and reliability processes utilize a structured approach of prevention, detection, response and recovery. A variety of activities related to release prevention, reduction, mitigation, response and training is undertaken annually. These activities are designed to eliminate potential releases, detect releases should they occur and if they do occur, ensure an effective and timely clean up. Key elements for achieving this strategy include:

- awareness training for employees and contractors
- pre-job preparation and hazard recognition
- surveillance and monitoring
- flowline leak detection
- routine integrity testing and maintenance
- regularly scheduled emergency response training and exercises and;
- incident reporting processes

For any new to site workers (both employees and contractors) a safety and environmental training package is reviewed covering environmental topics such as release prevention, reporting, waste management, and wildlife. Other tools such as Environmental Alerts, a one page bulletin intended as a high level overview of key topics, may be used to communicate to workers specific environmental information on an as needed basis.

Release reduction initiatives and target areas are continuously evaluated based on existing trends. In 2017, the focus areas were chemical releases and near misses (such as small leaks and drips). Similar to safety incidents, environmental incidents and associated learnings are reviewed real-time with the general workforce in daily operations and stewardship meetings.

7.2 Spill Summary

In 2017, Imperial reported two releases into the NEB's Event Reporting System (ERS) and the NT-NU Spill Report Line (Table A). The two incidents were either partially or completely contained (e.g. inside building, bermed area or into containment trays). The incidents were responded to immediately, cleaned up until no visual impacts remained, and the incident investigation closed. Incident investigation details and clean up status is provided to the NEB through the Monthly Release Report and the ERS, and to the SLWB in a Supplemental Release Report (30 Day Report).

Table D: Details on 2016 Norman Wells Operations NT-NU Reportable Releases

Date Occurred	NEB INC Number	NT/NU Spill Number	Location of Incident	Product Released	Volume Released (m³)	Volume Contained (m³)	Volume Reaching the Environment (m³)	Executive Summary	Direct Cause	Status of Clean Up
30-Jan	INC2017-014	17-031	Mainland	Sewage	0.03	0	0.03	Approximately 30L of sewage released at the on-site warehouse facility. The sewage line that connects from the building to the tank froze and split resulting in the release. System was immediately shutdown and isolated. The line was wiped clean of residual impacts. Impacted gravel was removed and disposed of appropriately.	Equipment - Mechanical Integrity	Complete
27-May	INC2017-074	17-181	Plant	Crude Oil	0.7	0.7	0	Approximately 700L of crude oil released from a flowline leading in to Tank 114 (shipping tank). Release was contained within the Tank 114 berm. Cause was determined to be a failure of hte flowline expansion joint which resulted The surface impacts were scraped up. Impacted gravel was removed and disposed of appropriately.	Equipment - Mechanical Integrity	Complete
15-Jun	N/A	N/A	Mainland	Freshwater	200	0	200	Approximately 200m3 of untested freshwater was withdrawn from the Refinery Water Flood Basin and used for dust supression on Mainland lease road. Cause was due to personnel not following surface water procedures. Post incident laboratory results met all Water Licence Criteria. (Reported only INAC inspector only)	People - Understood but did not follow procedure	Complete
TOTAL VOLUME (less freshwater) (m³)					0.73	0.7	0.03			

8 DRILLING ACTIVITY SUMMARY

8.1 Program Overview

There was no drilling activity in 2017 nor are there plans to drill in 2018.

8.2 2017 Drilling Sump Fluid Volumes

All drilling sumps have been capped and are in the remediation process. There were no drilling fluid releases in 2017.

9 WASTE

Waste generated on-site is collected and disposed of at appropriate waste facilities both on and off-site. In 2017, approximately 7 tonnes of hazardous waste and 293 tonnes of non-hazardous waste was transported to approved facilities outside of Norman Wells, and an estimated 21 tonnes of domestic waste was disposed of at the Town of Norman Wells Waste Disposal Facility.

Two Imperial owned soil treatment facilities (biocell) continue to operate, treating impacted material for reuse on site. In 2017, no additional soil was added into the biocell and approximately 371 m³ of soil was removed following treatment. The material removed was treated to meet Canadian Council of Ministers of the Environment (CCME) Industrial Soil Quality Guidelines and was used for backfill on Imperial's mainland lease area.

An active Waste Management Plan (WMP) serves as a resource document and field guide for waste management on site, and includes additional details about the biocell and other waste facilities at the Norman Wells Operation. As updates to this plan are made, the plan is filed with the SLWB.

10 EMERGENCY RESPONSE

10.1 Overview of Emergency and Spill Response

Imperial's Emergency Response Plan (ERP) includes set objectives for responding to emergencies in an effective and timely manner. These objectives include the following:

- Manage risks, inherent in all operations to minimize releases
- Ensure that all employees understand their responsibility as it relates to emergencies and preventing them from occurring
- Develop and maintain emergency response capabilities locally and have the ability to quickly expand and leverage other resources
- Initiate appropriate response measures immediately and take all reasonable measures to ensure the safety of our workforce and the public and for the protection of the community and the environment

In addition to the ERP mentioned above, a Spill Contingency and Response Plan (SCARP) also exists as a supplement the ERP. The SCARP is a more detailed field level strategy guide. Copies of both the ERP and SCARP are filed with the SLWB and NEB and other agencies as appropriate.

The local Norman Wells workforce, in the event of an emergency, would be known as the Emergency Response Team (ERT). The ERT completes regular training on roles and responsibilities, the structure and organization of the Incident Command System (ICS), emergency response equipment, as well as various response techniques (e.g. ice slot recovery). Within the scope of any training, the objectives of the exercise, learnings and any improvement areas are discussed throughout and followed up as required.

A summary of the exercises completed in 2017 are included in Table E.

Table E: 2017 Emergency Response Exercises

Date	Description
11-Jan-17	Tank Fire
7-Feb-17	Chlorine Release
8-May-17	Overdue Helicopter
11-May-17	Well Blowout - Heliskid
27-May-17	Pipeline Rupture in the Plant
29-May-17	Man Down - Helicopter
26-Jun-17	Man Down - Overboard
30-Jun-17	Grass Fire + Office Fire Drill
6-Jul-17	Gas Release
11-Jul-17	Man Down
27-Jul-17	TDG Release + Man Down in Confined Space
9-Aug-17	Spill Response - Mid Channel Recovery
29-Aug-17	Spill Response - Shoreline Recovery
21-Sep-17	Propane Bullet Fire

10.2 2017 Planned Emergency and Spill Response Exercises

Imperial will continue its focus on emergency response training in 2018.

10.3 Revisions to the Emergency Response Plan (ERP) and Spill Contingency and Response Plan (SCARP)

Both the ERP and SCARP are reviewed annually and updates are filed with the SLWB and other agencies as appropriate.

11 WORK SUMMARY

11.1 2017 Activities

Below is a list of modification (s) and maintenance work carried out as per Part G of the licence in 2017:

- Soil Washing Facility – on-going

The project is still on-going but includes the construction of a treatment pad, process water holding pond, a freshwater storage tank and access to freshwater from an onsite surface water runoff facility (SNP location). **Note:** This work is being executed and managed through the Closure and Reclamation department but since it falls under Part G of the licence it is being included in this report as well as, the Annual C&R Report.

All of the above work was submitted to the SLWB in a proposed plan and approved prior to commencing activities.

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Appendix A. CPF Inlet and CPF Outlet Water Data

Total Petroleum Hydrocarbons and Phenols

	CPF Inlet Total Petroleum Hydrocarbons (mg/L)	CPF Inlet Phenols (mg/L)	CPF Outlet Total Petroleum Hydrocarbons (mg/L)	CPF Outlet Phenols (mg/L)
SNP Station	S13L1-007-1	S13L1-007-1	S13L1-007-2	S13L1-007-2
Water Licence Criteria	n/a	n/a	5.0 mg/L	0.14mg/L
Dec 26 - Jan 2	<2.0	<0.0020	<2.0	0.0023
Jan 2 - 9	<2.0	<0.0020	<2.0	<0.0020
Jan 9 - 16	<2.0	<0.0020	<2.0	<0.0020
Jan 16 - 23	<2.0	<0.0020	<2.0	<0.0020
Jan 23 - 30	<2.0	<0.0020	<2.0	<0.0020
Jan 30 - Feb 6	<2.0	<0.0020	<2.0	<0.0020
Feb 6 - 13	<2.0	<0.0020	<2.0	<0.0020
Feb 13 - 20	<2.0	<0.0020	<2.0	<0.0020
Feb 20 - 27	<2.0	<0.0020	<2.0	<0.0020
February 27 - December 31	*	*	*	*

* Operations shut down due to Enbridge Line 21

Total Suspended Solids (TSS), pH and Specific Conductivity (EC)

	CPF Inlet Total TSS (mg/L)	CPF Inlet Total pH (mg/L)	CPF Inlet Total EC (mg/L)	CPF Outlet Total TSS (mg/L)	CPF Outlet Total pH (mg/L)	CPF Outlet Total EC (mg/L)
SNP Station	S13L1-007-1	S13L1-007-1	S13L1-007-1	S13L1-007-2	S13L1-007-2	S13L1-007-2
Water Licence Criteria	n/a	n/a	n/a	n/a	Between 6 – 9	n/a
Dec 29 - Jan 2	13	7.99	250	1.3	7.94	250
Jan 2 - 5	1.3	7.89	240	1.3	7.96	250
Jan 5 - 9	4.7	7.88	240	<1.0	7.92	240
Jan 9 - 12	25	7.93	250	<1.0	7.98	250
Jan 12 - 16	4	7.87	240	<1.0	7.97	240
Jan 16 - 19	12	7.93	240	<1.0	7.94	240
Jan 19 - 23	37	7.89	250	<1.0	7.92	240
Jan 23 - 26	17	7.88	240	<1.5	7.98	240
Jan 26 - 30	17	7.92	250	<1.0	8.02	250
Jan 30 - Feb 2	17	7.92	250	<1.5	8	240
Feb 2 - 6	17	7.89	240	<1.0	8.01	240
Feb 6 - 9	16	7.85	240	<1.5	7.96	240
Feb 9 - 13	<1.0	7.89	240	<1.0	8.02	240
Feb 13 - 16	2	7.97	240	<1.5	8.05	250
Feb 16 - 20	<1.0	7.98	240	<1.0	7.98	240
Feb 20 - 23	1.3	7.95	240	<1.0	7.97	240
Feb 23 - 27	2.7	7.85	230	2.7	8.04	230
February 27 - December 31	*	*	*	*	*	*

* Operations shut down due to Enbridge Line 21

Average Daily Chlorine and Temperature

	CPF (mg/L)	CPF Outlet Temperature
SNP Station	S13L1-007-1	S13L1-007-2
Water Licence Criteria	n/a	n/a
Dec 26 - Jan 2	*	13
Jan 2 - 9	*	12
Jan 9 - 16	*	11
Jan 16 - 23	*	11
Jan 23 - 30	*	12
Jan 30 - Feb 6	*	11
Feb 6 - 13	*	11
Feb 13 - 20	*	11
Feb 20 - 27	*	12
February 27 - December 31	**	**

* Chlorine injection system inoperable since June 2016. No chlorine sampling occurred during this time

** Operations shut down due to Enbridge Line 21

Four Week Rolling Average (S13L1-007-02)

	TPH (mg/L)	Phenols (mg/L)	TSS (mg/L)	pH	Specific Conductivity (uS/cm)	Daily Chlorine (mg/L)	Temperature (C)
Max. Average Limit	(5 mg/L)	0.014	n/a	6.0-9.0	n/a	n/a	n/a
Dec 5 - Jan 2	<2.0	0.0021	1.5	8.02	263	*	9
Dec 12 - Jan 9	<2.0	0.0021	1.5	7.99	255	*	10
Dec 19 - Jan 16	<2.0	0.0021	1.3	7.98	250	*	11
Dec 26 - Jan 23	<2.0	0.0021	1.1	7.96	245	*	10
Jan 2 - 30	<2.0	0.002	1.1	7.96	244	*	10
Jan 9 - Feb 6	<2.0	<0.0020	1.1	7.98	243	*	10
Jan 16 - Feb 13	<2.0	<0.0020	1.2	7.98	241	*	10
Jan 23 - Feb 20	<2.0	<0.0020	1.3	8	243	*	11
Jan 30 - Feb 27	<2.0	<0.0020	1.4	8	240	*	11
February 27 - December 31	**	**	**	**	**	**	**

* Chlorine injection system inoperable since June 2016. No chlorine sampling occurred during this time

** Operations shut down due to Enbridge Line 21

Quarterly Acute Lethality Data

CPF Outlet (S13L1-007-2)		
Date	Rainbow Trout	Daphnia Magna
Licence Criteria	50% Survival	50% Survival
Q1 – January 2017	100% Survival	100% Survival
Q2 - April 2017	*	*
Q3 - August 2017	*	*
Q4 - October 2017	*	*

* Operations shut down due to Enbridge Line 21

Quarterly Data

SNP S13L1-007-1 (Inlet)					
Date	Q1	Q2	Q3	Q4	YTD Avg. (mg/L)
	January 2017 mg/L	April 2017 (mg/L)	August 2017 (mg/L)	October 2017 (mg/L)	
pH	7.9	N/A	N/A	N/A	7.9
Phenols	<0.0020				<0.0020
Dissolved Sodium	8.8				8.8
Total Sodium	8.4				8.4
Dissolved Potassium	0.92				0.92
Total Potassium	0.92				0.92
Dissolved Sulphate	30				30
Dissolved Chloride	10				10
Dissolved Calcium	28				28
Total Calcium	26				26
Dissolved Magnesium	10				10
Total Magnesium	9.1				9.1
Total Alkalinity	75				75
Specific Conductivity	240				240
Total Suspended Solids	23				23
Total Dissolved Solids	140				140
Total Petroleum Hydrocarbons	<2.0				<2.0
Total Phosphorus	<0.10				<0.10
Total Hardness	110				110

SNP S13L1-007-2 (Outlet)					
Date	Q1	Q2	Q3	Q4	YTD Avg. (mg/L)
	January 2017 (mg/L)	April 2017 (mg/L)	August 2017 (mg/L)	October 2017 (mg/L)	
pH	7.88	N/A	N/A	N/A	7.88
Phenols	<0.0020				<0.0020
Dissolved Sodium	8.9				8.9
Total Sodium	8.4				8.4
Dissolved Potassium	0.9				0.9
Total Potassium	0.86				0.86
Dissolved Sulphate	30				30
Dissolved Chloride	10				10
Dissolved Calcium	28				28
Total Calcium	26				26
Dissolved Magnesium	10				10
Total Magnesium	9.1				9.1
Total Alkalinity	78				78
Specific Conductivity	240				240
Total Suspended Solids	1.3				1.3
Total Dissolved Solids	140				140
Total Petroleum Hydrocarbons	<2.0				<2.0
Total Phosphorus	<0.10				<0.10
Total Hardness	110				110

Appendix B. Surface Water Runoff Data

Category A Locations

Location	Date	Total Discharge Volume (m³)	Chlorides (mg/L)	pH	Sheen Y/N
Sample Limits			< 500	6.0-9.0	N
Mainland					
LT-11	3-May	60	30	6	N
	4-May				
	5-Jun	908	0	6	N
F-31	3-May	60	30	6	N
D-42	5-May	70	30	6	N
	8-May				
Bear Island					
I-50X	12-Aug	5	0	6	N
J-45X	12-Aug	5	0	6.5	N
J-47X	12-Aug	5	0	6.5	N
L-47X	12-Aug	6	0	6.5	N
J-52X	13-Aug	4	0	6.5	N
K-48X	13-Aug	5	0	6	N
L-52X	13-Aug	5	0	6.5	N
Goose Island					
N-31	14-Jun	5	0	6	N
N-21	14-Jun	4	0	6	N
N-23	14-Jun	5	0	6	N
N-27	14-Jun	3	0	6	N
N-29	14-Jun	4	0	6	N
P-21	19-Jun	4	0	7	N
O-20	19-Jun	4	0	7	N
O-18	19-Jun	6	0	6	N
T-12	23-Jun	7	0	6	N
S-14	23-Jun	6	0	6	N
S-12	23-Jun	7	0	6	N
S-10	23-Jun	7	0	6	N
Q-17-1	30-Jun	5	0	6	N
P-19	30-Jun	3	0	6	N
R-15	30-Jun	7	0	6	N
N-19X	1-Jul	7	0	6	N
L-15X	1-Jul	7	0	6	N
M-13X	1-Jul	6	0	6	N
T-16X	2-Jul	6	0	6	N
O-12X	2-Jul	3	0	6	N
T-21X	2-Jul	7	0	6	N
T-15X	2-Jul	6	0	6	N
T-19X	2-Jul	6	0	6	N
R-13X	2-Jul	5	0	6	N
T-13X	2-Jul	6	0	6	N
T-11X	2-Jul	7	0	6	N
N-22X	4-Jul	6	0	6	N
P-22X	4-Jul	5	0	6	N
T-07X	13-Jul	1	0	7	N
S-06X	13-Jul	4	0	7	N
N-13X	26-Jul	3	0	6	N
O-16X	26-Jul	4	0	7	N
O-17X	26-Jul	1	0	7	N
P-13X	26-Jul	7	0	7	N
P-11X	26-Jul	2	0	7	N
N-15X	27-Jul	1	0	6	N
N-11X	27-Jul	3	0	6	N
M-48X	27-Jul	2	0	6	N
S-26X	29-Jul	8	0	6	N

O-10X	29-Jul	5	0	6	N
N-14X	29-Jul	7	0	6	N
T-25X	29-Jul	8	0	6	N
R-27X	29-Jul	8	0	6	N
T-19X	19-Sep	3	0	6	N
T-15X	19-Sep	2	0	6	N
T-13X	20-Sep	1	0	6	N
O-07X	20-Sep	1	0	6	N

Category B Locations

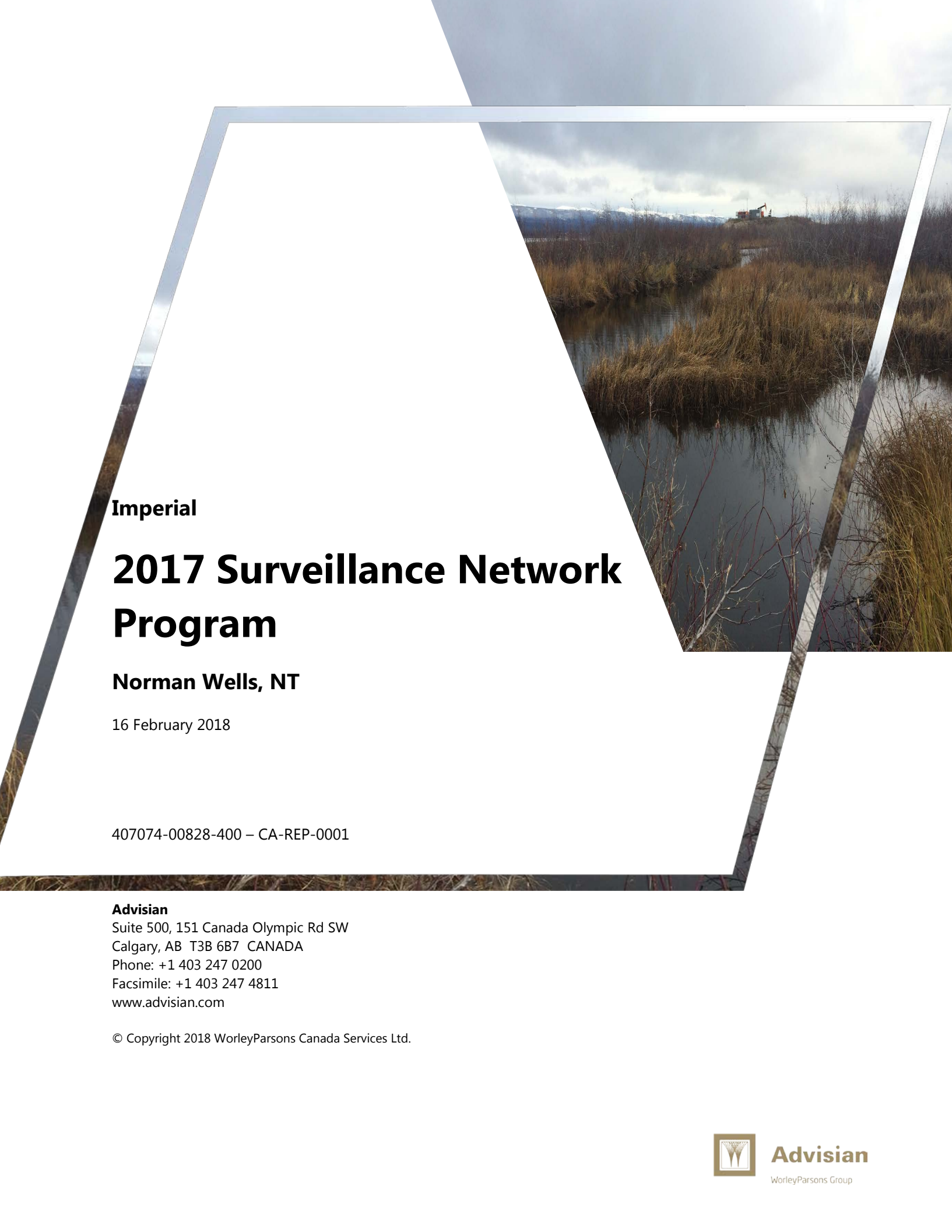
	Date	Start/ Middle/ End	Total Discharge Volume (m³)	Total Petroleum Hydrocarbons (mg/l)	Phenols (mg/l)	Chlorides (mg/L)	pH	Total Suspended Solids (mg/l)	Total Dissolved Solids (mg/l)	Specific Conduct. (uS/cm)
Max Grab Sample Limit				5	0.14	<500	6.0-9.0	n/a	n/a	n/a
Mainland Areas										
CPF Impound	4-May	Start	580	<2.0	0.0076	4.8	7.78	5.3	200	410
	10-May	Mid 1		<2.0	0.0057	3.9	7.8	11	190	280
	17-May	Mid 2		<2.0	0.0036	6.8	8.03	10	290	450
	24-May	End		<2.0	0.0034	12	8.02	45	620	860
	31-Aug	Start	254	<2.0	0.0033	15	7.86	6	1000	1400
	7-Sep	Mid 1		<2.0	0.0041	17	7.98	2.7	1100	1300
	14-Sep	Mid 2		<2.0	0.0033	15	7.36	35	1100	1300
	21-Sep	Mid 3		<2.0	0.0038	15	7.63	11	680	930
	28-Sep	End		<2.0	0.011	14	7.65	22	770	1100
Refinery Impound	4-May	Start	6,516	<2.0	0.092	8.3	7.72	25	190	340
	10-May	Mid 1		<2.0	0.043	8.4	7.76	22	320	470
	17-May	Mid 2		<2.0	0.0087	14	8.08	17	400	610
	24-May	End		<2.0	0.0086	22	8.09	2	490	750
	13-Jul	Start	1,476	<2.0	0.0087	34	8.07	51	530	840
	20-Jul	Mid 1		<2.0	0.011	38	8.46	4	520	820
	27-Jul	End		<2.0	0.012	36	8.18	4.7	510	780
	17-Aug	Start	1,590	<2.0	0.0130	43	7.98	3.3	510	800
	24-Aug	Mid 1		<2.0	0.0089	37	8.25	1.3	520	830
	31-Aug	Mid 2		<2.0	0.0056	31	8.14	5.3	670	1000
	7-Sep	Mid 3	1,198	<2.0	0.0051	29	8.18	5.3	700	1000
	14-Sep	Mid 4		<2.0	0.0035	28	8.13	1.3	720	1000
	21-Sep	Mid 5		<2.0	0.0064	30	7.91	25	670	940
	28-Sep	End		<2.0	0.0044	30	8.14	6.7	720	1100
Retention Area	16-Sep	Start	*	**	**	**	**	**	**	**
	21-Sep	Mid 1		<2.0	0.0035	13	7.84	17	570	800
	26-Sep	Mid 2		<2.0	0.0054	16	7.85	2.0	650	980
	28-Sep	End		<2.0	0.0038	14	8.08	10	720	1000
Settling Pond	8-Sep	Start	2,287	<2.0	0.0023	***	8.24	5.3	***	490
	14-Sep	Mid 1		<2.0	<0.0020	***	8.22	4	***	510
	19-Sep	Mid 2		<2.0	<0.0020	***	8.04	14	***	570
	26-Sep	Mid 3		<2.0	<0.0020	***	7.79	4.7	***	1000
	28-Sep	End		<2.0	<0.0020	***	7.78	22	***	1000
LT – 11 Impound	6-May	Start	660	<2.0	0.021	5	7.67	6.7	100	300
	10-May	Mid 1		<2.0	0.023	7.2	7.54	6.7	220	320
	17-May	Mid 2		<2.0	0.0089	2.6	7.65	4	360	530
	24-May	End		<2.0	0.0075	3.1	7.48	40	540	700
Misc. Mainland Impound Areas										
Mainland Sump 5			0							
Refinery Water Flood Pond	29-Jun	Start	294	<2.0	0.0051	28	8.85	<1.0	510	850
	6-Jul	Mid 1		<2.0	0.0055	28	8.85	2	500	850
	13-Jul	Mid 2		<2.0	0.0037	30	8.74	51	530	850
	20-Jul	Mid 3		<2.0	0.0043	30	8.91	150	520	860
	27-Jul	Mid 4		<2.0	0.006	30	8.61	2.7	500	890
	3-Aug	Mid 5	70	<2.0	0.0042	30	8.83	1.3	520	880
	10-Aug	Mid 6		<2.0	0.0035	30	8.82	4	520	890
	17-Aug	Mid 7		<2.0	0.0043	31	8.56	1.3	500	880

	24-Aug	Mid 8		<2.0	0.0020	31	8.59	13	510	900
	31-Aug	Mid 9		<2.0	0.0050	30	8.60	2.7	520	930
RTK 109 – 111	29-Jun	Start	149	<2.0	0.016	18	8.34	18	460	670
	6-Jul	Mid 1		<2.0	0.016	20	8.45	170	580	660
	7-Jul	End		<2.0	0.017	19	7.68	300	720	750
RTK 116 – 118	29-Jun	Start	170	<2.0	0.019	14	7.96	3	370	580
	6-Jul	Mid 1		<2.0	0.018	12	8.13	2	360	570
	7-Jul	End		<2.0	0.015	12	8.01	95	360	560
RTK 119	29-Jun	Start	32	<2.0	0.024	9.5	8.18	7.3	250	380
	6-Jul	Mid 1		<2.0	0.016	20	8.51	11	600	650
	7-Jul	End		<2.0	0.013	6.8	7.75	56	440	620
Misc. Bear Impound Areas										
			0							
Misc. Goose Impound Areas										
			0							

* Volume released from the Retention Area is captured in CPF Impound Basin volumes; Retention Area flows under the roadway to CPF Impound Basin
** No water present to sample
*** Parameter not requested for analysis due to human error

Appendix C. Groundwater Surveillance Network Program (GW-SNP)

A copy of the Groundwater Surveillance Network Program report is filed behind this page.



Imperial

2017 Surveillance Network Program

Norman Wells, NT

16 February 2018

407074-00828-400 – CA-REP-0001

Advisian

Suite 500, 151 Canada Olympic Rd SW

Calgary, AB T3B 6B7 CANADA

Phone: +1 403 247 0200

Facsimile: +1 403 247 4811

www.advisian.com

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THIS REPORT CONTAINS PROVISIONS LIMITING LIABILITY, THE SCOPE OF THE REPORT AND THIRD PARTY RELIANCE

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**Project No. 407074-00828-400-CA-REP-0001 - 2017 Surveillance Network Program:
Norman Wells, NT**

Rev	Description	Originator Approval	Reviewer Approval	Project Manager Approval	Date
0	Issued as final				16-Feb-18
		M. Lord	M. Brown	S. Gibb	

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1. Introduction

The Imperial Oil Resources N.W.T. Limited (Imperial) Norman Wells Operation is an upstream oil and gas field located 700 km northwest of Yellowknife, Northwest Territories (Latitude 65° 17' N, Longitude 126°51 W; the "Site"). Operations include a Central Processing Facility (CPF) on the northeastern shore of the Mackenzie River which receives production from wells on the mainland, three natural islands (Goose Island, Bear Island and Frenchy's Island) and six artificial islands (Figure 1). Work was conducted for Imperial under Imperial Oil Limited Contract A2275233.

Limitations of Liability, Scope of Report and Third Party Reliance for this report are provided in Appendix A.

1.1 Background

The Norman Wells Operations Groundwater Management Plan (GMP) was created in September 2014 as part of Imperial's Water Licence Renewal Application submitted to the Sahtu Land and Water Board (Imperial 2014). A key component of the GMP is the sampling of a select subset of existing groundwater monitoring wells installed at strategic locations between operating facilities and potential receptors across the Site, referred to as the Groundwater Surveillance Network Program (SNP). These wells are sampled twice annually in accordance with the GMP, in order to provide ongoing monitoring of groundwater conditions adjacent to Site activities. The goal of the SNP is to identify existing groundwater quality issues and to provide early detection of groundwater changes across the Site.



2. Scope of Work

WorleyParsons Canada Services Ltd., operating as Advisian, was retained by Imperial to conduct groundwater monitoring and sampling activities for the established sentinel network. The scope of work for the 2017 groundwater monitoring program at the Site included the following:

- check monitoring well integrity and measure static groundwater levels of 17 groundwater wells;
- collect groundwater samples for laboratory analysis of dissolved chloride and benzene, toluene, ethylbenzene and total xylenes (BTEX) parameters, as well as petroleum hydrocarbon fractions F1 and F2; and
- provide a summary report presenting the results of the 2017 groundwater sampling program.

The GMP lists chloride, benzene, toluene and ethylbenzene as the primary indicator parameters. Due to established laboratory analytical packages, additional analyses were also completed. The scope of this report is to review the primary indicator parameters per the GMP.



3. Environmental Assessment Guidelines

At present, no specific groundwater quality guidelines exist for the Northwest Territories. As a conservative measure, groundwater quality assessment parameters in this report are compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (CEQG) for the Protection of Freshwater Aquatic Life (FWAL; CCME 2015), as surface water bodies (e.g. Bosworth Creek and the Mackenzie River) are potential receptors of groundwater in most areas of interest for this program.

It should be emphasized that the aforementioned guidelines are used for comparative purposes only in the context of this report.



4. Groundwater Monitoring Network

Twelve monitoring wells and three contingency wells are written into Imperial's Water Licence S13L1-007 and make up the Groundwater Surveillance Network Program (SNP). These wells were selected based on proximity to operating facilities and potential receptors, historical groundwater quality, well completion information, and overall Site coverage. The contingency wells serve as replacement sampling locations in the event that a primary SNP monitoring well is dry, damaged, frozen, or otherwise cannot produce water during a scheduled sampling event. Two additional monitoring wells have been historically sampled during the SNP, and are also included in this report as additional contingency sampling locations.

The main receptors identified during the development of the SNP were the Mackenzie River, Bosworth Creek, and the Town of Norman Wells.

A summary of the selected monitoring wells is provided below as Table A.

Table A SNP Monitoring Locations

Monitoring Well	Location	Rationale for Selection
CPF 97-7-5	Mainland West	Situated between CPF and Bosworth Creek
CPF 98-8-3	Mainland West	Situated between CPF and Mackenzie River
WSY 97-1-5	Mainland East	Situated between Well Services Yard and Bosworth Creek
ARB-12-3-3	Mainland East	Adjacent Biocell 1
C38 08-1-4	Mainland East	Situated between known historical well issues (C-36X) and Mackenzie River
TF 03-12-3	Mainland East	Situated between Tank Farm and Mackenzie River; downgradient of known hydrocarbon source
MTF 97-1-5	Mainland East	Situated between Tank Farm and Town of Norman Wells
BIS 97-1-3	Bear Island	Situated between Bear Island Sump #5 and the Mackenzie River
BI-13-3-4.5	Bear Island	Situated near Bear Island Sump #6 and the Mackenzie River
BIBG-12-1-7	Bear Island	Situated at western edge of development on Bear Island, near Mackenzie River
GIBG-10-2-3	Goose Island	Situated between well pads and Mackenzie River
GIQ8-10-2-4	Goose Island	Situated between fuel storage/handling area and the Mackenzie River



Monitoring Well	Location	Rationale for Selection

Contingency Wells*

MEBG-10-1-3	Mainland East	Situated between Mainland Sumps and Mackenzie River
GIP11 09-1-4	Goose Island	Situated between a sump and the Mackenzie River
BI-13-1-4	Bear Island	Situated near Bear Island Sump #6 and the Mackenzie River
BISS2-09-DP-1**	Bear Island	Situated on Bear Island, near Mackenzie River and local wetland
BISS2-09-DP-2**	Bear Island	Situated on Bear Island, near Mackenzie River and local wetland

* Wells serve as contingency monitoring locations in the event that a sample cannot be collected from all primary SNP locations

** Wells not specified as primary or contingency SNP monitoring locations but included in this report to provide additional spatial coverage

5. Sampling and Methodology

5.1 Field Methodology

The SNP groundwater sampling was conducted by Advisian personnel between August 12-20, September 12-14, and November 22, 2017. Advisian staff followed field procedures as summarized in Appendix B.

Groundwater samples were collected using HydraSleeves™, dedicated Waterra™ tubing, or dedicated/disposable bailers following no-purge methodology. A total of 41 samples, including 28 groundwater samples, three field duplicate samples, four field blank samples and six trip blank samples, were collected in pre-cleaned laboratory-provided bottles as part of the SNP. Results were compared to the CCME FWAL guidelines and historical records, as applicable.

All groundwater samples were submitted for laboratory analysis at an accredited third party laboratory in Edmonton (Maxxam Analytics) in accordance with standard packaging, preservation, and chain-of-custody (COC) procedures.

The methodology for measuring field parameters and collecting groundwater samples is summarized in Appendix B.

5.2 Statistical Analyses

5.2.1 Shewhart-Cumulative Sum Trend Analyses

Combined Shewhart-Cumulative Sum (CUSUM) control charts provide a common means of statistical trend evaluation in many environmental monitoring programs, and are in fact the only statistical procedure that is directly recommended for use in intra-well monitoring by the United States Environmental Protection Agency (U.S. EPA 1989, 1992). The Shewhart control chart is designed to detect an immediate increase over the background distribution for a particular monitoring constituent, whereas the CUSUM control chart is designed to detect more gradual increases over background (Gibbons 1999).

5.2.2 Mann-Kendall Statistical Analyses

The non-parametric Mann-Kendall test for trend can be used in combination with a modified version of Sen's non-parametric slope estimator (Gibbons 1994). In both tests, four or more points of data are placed in chronological order, and the sign of the differences between all forward combinations of data pairs are used to compute the Mann-Kendall statistic (S). The Mann-Kendall statistic (S), along with the number of the data points (n), is used for the normal approximation test, and the results yield a probability from 0 to 1.

Sen's slope is used to provide an approximate magnitude of change on trend lines. Sen's slope is calculated by evaluating the slope between all forward combinations of data pairs. The slopes are then ranked and the median slope value is selected. Unlike least squares regression, the Sen's slope is not greatly affected by gross outliers, which are occasionally encountered in groundwater chemistry data. Slopes are presented in absolute terms [milligrams per litre (mg/L) per year] and/or normalized relative to the median concentration (% change per year).

In each case, trend analyses are conducted using the available data series collected following installation of the monitoring wells. The Mann-Kendall statistics are evaluated only on datasets where at least four data points exist. It is important to note that some parameters returned "below detection" results for part or all of the location's sampling history. If > 49% of data reported a 'non-detect' value, no Mann-Kendall was performed (i.e., petroleum hydrocarbon parameters in the SNP monitoring wells).

To indicate potentially significant temporal trends, results are screened according to three criteria:

- the probability of a trend;
- slope (e.g. in mg/L per year); and
- normalized slope (in % per year).

Location-specific discussions of statistical trend details and results are provided in Section 7.3.



6. Groundwater Monitoring

Samples were collected during three separate monitoring events in 2017, as summarized below:

Table B Groundwater Sampling Events

Well Identification	August 2017	September 2017	November 2017	Comments
CPF 97-7-5	✓	✓	x	
CPF 98-8-3	✓	✓	x	
WSY 97-1-5	✓	✓	x	
ARB-12-3-3	✓	✓	x	
C38 08-1-4	✓	✓	x	
TF 03-12-3	✓	✓	x	
MTF 97-1-5	✓	✓	x	
BIS 97-1-3	x	x	✓	Historically sampled BISS2-09-DP-1/BISS2-09-DP-2. BIS 97-1-3 now sampled to align with Water Licence S13L1-007
BI-13-3-4.5	✓	x	✓	
BIBG-12-1-7	x	x	x	Well damaged, recommend well replacement
GIBG-10-2-3	✓	✓	x	
GIQ8-10-2-4	✓	✓	x	
MEBG-10-1-3	✓	✓	x	



Well Identification	August 2017	September 2017	November 2017	Comments
GIP11 09-1-4	x	x	x	Well damaged, recommended well replacement
BI-13-1-4	✓	x	✓	Well frozen
BISS2-09-DP-1	✓	✓	x	
BISS2-09-DP-2	✓	✓	x	

- ✓ Indicates groundwater was sampled at this location during this event
 x Indicates groundwater was not sampled at this location during this event



7. Results and Interpretation

7.1 Site Hydrogeology

Monitoring well datum and groundwater surface elevations are presented in Table 1 and Figures 2A-C to 3A-C. Elevations are provided in metres above sea level (masl).

7.1.1 Mainland

Groundwater surface elevations do not indicate a consistent groundwater flow direction for the Mainland area. This is due, in part, to sparsity of the monitoring network for the SNP program, and to the presence of discontinuous permafrost beneath the Site. Ice lenses in the subsurface act as barriers to groundwater movement, due to the comparatively low hydraulic conductivity associated with frozen soil. As a result, groundwater flow conditions beneath the Site are complex, and small scale local variations are inferred to be present in many areas.

Generally speaking, groundwater is inferred to flow predominantly towards the Mackenzie River, with localized flow towards Bosworth Creek. More extensive monitoring events at the Site confirm this interpretation.

Groundwater surface elevations ranged from 56.91 to 63.45 masl in August (Figure 2A) and from 56.90 to 63.57 masl in September (Figure 3A). In general, hydraulic head is higher towards the north end of the Site, and decreases with proximity to the Mackenzie River.

7.1.2 Bear Island and Goose Island

Generally, groundwater surface elevations on Bear Island and Goose Island mimic the surface topography, with local flow directions inferred to be from high ground towards the closest surface water body. In most cases, the closest water body is the Mackenzie River; however, a number of unnamed surface water bodies also exist on both Islands (Figure 1).

Groundwater surface elevations on Bear Island ranged from 44.16 to 49.76 masl in August (Figure 2B), from 44.21 to 45.19 masl in October, and from 47.81 to 50.11 masl in November (Figure 3B).

Groundwater surface elevations on Goose Island ranged from 42.36 to 45.29 masl in August (Figure 2C) and from 42.55 to 45.47 masl in September (Figure 3C).

7.2 Groundwater Analytical Results

Current groundwater chemistry data for indicator and petroleum hydrocarbon parameters are presented in Tables 2 and 3. Analytical results for key Site indicator parameters, as compared to the CCME FWAL guidelines, are presented in Figures 4A-C and 5A-C.

The 2017 laboratory analytical reports, including both key indicator parameters and other associated chemistry data, are compiled in Appendix C. A description and summary of the quality assurance and quality control program is provided in Appendix D.

Background groundwater geochemical parameters were initially calculated in 2012 and have been characterized for two main areas (Natural Islands and Mainland), based on a database of information from three distinct hydrogeological units (surficial sediments, shallow bedrock, and deep bedrock). Estimated natural background geochemistry for shallow groundwater has been provided in Figures 4A-C. These background values are referred to periodically in the discussion below, and a brief summary has been included as Appendix F. An overview of the physical site characteristics has been provided in Appendix G.

7.2.1 Chloride

Above guideline chloride concentrations were reported for monitoring well TF 03-12-3 in 2017 (Table 2). These concentrations also exceeded the range of background concentrations in Mainland surficial sediments (Figure 4A). This monitoring location has historically yielded above-guideline concentrations of dissolved chloride. As it is installed downgradient of the Mainland Tank Farm, it is possible that these elevated chloride concentrations are indicative of anthropogenic impacts.

Five monitoring wells (CPF 97-7-5, ARB-12-3-3, C38 08-1-4, BIS 97-1-3, and WSY 97-1-5) had dissolved chloride concentrations below the CCME FWAL guideline but above the anticipated range of background concentrations in Mainland and Island surficial sediments (Figures 4A-C).

7.2.2 Petroleum Hydrocarbon Parameters

All petroleum hydrocarbon concentrations were below the applied guidelines and method detection limits (Figures 5A-C and Table 3).

7.3 Mann-Kendall Statistical Analyses

Mann-Kendall statistical analyses have been performed for all parameters having both an applied CCME FWAL guideline and four or more historical data points.

Locations were identified as exhibiting statistically-notable trends if the following criteria were met:

- >95% probability of occurrence (two-sided p-value <0.05); and
- significant rate of change (normalized slope > ±10% per year).

A decreasing trend indicates concentrations are decreasing over time while an increasing trend indicates concentrations are increasing over time. Statistical analyses, trend charts and a summary table are presented in Appendix E, and relevant trends are summarized in Table C below.



Table C Statistically-Notable Hydrochemical Trends

Monitoring Location	Parameter	Increasing Trend	Decreasing Trend	Number of Data Points
MEBG-10-1-3	Chloride		↓	11

8. Field and Laboratory Quality Assurance/Quality Control

A quality assurance/quality control (QA/QC) program was followed to manage and quantify the quality of the investigation results. The program included field procedures, laboratory procedures and the use of QC samples to quantify the results of the program.

Field QC sampling included three duplicate samples, four groundwater field blank samples, and six groundwater trip blank samples.

The laboratory QA/QC analyses are provided in the laboratory certificates of analysis, presented in Appendix C. The laboratory QA/QC program included calibration checks, surrogate matrix spikes, blanks and laboratory duplicates during analyses. Any data quality issues are discussed in the laboratory data checklists provided in Appendix C.

The results of the field QA/QC sample analyses are presented in Appendix D. All field and trip blank results were below the laboratory reportable detection limits (Table D-1).

Based on the QA/QC analyses, the data is considered fit for the purpose of this report.



9. Summary

Groundwater quality monitoring for the SNP was completed between August 12-20, September 12-14, and November 22, 2017. Activities included measurement of hydraulic head and collection of groundwater samples for laboratory analyses including key indicator parameters (dissolved chloride, benzene, toluene and ethylbenzene). A summary of the general conclusions from the sampling program is as follows:

- Due to the areal variability of permafrost presence across the Site and the widely spaced SNP network, groundwater surface elevations do not indicate a consistent flow direction. Based on more extensive monitoring programs at the Site, groundwater on the Mainland is generally inferred to flow predominantly towards the Mackenzie River, with localized flow towards Bosworth Creek. Groundwater surface elevations on Bear and Goose Island reflect the surface topography, with local flow directions inferred to be from high ground towards the closest surface water body;
- Dissolved chloride concentrations at one monitoring well exceeded the applied CCME FWAL guideline and the background range for surficial sediments. Chloride concentrations at five additional locations were below the applied guideline but exceeded the background range;
- All analyzed petroleum hydrocarbon results were below the applied guidelines and reportable detection limits; and
- Mann-Kendall trend analyses indicated one statistically-significant decreasing trend (dissolved chloride at MEBG-10-1-3).



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10. Closure

We trust that this report satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Report Prepared by

Melissa Lord, C.E.T.
Environmental Technologist

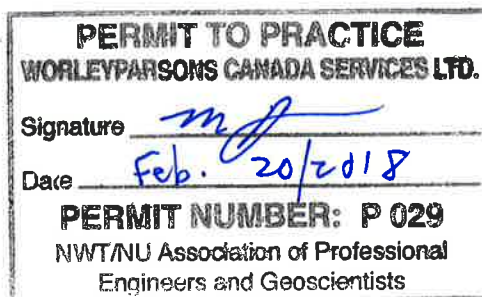
Senior Review by



Michael Brown, M.Sc., P.Geol. (AB, NT)
Principal Hydrogeologist

Lorian Glatiotis, B.Sc., P.Geol. (AB)
Hydrogeologist

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11. References

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Tables



Monitoring Well Installation Details: Datum/Groundwater Surface Elevations and Hydraulic Conductivities

PROJECT No.: 407074-00828-400																	
Monitoring Station	Status	Easting (m)	Northing (m)	Ground Elevation (masl)	Datum Elevation (masl)	Surveyed Stickup (m)	Total Depth of Piezometer (mbgs)	Bottom of Piezometer Elevation (masl)	Depth Interval of Screen (mbgs)	Date (dd-mmm-yyyy)	Depth to Groundwater (mbtoc)	Depth to Groundwater (mbgs)	Groundwater Surface Elevation (masl)	Depth to Bottom of Well (mbtoc)	Hydraulic Conductivity (m/s)	Lithology	Comments
Surveillance Network Program																	
Mainland																	
ARB-12-3-3	Active	599801.144	7242007.048	65.33	66.02	0.69	2.70	62.63	1.20 - 2.70	12-Aug-2017	2.62	1.93	63.40	3.50		Gravel fill / sand / peat	
C38 08-1-4	Active	600072.804	7241542.767	60.48	61.23	0.75	3.80	56.68	1.80 - 3.80	12-Sep-2017	2.45	1.76	63.57	N/M			
										12-Aug-2017	1.97	1.22	59.26	4.53	5.9E-06	Sandy silt / peat / silty clay	Frost jacked
CPF 97-7-5	Active	599100.347	7241852.827	58.64	59.49	0.84	4.90	53.87	1.90 - 4.90	12-Sep-2017	1.74	0.99	59.49	N/M			
										17-Aug-2017	1.25	0.41	58.24	5.88	1.1E-08	Silt / siltstone	
CPF 98-8-3	Active	598705.553	7241839.552	58.79	59.54	0.75	2.70	55.95	1.40 - 2.90	12-Sep-2017	1.39	0.55	58.10	N/M			
										17-Aug-2017	1.66	0.91	57.88	3.31	1.7E-06	Clayey silt	
MEBG-10-1-3	Active	600011.383	7241831.078	63.73	64.47	0.75	3.00	60.73	1.50 - 3.00	12-Sep-2017	1.31	0.56	58.23	N/M			
										12-Aug-2017	1.02	0.27	63.45	3.60	9.0E-07	Silty sand / clayey silt	
MTF 97-1-5	Active	600924.768	7241588.497	63.49	64.39	0.91	4.70	58.76	1.70 - 4.70	12-Sep-2017	0.92	0.17	63.55	N/M			
										17-Aug-2017	4.30	3.39	60.09	5.58	>1.0E-05	Silt	
TF 03-12-3	Active	600562.552	7241435.321	57.08	58.63	1.55	2.80	54.28	1.00 - 2.80	14-Sep-2017	4.13	3.22	60.26	N/M			
										17-Aug-2017	1.72	0.17	56.91	3.40	>1.0E-05	Silty clay and shale fill	
WSY 97-1-5	Active	599274.168	7242034.279	62.61	63.40	0.79	4.70	57.96	1.70 - 4.70	13-Sep-2017	1.73	0.18	56.90	N/M			
										18-Aug-2017	2.69	1.90	60.71	5.69	1.7E-07	Silt	
										12-Sep-2017	2.86	2.07	60.54	N/M			
Bear Island																	
BI-13-1-4	Active	599964.584	7238301.752	49.70	49.70	0.00	4.30	45.40	1.30 - 4.30	15-Aug-2017	1.30	1.30	48.40	3.93	2.60E-06		
BI-13-3-4.5	Active	599813.864	7238463.124	50.62	51.57	0.95	4.50	46.12	1.50 - 4.50	22-Nov-2017	1.89	1.89	47.81	N/M			
										15-Aug-2017	1.81	0.86	49.76	5.22	1.40E-06		Frozen @ 0.99m
BIBG-12-1-7	Damaged	597275.824	7238297.135	49.40	50.20	0.80	7.50	41.90	4.20 - 7.20	22-Nov-2017	N/M	N/M	N/A	N/M			
										15-Aug-2017	> 1.31	> 0.51	< 48.89	1.31		Silty sand / sandy silt	Dry, compromised, bentonite on water level tape
BIS 97-1-3	Active	598365.067	7238610.352	51.00	51.93	0.93	2.60	48.47	1.10 - 2.50	12-Sep-2017	1.82	0.89	50.11	N/M	6.5E-05	Silty peat / silt	
BISS2-09-DP-1	Active	599589.685	7238756.721	44.66	45.13	0.47	1.20	43.46	0.80 - 1.10	14-Aug-2017	0.29	-0.18	44.84	1.46		Silty clay / silty clay with sand inclusions	
										12-Sep-2017	0.92	0.45	44.21	N/M			
BISS2-09-DP-2	Active	599558.246	7238743.607	44.87	45.25	0.38	1.20	43.67	0.80 - 1.10	14-Aug-2017	1.09	0.71	44.16	1.49		Silty sand	
										12-Sep-2017	0.06	-0.32	45.19	N/M			
Goose Island																	
GIBG-10-2-3	Active	596138.596	7239661.038	43.66	44.20	0.54	3.00	40.66	1.43 - 3.00	20-Aug-2017	1.84	1.30	42.36	3.45	1.7E-05	Sand	Retrieved bailer from bottom of standpipe
										12-Sep-2017	1.65	1.11	42.55	N/M			
										12-Sep-2017	N/M	N/A	N/A	N/M	1.6E-05	Silty sand / sandy silt and clay / sand	Well broken at 1.33 mbtoc
GIP11 09-1-4	Damaged	595813.550	7240393.42	45.55	45.90	0.35	4.00	41.55	1.00 - 4.00								
GIQ8-10-2-4	Active	595306.125	7240333.425	47.50	47.72	0.22	3.95	43.55	0.95 - 3.95	20-Aug-2017	2.43	2.21	45.29	4.25	3.3E-06	Sandy silt	
										12-Sep-2017	2.25	2.03	45.47	N/M			

NOTES: 1. Data may be entered to the nearest mm, but are reported above to the nearest cm.
Apparent rounding errors may occasionally occur in calculated fields (e.g. Groundwater Surface Elevation).
2. All coordinates are provided in the UTM Zone 9N referenced to North American Datum of 1927 coordinate system.
3. N/M - Denotes not measured.
4. N/A - Denotes not available.
5. masl - Denotes metres above sea level.
6. mbgs - Denotes metres below ground surface.
7. mbtoc - Denotes metres below top of PVC casing.
8. m/s - metres per second
9. Where a measurement is not available due to the source being dry, depths and elevations are displayed as greater than the measured depth of well, where available, and where not the installed depth is used.



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Table 2

Groundwater Analytical Results: Dissolved Chloride

PROJECT No.: 407074-00828-400

PROJECT No.: 407074-00828-400			Anions
Monitoring Station	Date (dd-mmm-yyyy)	Status	Chloride (mg/L)
CCME CEQG Freshwater Aquatic Life ^{#1}			120
Surveillance Network Program			
Mainland			
ARB-12-3-3	12-Aug-2017	Active	12
	12-Sep-2017		22
C38 08-1-4	12-Aug-2017	Active	19
	12-Sep-2017		14 ^{#2}
CPF 97-7-5 (Duplicate)	17-Aug-2017	Active	19
	17-Aug-2017		19
	12-Sep-2017		18
CPF 98-8-3	17-Aug-2017	Active	9.4
	12-Sep-2017		9.1
MEBG-10-1-3	12-Aug-2017	Active	2.4
	12-Sep-2017		2.4
MTF 97-1-5	17-Aug-2017	Active	1.5
	14-Sep-2017		1.0
TF 03-12-3 (Duplicate)	17-Aug-2017	Active	160 ^{#1}
	13-Sep-2017		190 ^{#1}
	13-Sep-2017		160 ^{#1}
WSY 97-1-5	18-Aug-2017	Active	15
	12-Sep-2017		26
Bear Island			
BI-13-1-4	15-Aug-2017	Active	6.2
BI-13-3-4.5	15-Aug-2017	Active	8.7
	22-Nov-2017		6.5
BIS 97-1-3	22-Nov-2017	Active	20
BISS2-09-DP-1	14-Aug-2017	Active	3.9
	12-Sep-2017		6.9
BISS2-09-DP-2	14-Aug-2017	Active	4.3
	12-Sep-2017		4.8
Goose Island			
GIBG-10-2-3 (Duplicate)	20-Aug-2017	Active	2.4
	20-Aug-2017		2.3
	12-Sep-2017		2.9
GIQ8-10-2-4	20-Aug-2017	Active	5.8
	12-Sep-2017		9.4



Groundwater Analytical Results: Dissolved Chloride

PROJECT No.: 407074-00828-400

Monitoring Station		Date (dd-mmm-yyyy)	Status	Anions Chloride (mg/L)
CCME CEQG Freshwater Aquatic Life ^{#1}				120
Relative Percent Difference (RPD) Report				
CPF 97-7-5		17-Aug-2017	Active	19
(Duplicate)		17-Aug-2017		19
	RPD(%)			0.0%
GIBG-10-2-3		20-Aug-2017	Active	2.4
(Duplicate)		20-Aug-2017		2.3
	RPD(%)			4.3%
TF 03-12-3		13-Sep-2017	Active	190 ^{#1}
(Duplicate)		13-Sep-2017		160 ^{#1}
	RPD(%)			17.1%

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates parameters above applied guideline.
4. Superscript ^{#1} denotes values exceeding
(CCME. 2015. Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. <http://st-ts.ccme.ca/?chems=all&chapters=1> accessed September 2015.)
5. Superscript ^{#2} - Detection limits raised due to sample matrix.

Groundwater Analytical Results: Petroleum Hydrocarbons (PHCs)

PROJECT No.: 407074-00828-400

PROJECT No.: 407074-00828-400						
Monitoring Station	Date (dd-mmm-yyyy)	Status	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (Total) (mg/L)
CCME CEQG Freshwater Aquatic Life ^{#1}			0.37	0.002	0.09	---
Surveillance Network Program						
Mainland						
ARB-12-3-3	12-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
C38 08-1-4	12-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
CPF 97-7-5 (Duplicate)	17-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	17-Aug-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
CPF 98-8-3	17-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
MEBG-10-1-3	12-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
MTF 97-1-5	17-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	14-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
TF 03-12-3 (Duplicate)	17-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	13-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
	13-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
WSY 97-1-5	18-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
Bear Island						
BI-13-1-4	15-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
BI-13-3-4.5	15-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	22-Nov-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
BIS 97-1-3	22-Nov-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
BISS2-09-DP-1	14-Aug-2017	Active	< 0.00040	0.0012	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
BISS2-09-DP-2	14-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
Goose Island						
GIBG-10-2-3 (Duplicate)	20-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	20-Aug-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
GIQ8-10-2-4	20-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	12-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080

Relative Percent Difference (RPD) Report						
CPF 97-7-5 (Duplicate)	17-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	17-Aug-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
RPD(%)			---	---	---	---
GIBG-10-2-3 (Duplicate)	20-Aug-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	20-Aug-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
			---	---	---	---
RPD(%)						
TF 03-12-3 (Duplicate)	13-Sep-2017	Active	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	13-Sep-2017		< 0.00040	< 0.00040	< 0.00040	< 0.00080
RPD(%)			---	---	---	---

NOTES:



1. --- in guideline row(s) denotes no criteria for that parameter.

2. --- in detail data row(s) denotes parameter not analyzed.

3. Highlighting indicates parameters above applied guideline.

4. Highlighting indicates detection limit above applied guideline.

5. Highlighting indicates parameters at applied guideline.

6. Superscript ^{#1}denotes values exceeding
(CCME. 2015. Canadian Environmental Quality Guidelines Summary Table.
Water Quality Guidelines for the Protection of Freshwater Aquatic Life.
<http://st-ts.ccme.ca/?chems=all&chapters=1> accessed September 2015.)



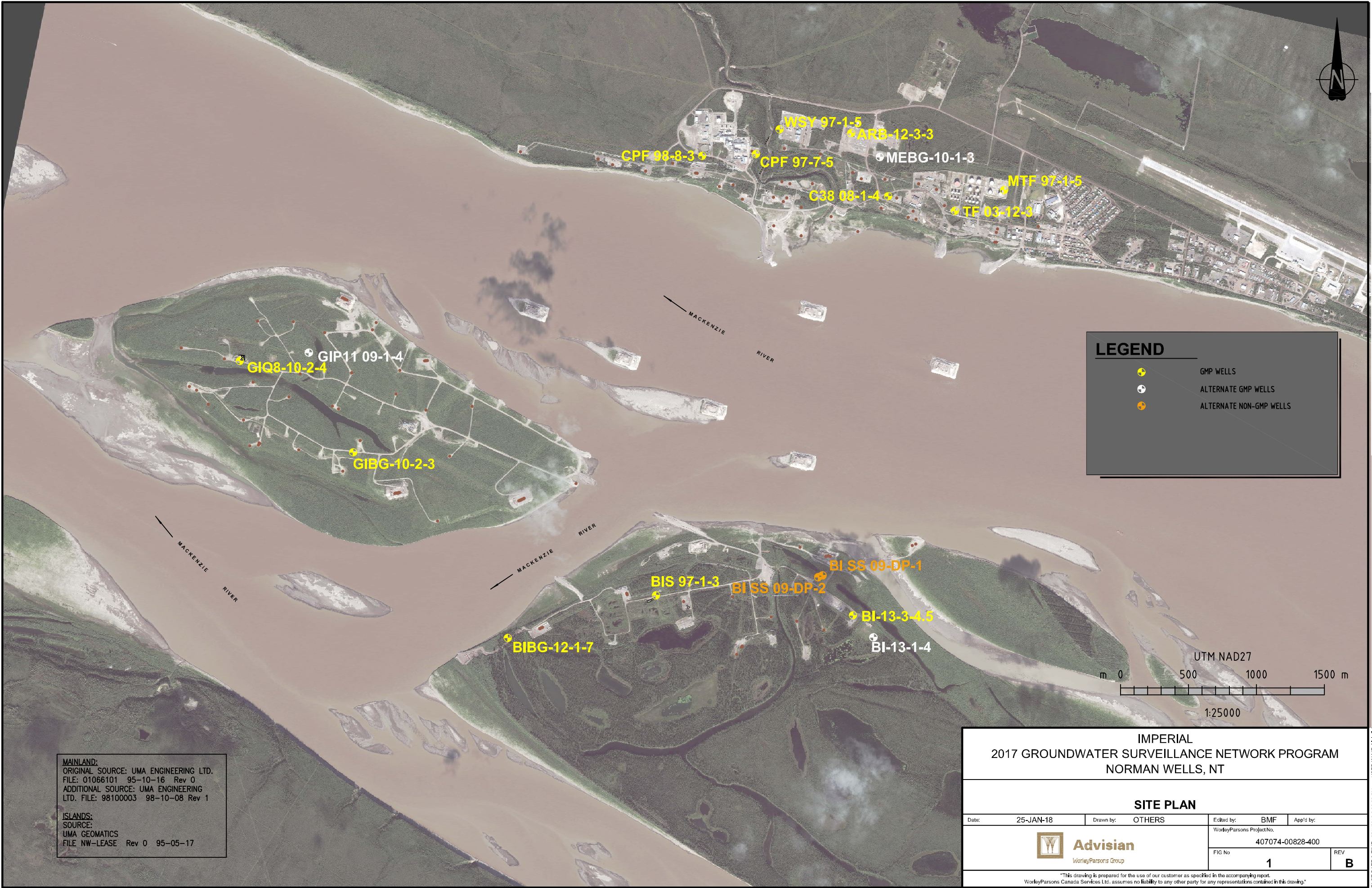
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Figures





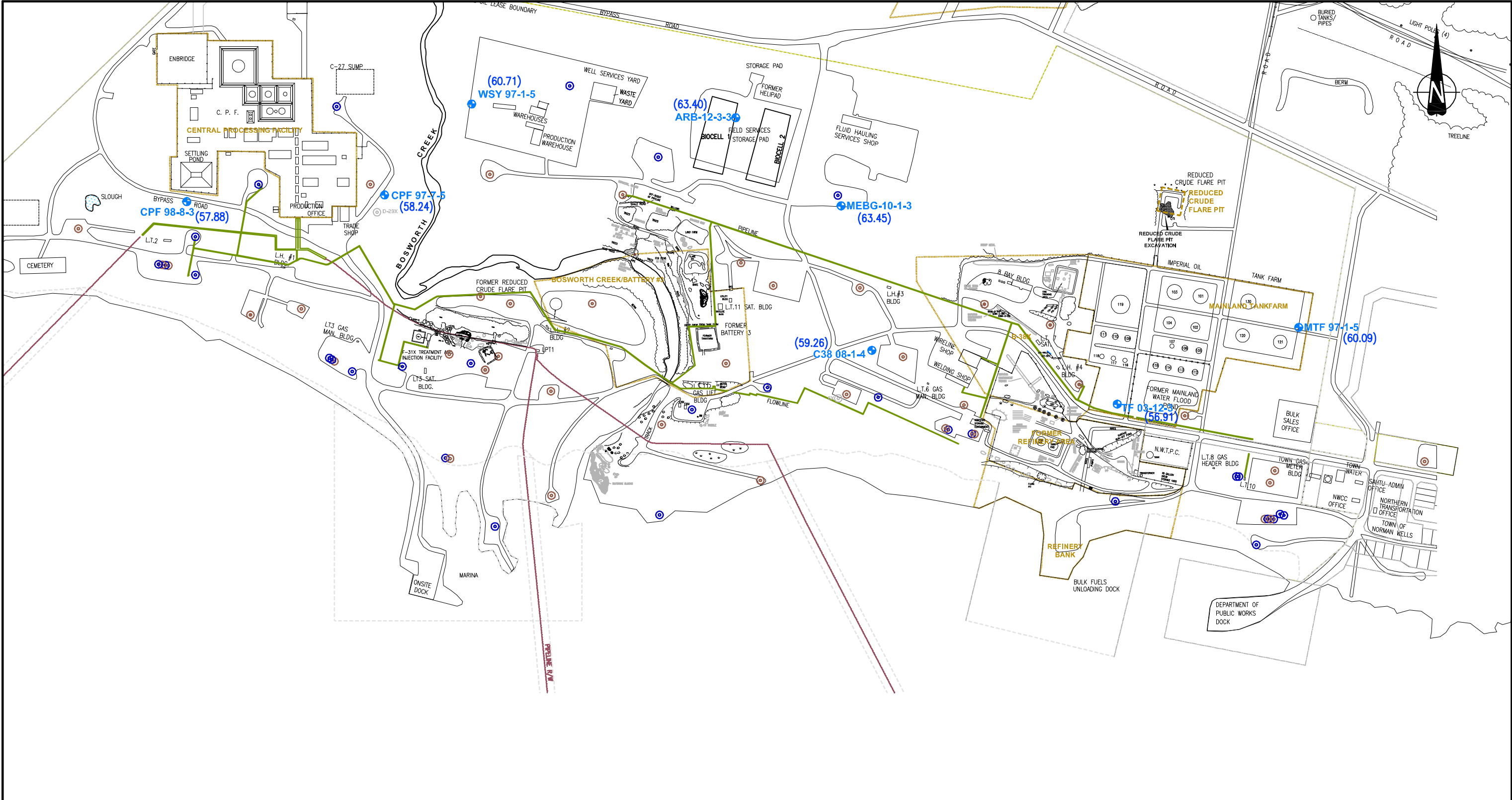
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ISLANDS:
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NORMAN WELLS, NT

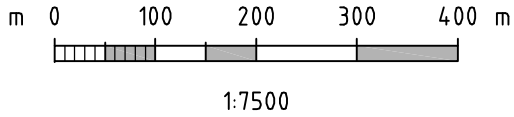
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 Advisian WorleyParsons Group			WorleyParsons Project No.	
			407074-00828-400	
			FIG No	1

*This drawing is prepared for the use of our customer as specified in the accompanying report.
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LEGEND

- INJECTION WELL LOCATION
- MONITORING WELL LOCATION
- GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (AUGUST 12 & 17-18, 2017)
- ESSO LEASE BOUNDARY
- PIPELINES
- UTILIDOR LOCATION
- PRODUCTION WELL LOCATION



SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08).

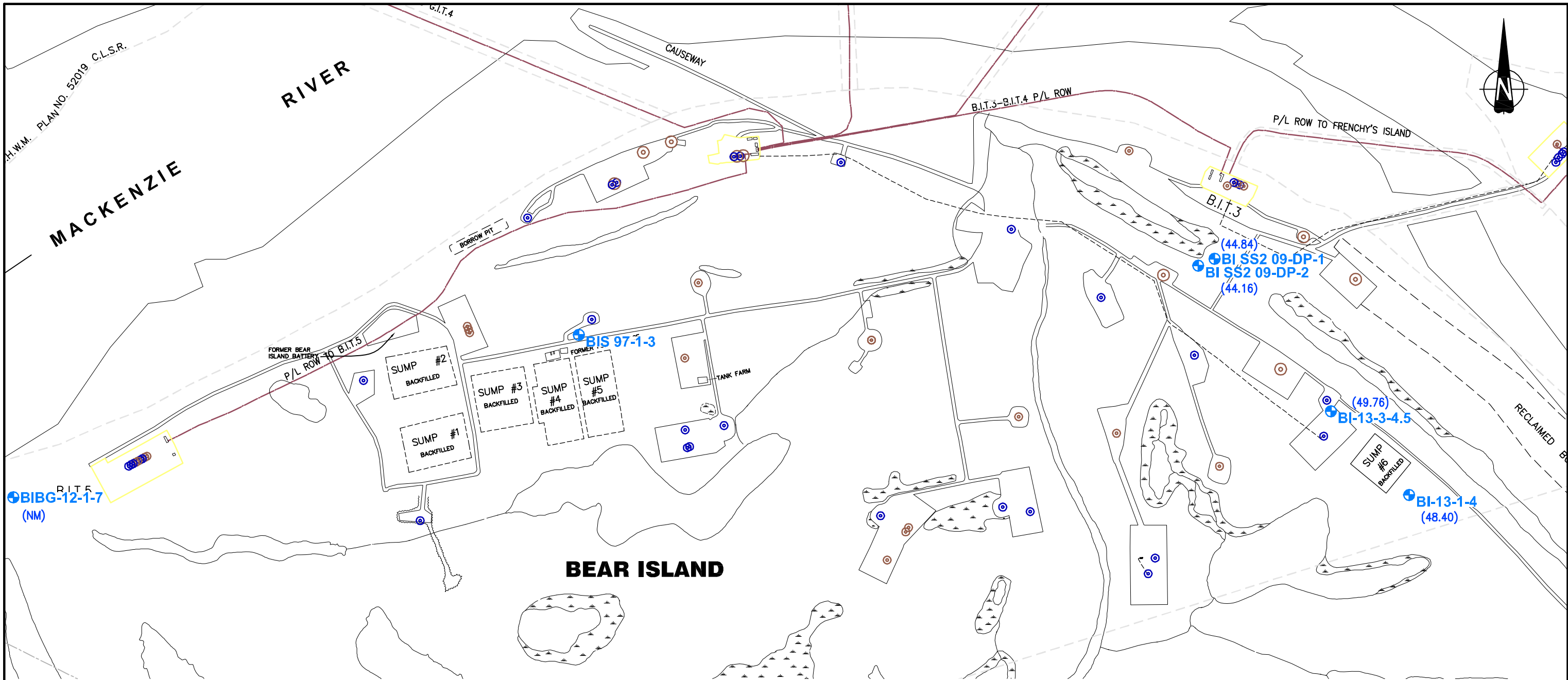
IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

GROUNDWATER SURFACE ELEVATIONS -
MAINLAND (AUGUST 2017)

Date:	25-JAN-18	Drawn by:	OTHERS	Edited by:	B.M.F.	App'd by:	
WorleyParsons Project No.				407074-00828-400			
FIG No				2A		REV B	



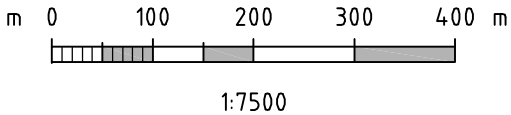
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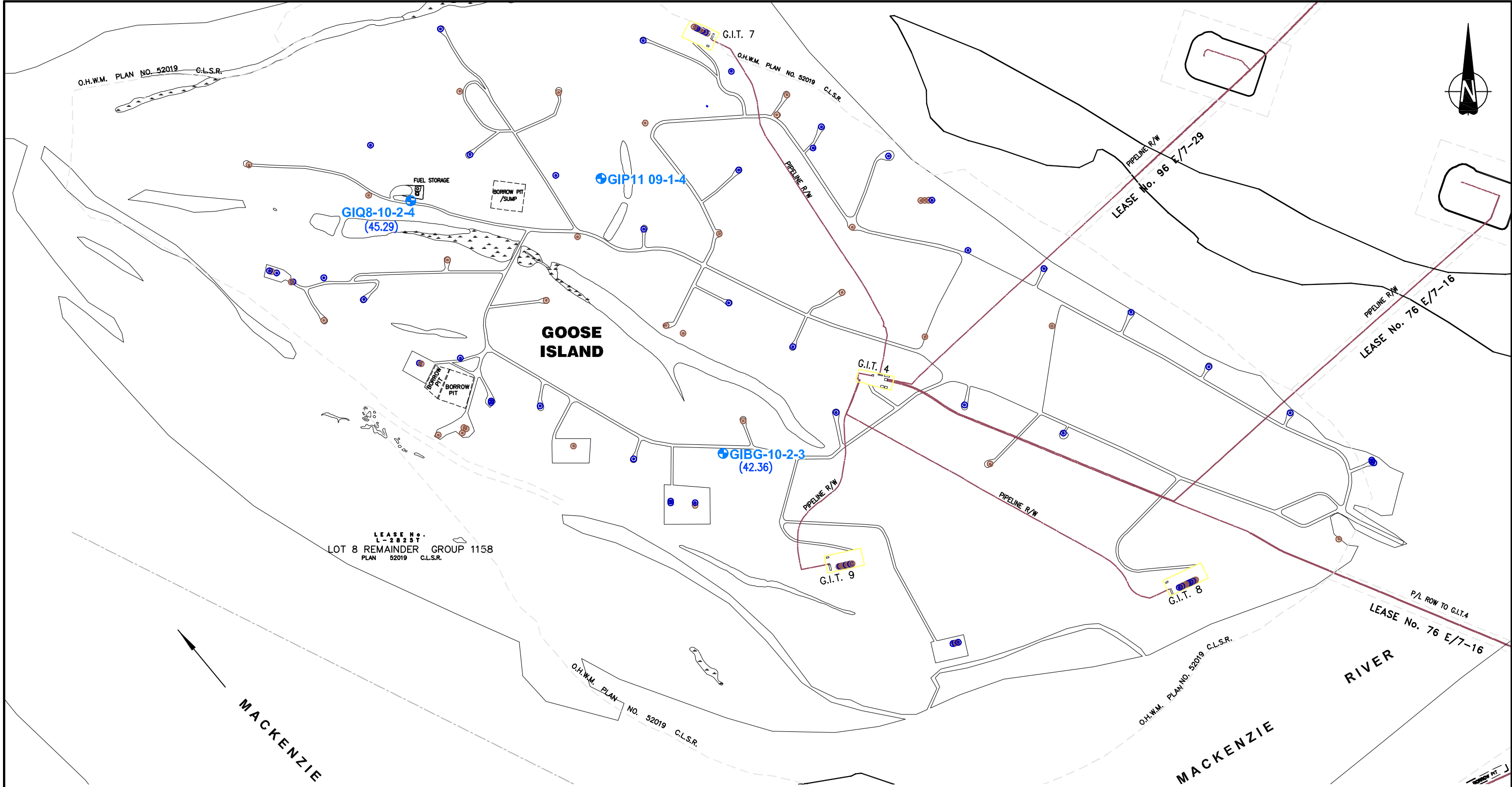
LEGEND

-  INJECTION WELL LOCATION
-  PRODUCTION WELL LOCATION
-  LEASE BOUNDARY (O.H.W.M.)
-  PIPELINE
-  MONITORING WELL LOCATION
-  GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (AUGUST 14, 2017)
-  NOT MEASURED - WELL DAMAGED

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



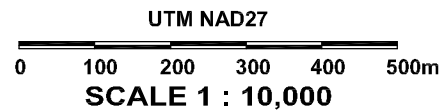
IMPERIAL 2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM NORMAN WELLS, NT					
GROUNDWATER SURFACE ELEVATIONS - BEAR ISLAND (AUGUST 2017)					
Date:	25-JAN-18	Drawn by:	OTHERS	Edited by:	B.M.F.
				App'd by:	
 WorleyParsons Group			WorleyParsons Project No. 407074-00828-400		
			FIG No	2B	REV B
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LEGEND

-  INJECTION WELL LOCATION
-  PRODUCTION WELL LOCATION
-  LEASE BOUNDARY (O.H.W.M.)
-  PIPELINE
-  MONITORING WELL LOCATION
-  GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (AUGUST 20, 2017)

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



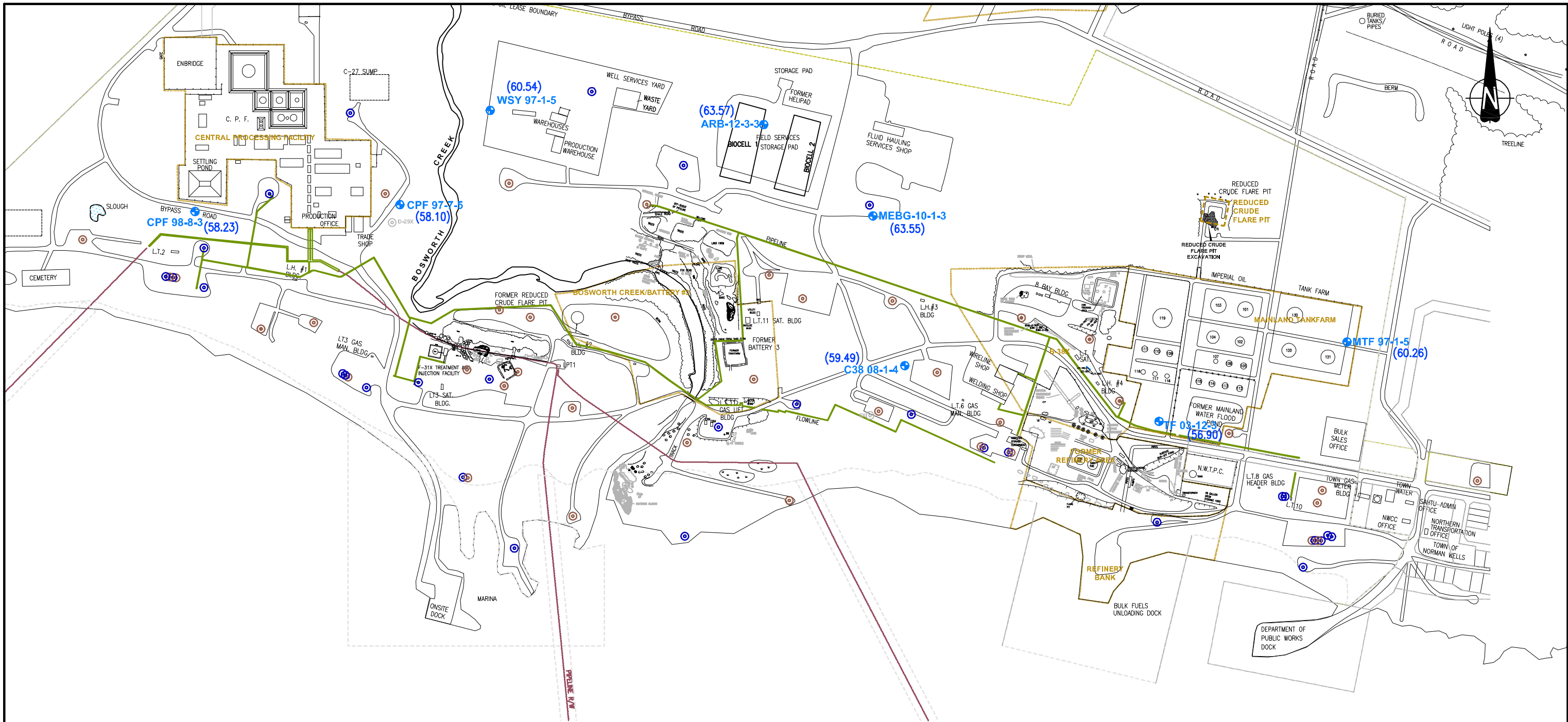
IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

GROUNDWATER SURFACE ELEVATIONS -
GOOSE ISLAND (AUGUST 2017)

Date:	25-JAN-18	Drawn by:	OTHERS	Edited by:	B.M.F.	App'd by:	
				WorleyParsons Project No.			
				407074-00828-400			
				FIG No.		REV	
				2C		B	



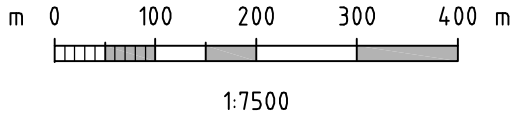
"This drawing is prepared for the use of our customer as specified in the accompanying report. WorleyParsons Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."



LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- MONITORING WELL LOCATION
- GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (SEPTEMBER 12-14, 2017)
- ESSO LEASE BOUNDARY
- PIPELINES
- UTILIDOR LOCATION

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08).



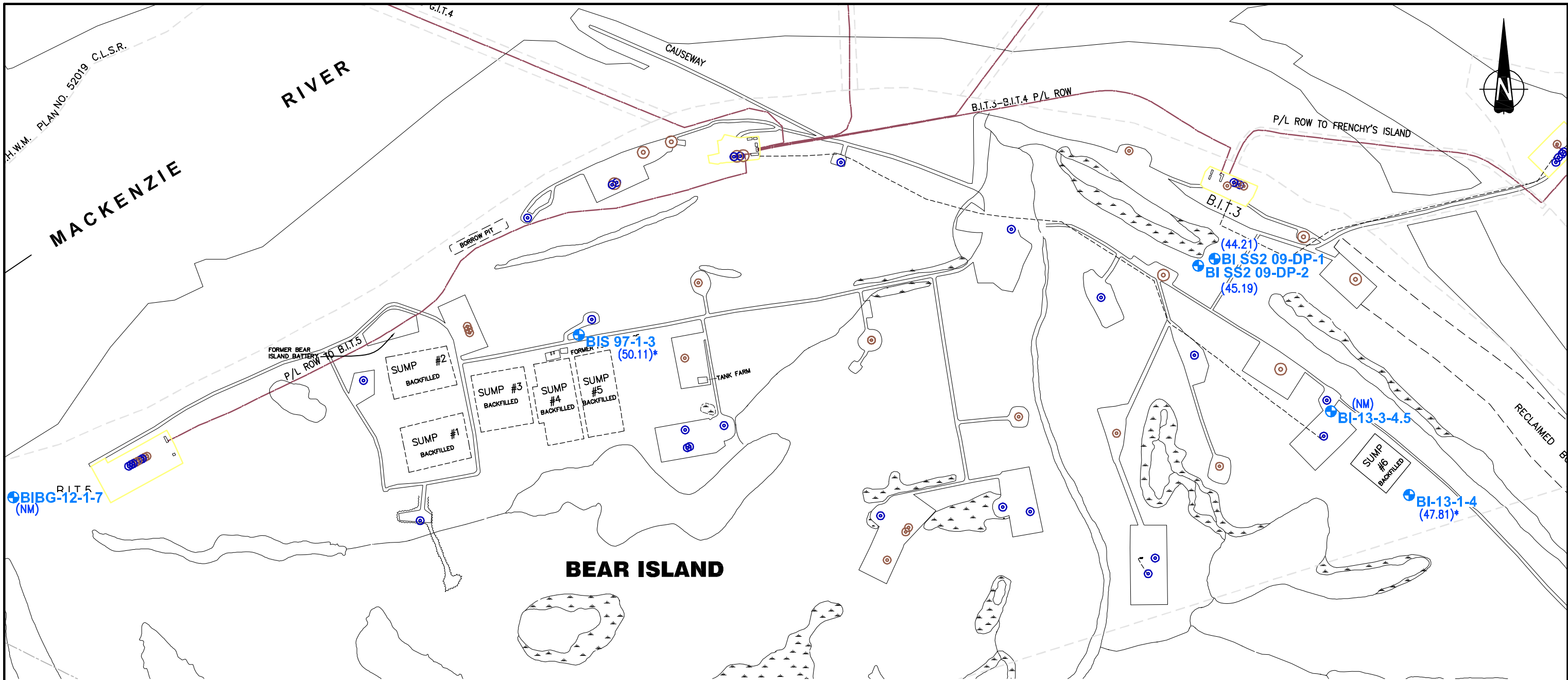
IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

**GROUNDWATER SURFACE ELEVATIONS -
MAINLAND (SEPTEMBER 2017)**

Date:	25-JAN-18	Drawn by:	OTHERS	Edited by:	B.M.F.	App'd by:	
WorleyParsons Project No.				407074-00828-400			
FIG No				3A		REV	B



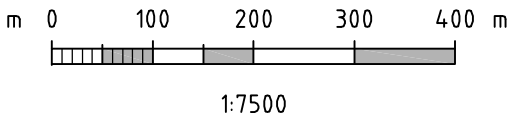
*This drawing is prepared for the use of our customer as specified in the accompanying report.
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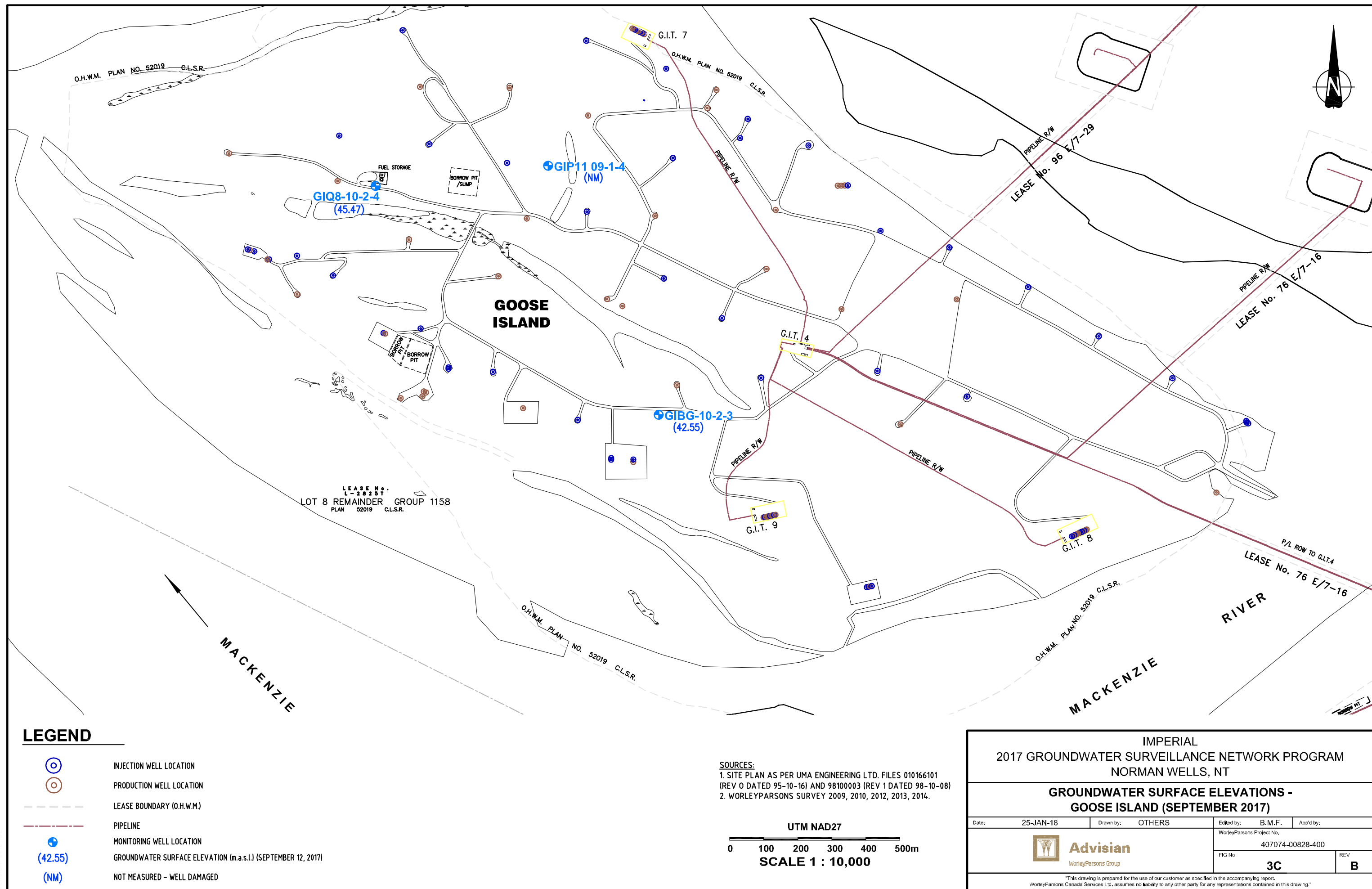
LEGEND

-  INJECTION WELL LOCATION
-  PRODUCTION WELL LOCATION
-  LEASE BOUNDARY (O.H.W.M.)
-  PIPELINE
-  MONITORING WELL LOCATION
-  GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (SEPTEMBER 12, 2017)
-  GROUNDWATER SURFACE ELEVATION (m.a.s.l.) (NOVEMBER 22, 2017)
-  NOT MEASURED - WELL DRY, DAMAGED OR FROZEN

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



IMPERIAL 2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM NORMAN WELLS, NT			
GROUNDWATER SURFACE ELEVATIONS - BEAR ISLAND (SEPTEMBER & NOVEMBER 2017)			
Date:	25-JAN-18	Drawn by:	OTHERS
Edited by:	B.M.F.	App'd by:	
WorleyParsons Project No.		407074-00828-400	
FIG No		3B	REV B
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CPF 98-8-3	
Screen Interval: 1.4 - 2.9 m	
Sample Date	Chloride
17-Aug-2017	9.4
12-Sep-2017	9.1

CPF 97-7-5	
Screen Interval: NA	
Sample Date	Chloride
17-Aug-2017	19
17-Aug-2017 (dup)	19
12-Sep-2017	18

WSY 97-1-5	
Screen Interval: 1.7 - 4.7 m	
Sample Date	Chloride
18-Aug-2017	15
12-Sep-2017	26

MTF 97-1-5	
Screen Interval: 1.7 - 4.7 m	
Sample Date	Chloride
17-Aug-2017	1.5
14-Sep-2017	1.0

ARB-12-3-3	
Screen Interval: 1.2 - 2.7 m	
Sample Date	Chloride
12-Aug-2017	12
12-Sep-2017	22

MEBG-10-1-3	
Screen Interval: 1.5 - 3.0 m	
Sample Date	Chloride
12-Aug-2017	2.4
12-Sep-2017	2.4

C38 08-1-4	
Screen Interval: 1.8 - 3.8 m	
Sample Date	Chloride
12-Aug-2017	19
12-Sep-2017	14

TF 03-12-3	
Screen Interval: 1.0 - 2.8 m	
Sample Date	Chloride
17-Aug-2017	160
13-Sep-2017	190
13-Sep-2017 (dup)	160

LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- ESSO LEASE BOUNDARY
- PIPELINES
- UTILIDOR LOCATION
- MONITORING WELL LOCATION

LIST OF APPLICABLE ABBREVIATIONS

- RDL REPORTABLE DETECTION LIMIT
- (dup) FIELD DUPLICATE

ANALYTICAL RESULTS

- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET GUIDELINE FOR ALL PARAMETERS THAT WERE ANALYZED, SHOWN IN GREEN.
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED GUIDELINE FOR AT LEAST ONE PARAMETER THAT WAS ANALYZED, SHOWN IN RED
- LOCATION NOT SAMPLED IN MOST RECENT SAMPLING EVENT
- 1234** EXCEEDANCES OF GUIDELINE, SHOWN IN RED AND BOLD

CCME CEQG Freshwater Aquatic Life	
Parameter	Chloride
CCME CEQG Freshwater Aquatic Life	120
95th Percentile Background - Surficial Sediments - Mainland	15
95th Percentile Background - Surficial Sediments - Islands	13
95th Percentile Background - Shallow Bedrock	332
RDL	1.0

NOTES

- ALL UNITS IN mg/L (MILLIGRAMS PER LITRE).
- SCREEN INTERVAL IN METRES BELOW GROUND SURFACE.

REFERENCES:

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE. 2015.

SOURCES:

- SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
- WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



1:7500

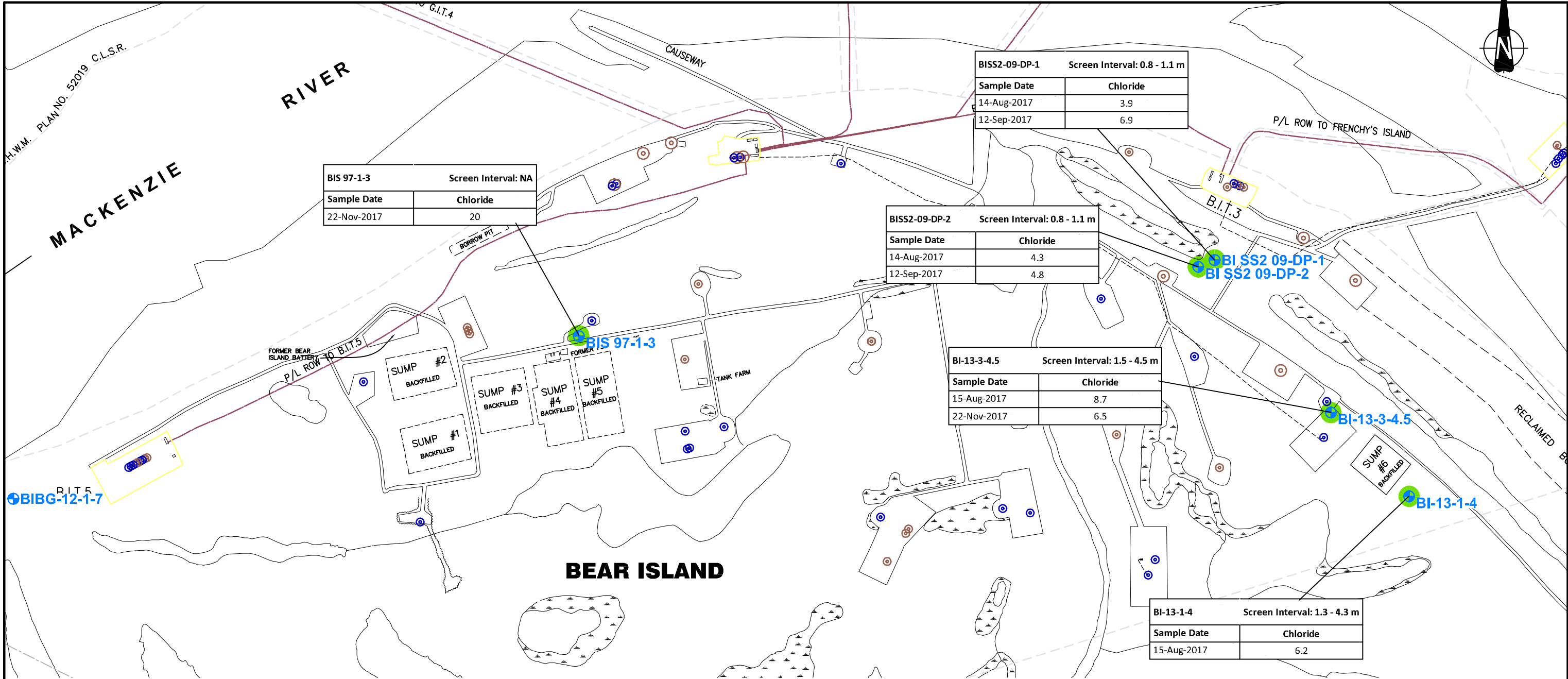
IMPERIAL 2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM NORMAN WELLS, NT

GROUNDWATER ANALYTICAL RESULTS: DISSOLVED CHLORIDE (MAINLAND)			
Date:	25-JAN-18	Drawn by:	OTHERS
Edited by:	B.M.F.	App'd by:	
WorleyParsons Project No.	407074-00828-400		
FIG No	4A	REV	B



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LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- LEASE BOUNDARY (O.H.W.M.)
- PIPELINE
- MONITORING WELL LOCATION

LIST OF APPLICABLE ABBREVIATIONS

RDL REPORTABLE DETECTION LIMIT

ANALYTICAL RESULTS

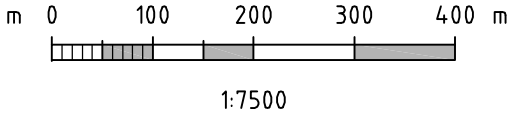
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET GUIDELINE FOR ALL PARAMETERS THAT WERE ANALYZED, SHOWN IN GREEN.
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED GUIDELINE FOR AT LEAST ONE PARAMETER THAT WAS ANALYZED, SHOWN IN RED
- LOCATION NOT SAMPLED IN MOST RECENT SAMPLING EVENT
- 1234 EXCEEDANCES OF GUIDELINE, SHOWN IN RED AND BOLD

CCME CEQG Freshwater Aquatic Life	
Parameter	Chloride
CCME CEQG Freshwater Aquatic Life	120
95th Percentile Background - Surficial Sediments - Mainland	15
95th Percentile Background - Surficial Sediments - Islands	13
95th Percentile Background - Shallow Bedrock	332
RDL	1.0

NOTES
1. ALL UNITS IN mg/L (MILLIGRAMS PER LITRE).
2. SCREEN INTERVAL IN METRES BELOW GROUND SURFACE.

REFERENCES:
CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE. 2015.

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



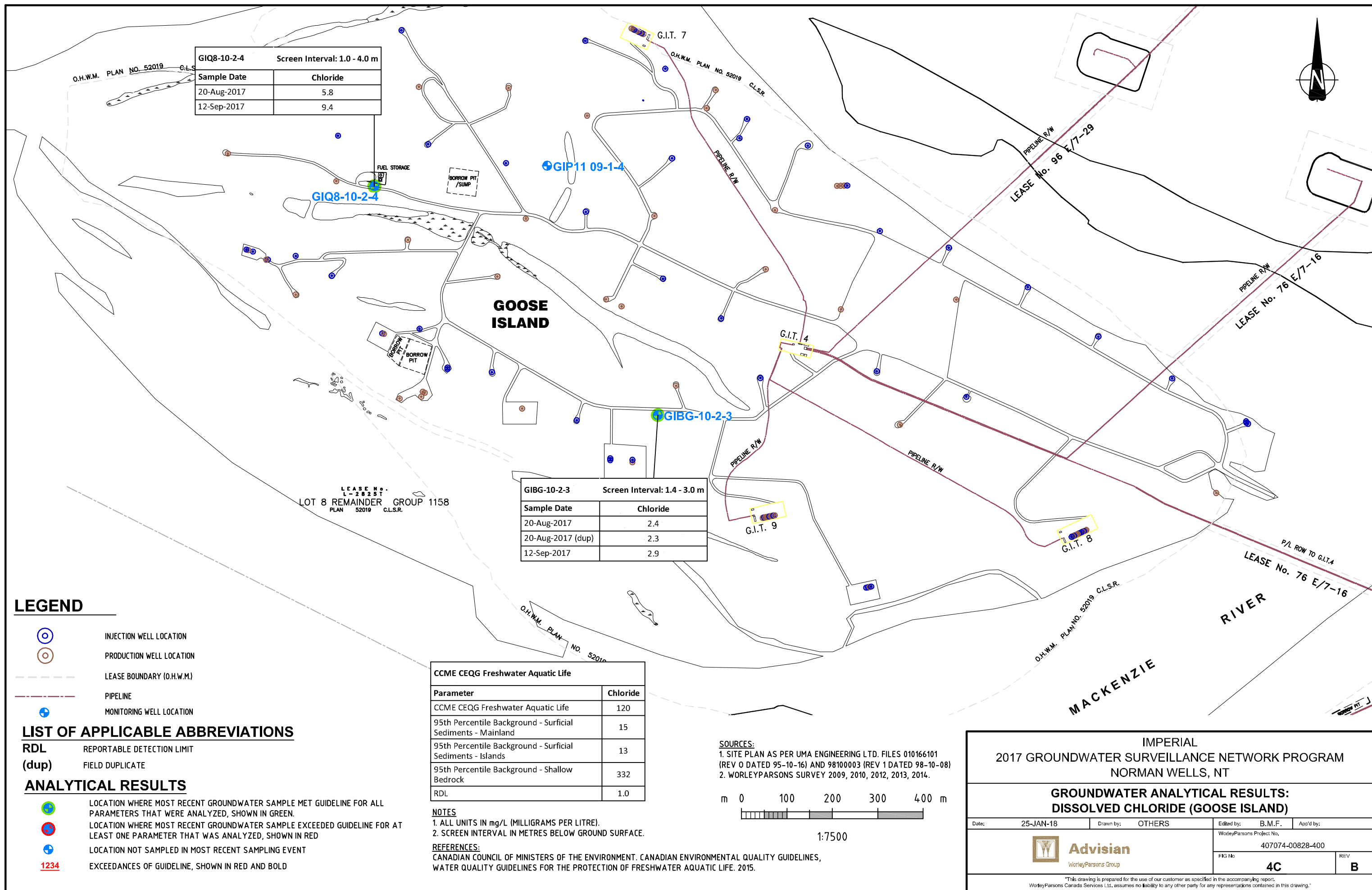
IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

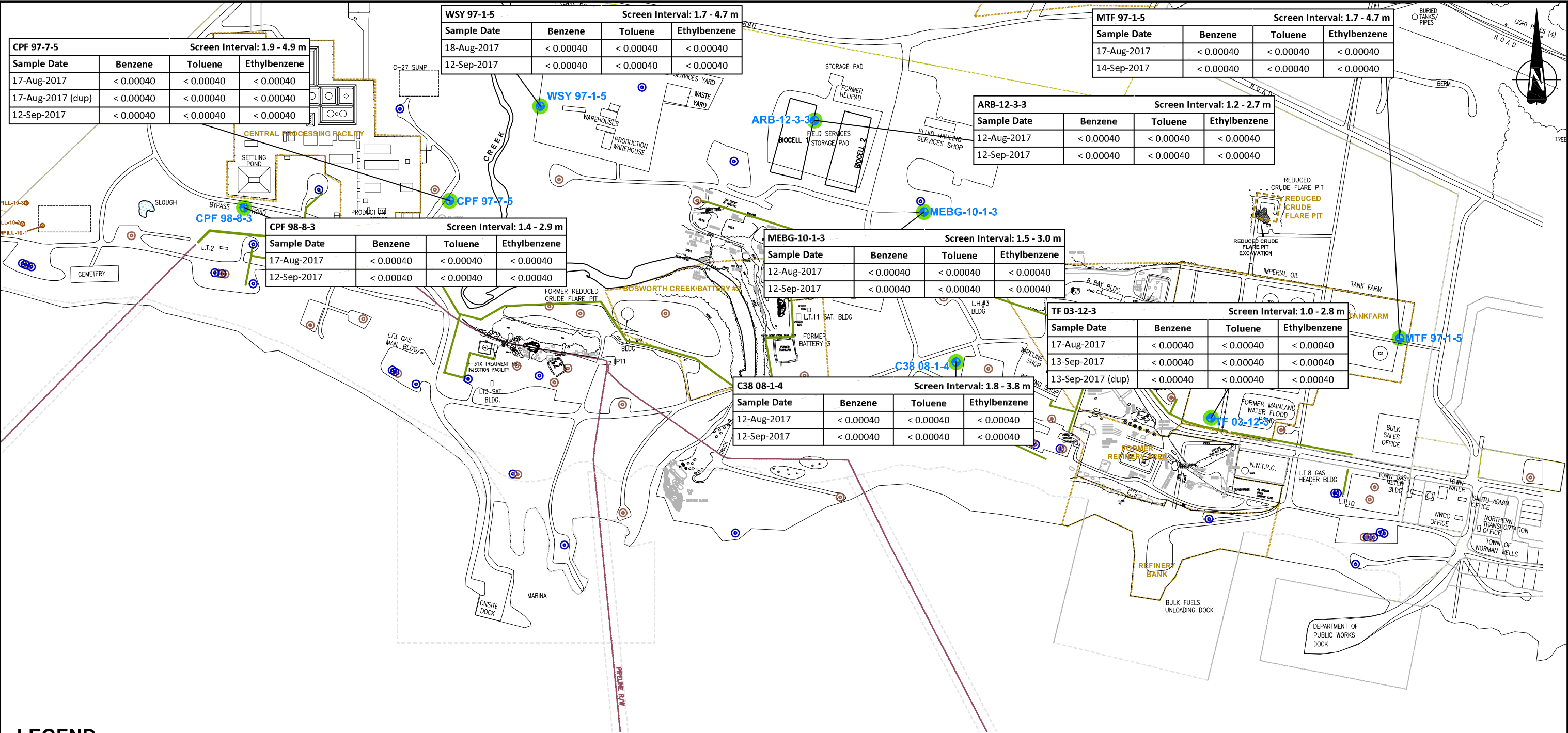
GROUNDWATER ANALYTICAL RESULTS:
DISSOLVED CHLORIDE (BEAR ISLAND)

Date:	25-JAN-18	Drawn by:	OTHERS	Edited by:	B.M.F.	App'd by:	
				WorleyParsons Project No.		407074-00828-400	
				FIG No		4B	REV B

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WorleyParsons Group

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LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- ESSO LEASE BOUNDARY
- PIPELINES
- UTILIDOR LOCATION
- MONITORING WELL LOCATION

LIST OF APPLICABLE ABBREVIATIONS

RDL REPORTABLE DETECTION LIMIT
(dup) FIELD DUPLICATE

ANALYTICAL RESULTS

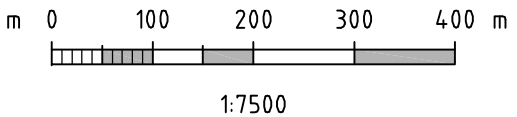
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET GUIDELINE FOR ALL PARAMETERS THAT WERE ANALYZED, SHOWN IN GREEN.
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED GUIDELINE FOR AT LEAST ONE PARAMETER THAT WAS ANALYZED, SHOWN IN RED
- LOCATION NOT SAMPLED IN MOST RECENT SAMPLING EVENT
- 1234 EXCEEDANCES OF GUIDELINE, SHOWN IN RED AND BOLD

CCME CEQG Freshwater Aquatic Life			
Parameter	Benzene	Toluene	Ethylbenzene
CCME CEQG Freshwater Aquatic Life	0.37	0.002	0.09
RDL	0.00040	0.00040	0.00040

NOTES
1. ALL UNITS IN mg/L (MILLIGRAMS PER LITRE).
2. SCREEN INTERVAL IN METRES BELOW GROUND SURFACE.

REFERENCES:
CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE. 2015.

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

GROUNDWATER ANALYTICAL RESULTS:
PETROLEUM HYDROCARBON PARAMETERS (MAINLAND)

Date: 25-JAN-18

Drawn by: OTHERS

Edited by: B.M.F.

App'd by:

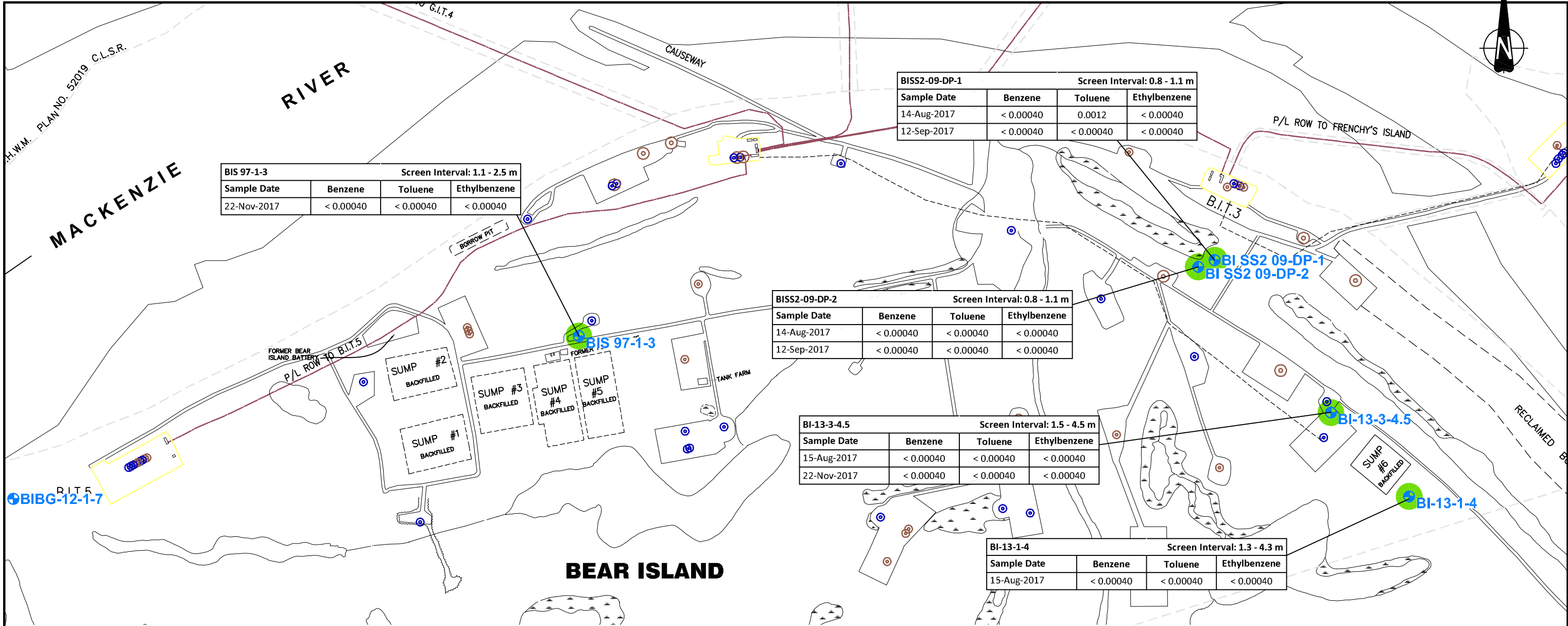
WorleyParsons Project No.
407074-00828-400

FIG No
5A

REV
B

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LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- LEASE BOUNDARY (O.H.W.M.)
- PIPELINE
- MONITORING WELL LOCATION

LIST OF APPLICABLE ABBREVIATIONS

RDL REPORTABLE DETECTION LIMIT

ANALYTICAL RESULTS

- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET GUIDELINE FOR ALL PARAMETERS THAT WERE ANALYZED, SHOWN IN GREEN.
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED GUIDELINE FOR AT LEAST ONE PARAMETER THAT WAS ANALYZED, SHOWN IN RED
- LOCATION NOT SAMPLED IN MOST RECENT SAMPLING EVENT
- 1234 EXCEEDANCES OF GUIDELINE, SHOWN IN RED AND BOLD

CCME CEQG Freshwater Aquatic Life				
Parameter	Benzene	Toluene	Ethylbenzene	
CCME CEQG Freshwater Aquatic Life	0.37	0.002	0.09	
RDL	0.00040	0.00040	0.00040	

- NOTES
- ALL UNITS IN mg/L (MILLIGRAMS PER LITRE).
 - SCREEN INTERVAL IN METRES BELOW GROUND SURFACE.

REFERENCES:
CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE. 2015.

BISS2-09-DP-1			
Screen Interval: 0.8 - 1.1 m			
Sample Date	Benzene	Toluene	Ethylbenzene
14-Aug-2017	< 0.00040	0.0012	< 0.00040
12-Sep-2017	< 0.00040	< 0.00040	< 0.00040

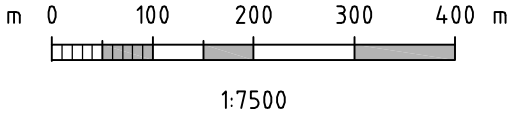
BIS 97-1-3			
Screen Interval: 1.1 - 2.5 m			
Sample Date	Benzene	Toluene	Ethylbenzene
22-Nov-2017	< 0.00040	< 0.00040	< 0.00040

BISS2-09-DP-2			
Screen Interval: 0.8 - 1.1 m			
Sample Date	Benzene	Toluene	Ethylbenzene
14-Aug-2017	< 0.00040	< 0.00040	< 0.00040
12-Sep-2017	< 0.00040	< 0.00040	< 0.00040

BI-13-3-4.5			
Screen Interval: 1.5 - 4.5 m			
Sample Date	Benzene	Toluene	Ethylbenzene
15-Aug-2017	< 0.00040	< 0.00040	< 0.00040
22-Nov-2017	< 0.00040	< 0.00040	< 0.00040

BI-13-1-4			
Screen Interval: 1.3 - 4.3 m			
Sample Date	Benzene	Toluene	Ethylbenzene
15-Aug-2017	< 0.00040	< 0.00040	< 0.00040

- SOURCES:
- SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
 - WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



IMPERIAL

2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM

NORMAN WELLS, NT

BEAR ISLAND GROUNDWATER

ANALYTICAL RESULTS: PETROLEUM HYDROCARBON PARAMETERS

Date: 25-JAN-18

Drawn by: OTHERS

Edited by: B.M.F.

App'd by:

WorleyParsons Project No.

407074-00828-400

FIG No

5B

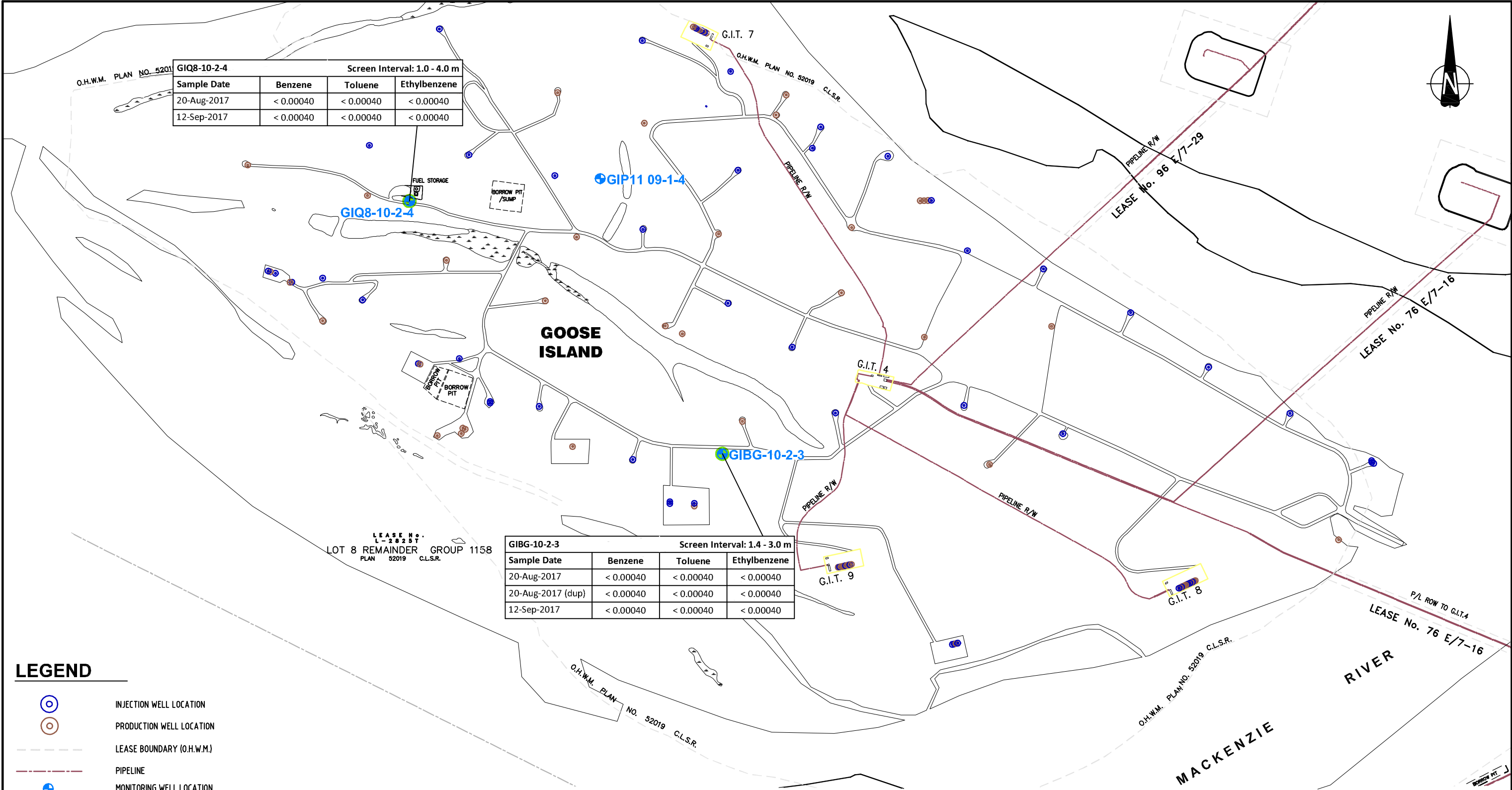
REV

B

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LEGEND

- INJECTION WELL LOCATION
- PRODUCTION WELL LOCATION
- LEASE BOUNDARY (O.H.W.M.)
- PIPELINE
- MONITORING WELL LOCATION

LIST OF APPLICABLE ABBREVIATIONS

RDL REPORTABLE DETECTION LIMIT
(dup) FIELD DUPLICATE

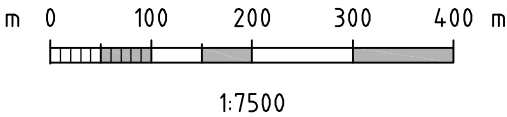
ANALYTICAL RESULTS

- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE MET GUIDELINE FOR ALL PARAMETERS THAT WERE ANALYZED, SHOWN IN GREEN.
- LOCATION WHERE MOST RECENT GROUNDWATER SAMPLE EXCEEDED GUIDELINE FOR AT LEAST ONE PARAMETER THAT WAS ANALYZED, SHOWN IN RED
- LOCATION NOT SAMPLED IN MOST RECENT SAMPLING EVENT
- 1234 EXCEEDANCES OF GUIDELINE, SHOWN IN RED AND BOLD

CCME CEQG Freshwater Aquatic Life			
Parameter	Benzene	Toluene	Ethylbenzene
CCME CEQG Freshwater Aquatic Life	0.37	0.002	0.09
RDL	0.00040	0.00040	0.00040

NOTES
1. ALL UNITS IN mg/L (MILLIGRAMS PER LITRE).
2. SCREEN INTERVAL IN METRES BELOW GROUND SURFACE.
REFERENCES:
CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. CANADIAN ENVIRONMENTAL QUALITY GUIDELINES, WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE. 2015.

SOURCES:
1. SITE PLAN AS PER UMA ENGINEERING LTD. FILES 010166101 (REV 0 DATED 95-10-16) AND 98100003 (REV 1 DATED 98-10-08)
2. WORLEYPARSONS SURVEY 2009, 2010, 2012, 2013, 2014.



IMPERIAL
2017 GROUNDWATER SURVEILLANCE NETWORK PROGRAM
NORMAN WELLS, NT

GOOSE ISLAND GROUNDWATER
ANALYTICAL RESULTS: PETROLEUM HYDROCARBON PARAMETERS

Date: 25-JAN-18	Drawn by: OTHERS	Edited by: B.M.F.	App'd by:
WorleyParsons Project No. 407074-00828-400		FIG No. 5C	
WorleyParsons Group		REV B	

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Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendices





Advisian
WorleyParsons Group

Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendix A

Limitation of Liability, Scope of Report and Third Party Reliance



Limitation of Liability, Scope of Report, and Third Party Reliance

This report has been prepared and the work referred to in this report has been undertaken by WorleyParsons Canada Services Ltd., operating as Advisian (Advisian) for Imperial Oil Limited. It is intended for the sole and exclusive use of Imperial Oil Limited, its affiliated companies and partners and their respective [insurers], agents, employees, and advisors (collectively, "Imperial Oil"). Any use, reliance on or decision made by any person other than Imperial Oil based on this report is the sole responsibility of such other person. Imperial Oil and Advisian make no representation or warranty to any other person with regard to this report and the work referred to in this report and they accept no duty of care to any other person or any liability or responsibility whatsoever for any losses, expenses, damages, fines, penalties or other harm that may be suffered or incurred by any other person as a result of the use of, reliance on, any decision made or any action taken based on this report or the work referred to in this report.

The investigation undertaken by Advisian with respect to this report and any conclusions or recommendations made in this report reflect Advisian's judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for the specific application to this site and it is based, in part, upon visual observation of the site, subsurface investigation at discrete locations and depths, and specific analysis of specific chemical parameters and materials during a specific time interval, all as described in this report. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, portions of the site which were unavailable for direct investigation, subsurface locations which were not investigated directly, or chemical parameters, materials or analysis which were not addressed. Substances other than those addressed by the investigation described in this report may exist within the site, substances addressed by the investigation may exist in areas of the site not investigated and concentrations of substances addressed which are different than those reported may exist in areas other than the locations from which samples were taken.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings, conclusions, and recommendations in this report may be necessary.

Other than by Imperial Oil, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of Advisian. Nothing in this report is intended to constitute or provide a legal opinion.



Advisian
WorleyParsons Group

Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendix B

Field Methodologies



Groundwater Sampling Methods

Field Measurements, Sampling and Handling

Prior to collection of groundwater samples, the water and/or hydrocarbon level was measured from the top of the piezometer PVC casing using a Solinst or other commercially-available electric water level meter or two-phase probe.

Subsequently, groundwater from each monitoring well was collected for field-measured parameters and laboratory analysis, using either dedicated or disposable bailers, Waterra™, or HydraSleeves™ with no-purge methodology.

Field measurements of the following time-sensitive water quality parameters were conducted during the field sampling program:

Temperature: measured at surface using a pH or EC meter temperature probe.

pH: measured with a WTW pH 3150i meter equipped with a SenTix 41 probe, a HI 9024 pH meter equipped with a HI 76302 probe, or an Oakton PC 300 joint pH and EC meter, calibrated using buffer solutions of pH 4, pH 7 and/or pH 10.

EC: electrical conductivity (temperature-corrected) measured with a WTW Cond 3150i meter equipped with a TetraCon 325 probe, a HI 9033 EC meter equipped with a HI 1230 probe, or an Oakton PC 300 joint pH and EC meter, calibrated with standard KCl solution ($\approx 1,413 \mu\text{S}/\text{cm}$ @ 25°C).

All meters were calibrated on site. Immediately following collection of the above readings, all equipment was rinsed thoroughly with deionized water.

Once field parameters had been measured, samples were collected for the following analyses per the GMP:

Dissolved Chloride: 1 x 500 mL aliquot (unfiltered and chemically unpreserved) for analysis of major ions.

BTEX: 2 x 44 mL aliquots (placed in glass vials containing NaHSO_4 preservative, no headspace) for analysis of BTEX compounds (benzene, toluene, ethylbenzene and total xylenes).

Upon completion of sampling at each location, all equipment was thoroughly rinsed with deionized water. New bailing rope (as required) and clean disposable nitrile gloves were used at each piezometer to reduce the potential for cross-contamination. Samples were stored in iced coolers to maintain approximate in situ temperatures, and were promptly shipped to Maxxam Analytics Inc., in Edmonton, Alberta. Standard chain-of-custody procedures were followed.



Advisian
WorleyParsons Group

Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendix C Laboratory Analytical Results



Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294858

Report Date: 2017/08/21

Report #: R2431252

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B768369

Received: 2017/08/14, 09:40

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	3	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	3	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	3	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	3	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	3	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	3	AB SOP-00037	CCME PHC-CWS m
Hardness	3	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	3	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	3	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	3	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	3	AB WI-00065	Auto Calc
Nitrate and Nitrite	3	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	3	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	3	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (3)	1	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	1	AB SOP-00037 / AB SOP-00003	EPA 3510C/8270D m
Phenols (4-AAP)	3	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	3	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	3	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294858

Report Date: 2017/08/21

Report #: R2431252

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B768369

Received: 2017/08/14, 09:40

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

(3) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key



Jenna Chernuka
Project Manager
21 Aug 2017 12:27:56

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RS6041	RS6042	RS6043		
Sampling Date		2017/08/12 10:25	2017/08/12 09:00	2017/08/12 08:15		
COC Number		294858	294858	294858		
	UNITS	C38 08-1-4	MEBG-10-1-3	ARB-12-3-3	RDL	QC Batch
Ext. Pet. Hydrocarbon						
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	0.10	8727866
Volatiles						
Benzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8726457
Toluene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8726457
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8726457
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	0.00080	8726457
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8726457
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	0.00080	8726457
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	0.10	8726457
F1 (C6-C10)	mg/L	<0.10	<0.10	<0.10	0.10	8726457
Extraction Surrogate Recovery (%)						
O-TERPHENYL (sur.)	%	97	96	97		8727866
Instrument Surrogate Recovery (%)						
1,4-Difluorobenzene (sur.)	%	98	98	96		8726457
4-Bromofluorobenzene (sur.)	%	99	100	99		8726457
D4-1,2-Dichloroethane (sur.)	%	101	98	100		8726457
RDL = Reportable Detection Limit						

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RS6041	RS6042	RS6043		
Sampling Date		2017/08/12 10:25	2017/08/12 09:00	2017/08/12 08:15		
COC Number		294858	294858	294858		
	UNITS	C38 08-1-4	MEBG-10-1-3	ARB-12-3-3	RDL	QC Batch
Low Level Elements						
Dissolved Cadmium (Cd)	mg/L	<0.000020	0.000032	0.000077	0.000020	8725353
Elements						
Dissolved Aluminum (Al)	mg/L	0.067	0.0044	0.015	0.0030	8726900
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	0.00060	8726900
Dissolved Arsenic (As)	mg/L	0.023	0.00096	0.00076	0.00020	8726900
Dissolved Barium (Ba)	mg/L	0.55	0.39	0.11	0.010	8730342
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	8726900
Dissolved Boron (B)	mg/L	0.061	0.022	0.049	0.020	8730342
Dissolved Calcium (Ca)	mg/L	160	230	160	0.30	8730342
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	8726900
Dissolved Cobalt (Co)	mg/L	0.0052	0.0014	<0.00030	0.00030	8726900
Dissolved Copper (Cu)	mg/L	0.00034	0.00078	0.0063	0.00020	8726900
Dissolved Iron (Fe)	mg/L	27	2.8	<0.060	0.060	8730342
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	0.00020	8726900
Dissolved Lithium (Li)	mg/L	0.024	<0.020	<0.020	0.020	8730342
Dissolved Magnesium (Mg)	mg/L	50	48	44	0.20	8730342
Dissolved Manganese (Mn)	mg/L	1.8	0.67	0.057	0.0040	8730342
Dissolved Molybdenum (Mo)	mg/L	0.00033	0.0027	0.0015	0.00020	8726900
Dissolved Nickel (Ni)	mg/L	0.0068	0.0052	0.0057	0.00050	8726900
Dissolved Phosphorus (P)	mg/L	0.13	<0.10	<0.10	0.10	8730342
Dissolved Potassium (K)	mg/L	3.3	1.5	1.9	0.30	8730342
Dissolved Selenium (Se)	mg/L	0.0028	0.00039	0.00058	0.00020	8726900
Dissolved Silicon (Si)	mg/L	11	4.3	5.0	0.10	8730342
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	0.00010	8726900
Dissolved Sodium (Na)	mg/L	39	40	12	0.50	8730342
Dissolved Strontium (Sr)	mg/L	0.53	0.72	0.62	0.020	8730342
Dissolved Sulphur (S)	mg/L	10	65	20	0.20	8730342
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	0.00020	8726900
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	8726900
Dissolved Titanium (Ti)	mg/L	0.0013	<0.0010	<0.0010	0.0010	8726900
RDL = Reportable Detection Limit						

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RS6041	RS6042	RS6043		
Sampling Date		2017/08/12 10:25	2017/08/12 09:00	2017/08/12 08:15		
COC Number		294858	294858	294858		
	UNITS	C38 08-1-4	MEBG-10-1-3	ARB-12-3-3	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0013	0.011	0.011	0.00010	8726900
Dissolved Vanadium (V)	mg/L	0.0015	<0.0010	<0.0010	0.0010	8726900
Dissolved Zinc (Zn)	mg/L	0.0047	0.0040	0.011	0.0030	8726900
Low Level Elements						
Dissolved Mercury (Hg)	mg/L	0.0000021	<0.0000020	<0.0000020	0.0000020	8729114
RDL = Reportable Detection Limit						

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RS6041		RS6042	RS6043		
Sampling Date		2017/08/12 10:25		2017/08/12 09:00	2017/08/12 08:15		
COC Number		294858		294858	294858		
	UNITS	C38 08-1-4	RDL	MEBG-10-1-3	ARB-12-3-3	RDL	QC Batch
Calculated Parameters							
Hardness (CaCO ₃)	mg/L	590	0.50	760	580	0.50	8725088
Ion Balance (% Difference)	%	1.0	N/A	1.7	0.41	N/A	8725089
Dissolved Nitrate (NO ₃)	mg/L	<0.044	0.044	0.048	4.8	0.044	8725829
Nitrate plus Nitrite (N)	mg/L	<0.014	0.014	<0.014	1.1	0.014	8725830
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	<0.033	<0.033	0.033	8725829
Misc. Inorganics							
Conductivity	uS/cm	1300	1.0	1400	1100	1.0	8726519
Total Dissolved Solids	mg/L	780 (1)	50	890	640	10	8727715
Anions							
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	8726518
Alkalinity (Total as CaCO ₃)	mg/L	670	0.50	630	530	0.50	8726518
Bicarbonate (HCO ₃)	mg/L	820	0.50	770	650	0.50	8726518
Carbonate (CO ₃)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	8726518
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	8726518
Dissolved Sulphate (SO ₄)	mg/L	18	1.0	180	60	1.0	8726566
Dissolved Chloride (Cl)	mg/L	19	1.0	2.4	12	1.0	8726539
Nutrients							
Dissolved Nitrite (N)	mg/L	<0.010	0.010	<0.010	<0.010	0.010	8726285
Dissolved Nitrate (N)	mg/L	<0.010	0.010	0.011	1.1	0.010	8726285
Misc. Organics							
Phenols	mg/L	0.029	0.0020	0.0039	0.0043	0.0020	8731484
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis.							

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		RS6042		
Sampling Date		2017/08/12 09:00		
COC Number		294858		
	UNITS	MEBG-10-1-3	RDL	QC Batch
Polycyclic Aromatics				
Benzo[a]pyrene equivalency	mg/L	<0.000010	0.000010	8725704
Acenaphthene	mg/L	<0.00010	0.00010	8721852
Acenaphthylene	mg/L	<0.00010	0.00010	8721852
Acridine	mg/L	<0.000050	0.000050	8721852
Anthracene	mg/L	<0.000010	0.000010	8721852
Benzo(a)anthracene	mg/L	<0.0000085	0.0000085	8721852
Benzo(b&j)fluoranthene	mg/L	<0.0000085	0.0000085	8721852
Benzo(k)fluoranthene	mg/L	<0.0000085	0.0000085	8721852
Benzo(g,h,i)perylene	mg/L	<0.0000085	0.0000085	8721852
Benzo(c)phenanthrene	mg/L	<0.000050	0.000050	8721852
Benzo(a)pyrene	mg/L	<0.0000075	0.0000075	8721852
Benzo[e]pyrene	mg/L	<0.000050	0.000050	8721852
Chrysene	mg/L	<0.0000085	0.0000085	8721852
Dibenz(a,h)anthracene	mg/L	<0.0000075	0.0000075	8721852
Fluoranthene	mg/L	0.000042	0.000010	8721852
Fluorene	mg/L	<0.000050	0.000050	8721852
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	0.0000085	8721852
2-Methylnaphthalene	mg/L	<0.00010	0.00010	8721852
Naphthalene	mg/L	<0.00010	0.00010	8721852
Phenanthrene	mg/L	0.000080	0.000050	8721852
Perylene	mg/L	<0.000050	0.000050	8721852
Pyrene	mg/L	0.000037	0.000020	8721852
Quinoline	mg/L	<0.00020	0.00020	8721852
Extraction Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	113		8721852
D8-ACENAPHTHYLENE (sur.)	%	98		8721852
D8-NAPHTHALENE (sur.)	%	95		8721852
TERPHENYL-D14 (sur.)	%	127		8721852
RDL = Reportable Detection Limit				

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RS6041
Sample ID: C38 08-1-4
Matrix: Water

Collected: 2017/08/12
Relinquished: 2017/08/13
Received: 2017/08/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8726518	N/A	2017/08/15	Malina Alamyar
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8726457	N/A	2017/08/15	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8725353	N/A	2017/08/16	Automated Statchk
Chloride by Automated Colourimetry	KONE	8726539	N/A	2017/08/16	Anna Lebowa
Conductivity @25C	COND	8726519	N/A	2017/08/15	Malina Alamyar
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8727866	2017/08/16	2017/08/16	Jana Rychlikova
Hardness	CALC	8725088	N/A	2017/08/19	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8729114	2017/08/17	2017/08/17	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8730342	N/A	2017/08/18	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8726900	N/A	2017/08/15	Julie Harrison
Ion Balance	CALC	8725089	N/A	2017/08/15	Automated Statchk
Nitrate and Nitrite	CALC	8725829	N/A	2017/08/15	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8725830	N/A	2017/08/15	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8726285	N/A	2017/08/15	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8731484	N/A	2017/08/19	Ying Yang
Sulphate by Automated Colourimetry	KONE	8726566	N/A	2017/08/16	Anna Lebowa
Total Dissolved Solids (Filt. Residue)	BAL	8727715	2017/08/16	2017/08/17	Kruti Patel

Maxxam ID: RS6042
Sample ID: MEBG-10-1-3
Matrix: Water

Collected: 2017/08/12
Relinquished: 2017/08/13
Received: 2017/08/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8726518	N/A	2017/08/15	Malina Alamyar
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8726457	N/A	2017/08/15	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8725353	N/A	2017/08/16	Automated Statchk
Chloride by Automated Colourimetry	KONE	8726539	N/A	2017/08/16	Anna Lebowa
Conductivity @25C	COND	8726519	N/A	2017/08/15	Malina Alamyar
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8727866	2017/08/16	2017/08/16	Jana Rychlikova
Hardness	CALC	8725088	N/A	2017/08/19	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8729114	2017/08/17	2017/08/17	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8730342	N/A	2017/08/18	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8726900	N/A	2017/08/15	Julie Harrison
Ion Balance	CALC	8725089	N/A	2017/08/15	Automated Statchk
Nitrate and Nitrite	CALC	8725829	N/A	2017/08/15	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8725830	N/A	2017/08/15	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8726285	N/A	2017/08/15	Krista Dawe
Benzo[a]pyrene Equivalency	GC/MSD	8725704	N/A	2017/08/17	Daniel Reslan
PAH in Water by GC/MS	GC/MS	8721852	2017/08/16	2017/08/17	Bert Chi
Phenols (4-AAP)	TECH/4AAP	8731484	N/A	2017/08/19	Ying Yang
Sulphate by Automated Colourimetry	KONE	8726566	N/A	2017/08/16	Anna Lebowa
Total Dissolved Solids (Filt. Residue)	BAL	8727715	2017/08/16	2017/08/17	Kruti Patel

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RS6043
Sample ID: ARB-12-3-3
Matrix: Water

Collected: 2017/08/12
Relinquished: 2017/08/13
Received: 2017/08/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8726518	N/A	2017/08/15	Malina Alamyar
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8726457	N/A	2017/08/15	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8725353	N/A	2017/08/16	Automated Statchk
Chloride by Automated Colourimetry	KONE	8726539	N/A	2017/08/16	Anna Lebowa
Conductivity @25C	COND	8726519	N/A	2017/08/15	Malina Alamyar
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8727866	2017/08/16	2017/08/16	Jana Rychlikova
Hardness	CALC	8725088	N/A	2017/08/19	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8729114	2017/08/17	2017/08/17	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8730342	N/A	2017/08/18	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8726900	N/A	2017/08/15	Julie Harrison
Ion Balance	CALC	8725089	N/A	2017/08/15	Automated Statchk
Nitrate and Nitrite	CALC	8725829	N/A	2017/08/15	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8725830	N/A	2017/08/15	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8726285	N/A	2017/08/15	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8731484	N/A	2017/08/19	Ying Yang
Sulphate by Automated Colourimetry	KONE	8726566	N/A	2017/08/16	Anna Lebowa
Total Dissolved Solids (Filt. Residue)	BAL	8727715	2017/08/16	2017/08/17	Kruti Patel

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Results relate only to the items tested.

Maxxam Job #: B768369
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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8721852	BC5	Method Blank	D10-ANTHRACENE (sur.)	2017/08/15		119	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/15		127	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/15		92	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/15		89	%	50 - 130
			Acenaphthene	2017/08/15	<0.00010		mg/L	
			Acenaphthylene	2017/08/15	<0.00010		mg/L	
			Acridine	2017/08/15	<0.000050		mg/L	
			Anthracene	2017/08/15	<0.000010		mg/L	
			Benzo(a)anthracene	2017/08/15	<0.0000085		mg/L	
			Benzo(b&j)fluoranthene	2017/08/15	<0.0000085		mg/L	
			Benzo(k)fluoranthene	2017/08/15	<0.0000085		mg/L	
			Benzo(g,h,i)perylene	2017/08/15	<0.0000085		mg/L	
			Benzo(c)phenanthrene	2017/08/15	<0.000050		mg/L	
			Benzo(a)pyrene	2017/08/15	<0.0000075		mg/L	
			Benzo[e]pyrene	2017/08/15	<0.000050		mg/L	
			Chrysene	2017/08/15	<0.0000085		mg/L	
			Dibenz(a,h)anthracene	2017/08/15	<0.0000075		mg/L	
			Fluoranthene	2017/08/15	<0.000010		mg/L	
			Fluorene	2017/08/15	<0.000050		mg/L	
			Indeno(1,2,3-cd)pyrene	2017/08/15	<0.0000085		mg/L	
			2-Methylnaphthalene	2017/08/15	<0.00010		mg/L	
			Naphthalene	2017/08/15	<0.00010		mg/L	
			Phenanthrene	2017/08/15	<0.000050		mg/L	
			Perylene	2017/08/15	<0.000050		mg/L	
			Pyrene	2017/08/15	<0.000020		mg/L	
			Quinoline	2017/08/15	<0.00020		mg/L	
8726285	KD5	Method Blank	Dissolved Nitrite (N)	2017/08/15	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/08/15	<0.010		mg/L	
8726457	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/15		97	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/15		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/15		97	%	70 - 130
			Benzene	2017/08/15	<0.00040		mg/L	
			Toluene	2017/08/15	<0.00040		mg/L	
			Ethylbenzene	2017/08/15	<0.00040		mg/L	
			m & p-Xylene	2017/08/15	<0.00080		mg/L	
			o-Xylene	2017/08/15	<0.00040		mg/L	
			Xylenes (Total)	2017/08/15	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/15	<0.10		mg/L	
			F1 (C6-C10)	2017/08/15	<0.10		mg/L	
8726518	MA4	Method Blank	Alkalinity (Total as CaCO3)	2017/08/15	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/15	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/15	<0.50		mg/L	
			Carbonate (CO3)	2017/08/15	<0.50		mg/L	
			Hydroxide (OH)	2017/08/15	<0.50		mg/L	
8726519	MA4	Method Blank	Conductivity	2017/08/15	<1.0		uS/cm	
8726539	AL2	Method Blank	Dissolved Chloride (Cl)	2017/08/16	<1.0		mg/L	
8726566	AL2	Method Blank	Dissolved Sulphate (SO4)	2017/08/16	<1.0		mg/L	
8726900	JHS	Method Blank	Dissolved Aluminum (Al)	2017/08/15	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/15	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/15	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/15	<0.00020		mg/L	

Maxxam Job #: B768369
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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Lead (Pb)	2017/08/15	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/15	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/15	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/15	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/15	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/15	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/15	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/15	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/15	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/15	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/15	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/15	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/15	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/15	<0.0010		mg/L	
8727715	KPG	Method Blank	Total Dissolved Solids	2017/08/17	<10		mg/L	
8727866	JR1	Method Blank	O-TERPHENYL (sur.)	2017/08/16		94	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/16	<0.10		mg/L	
8729114	NP4	Method Blank	Dissolved Mercury (Hg)	2017/08/17	<0.0000020		mg/L	
8730342	JK9	Method Blank	Dissolved Iron (Fe)	2017/08/18	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/18	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/18	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/18	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/18	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/18	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/18	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/18	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/18	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/18	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/18	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/18	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/18	<0.30		mg/L	
8731484	YY	Method Blank	Phenols	2017/08/19	<0.0020		mg/L	
8726457	SES	Matrix Spike [RS6041-07]	1,4-Difluorobenzene (sur.)	2017/08/15		96	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/15		103	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/15		106	%	70 - 130
			Benzene	2017/08/15		100	%	70 - 130
			Toluene	2017/08/15		93	%	70 - 130
			Ethylbenzene	2017/08/15		102	%	70 - 130
			m & p-Xylene	2017/08/15		103	%	70 - 130
			o-Xylene	2017/08/15		101	%	70 - 130
			F1 (C6-C10)	2017/08/15		74	%	70 - 130
8721852	BC5	LCS	D10-ANTHRACENE (sur.)	2017/08/12		89	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/12		110	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/12		82	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/12		101	%	50 - 130
			Acenaphthene	2017/08/12		89	%	50 - 130
			Acenaphthylene	2017/08/12		85	%	50 - 130
			Acridine	2017/08/12		76	%	50 - 130
			Anthracene	2017/08/12		93	%	50 - 130
			Benzo(a)anthracene	2017/08/12		128	%	50 - 130
			Benzo(b&j)fluoranthene	2017/08/12		125	%	50 - 130

Maxxam Job #: B768369
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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8726285	KD5	LCS	Benzo(k)fluoranthene	2017/08/12		112	%	50 - 130
			Benzo(g,h,i)perylene	2017/08/12		124	%	50 - 130
			Benzo(c)phenanthrene	2017/08/12		122	%	50 - 130
			Benzo(a)pyrene	2017/08/12		119	%	50 - 130
			Benzo[e]pyrene	2017/08/12		120	%	50 - 130
			Chrysene	2017/08/12		112	%	50 - 130
			Dibenz(a,h)anthracene	2017/08/12		133 (1)	%	50 - 130
			Fluoranthene	2017/08/12		92	%	50 - 130
			Fluorene	2017/08/12		92	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2017/08/12		133 (1)	%	50 - 130
			2-Methylnaphthalene	2017/08/12		121	%	50 - 130
			Naphthalene	2017/08/12		104	%	50 - 130
			Phenanthrene	2017/08/12		91	%	50 - 130
			Perylene	2017/08/12		109	%	50 - 130
			Pyrene	2017/08/12		91	%	50 - 130
8726457	SES	LCS	Quinoline	2017/08/12		116	%	50 - 130
			Dissolved Nitrite (N)	2017/08/15		101	%	80 - 120
			Dissolved Nitrate (N)	2017/08/15		102	%	80 - 120
			1,4-Difluorobenzene (sur.)	2017/08/15		95	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/15		103	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/15		102	%	70 - 130
			Benzene	2017/08/15		97	%	70 - 130
			Toluene	2017/08/15		91	%	70 - 130
			Ethylbenzene	2017/08/15		101	%	70 - 130
			m & p-Xylene	2017/08/15		101	%	70 - 130
8726518	MA4	LCS	o-Xylene	2017/08/15		102	%	70 - 130
			F1 (C6-C10)	2017/08/15		108	%	70 - 130
			Alkalinity (Total as CaCO3)	2017/08/15		100	%	80 - 120
			Conductivity	2017/08/15		98	%	90 - 110
			Dissolved Chloride (Cl)	2017/08/16		102	%	80 - 120
			Dissolved Sulphate (SO4)	2017/08/16		102	%	80 - 120
			Dissolved Aluminum (Al)	2017/08/15		100	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/15		99	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/15		99	%	80 - 120
			Dissolved Copper (Cu)	2017/08/15		98	%	80 - 120
8726900	JHS	LCS	Dissolved Lead (Pb)	2017/08/15		97	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/15		99	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/15		100	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/15		97	%	80 - 120
			Dissolved Selenium (Se)	2017/08/15		100	%	80 - 120
			Dissolved Silver (Ag)	2017/08/15		100	%	80 - 120
			Dissolved Arsenic (As)	2017/08/15		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/15		97	%	80 - 120
			Dissolved Tin (Sn)	2017/08/15		99	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/15		101	%	80 - 120
8727715	KPG	LCS	Dissolved Uranium (U)	2017/08/15		95	%	80 - 120
			Dissolved Vanadium (V)	2017/08/15		100	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/15		99	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/15		98	%	80 - 120
			Total Dissolved Solids	2017/08/17		100	%	80 - 120
			O-TERPHENYL (sur.)	2017/08/16		101	%	60 - 130
8727866	JR1	LCS						

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WORLEY PARSONS
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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			F2 (C10-C16 Hydrocarbons)	2017/08/16		108	%	70 - 130
8729114	NP4	LCS	Dissolved Mercury (Hg)	2017/08/17		98	%	80 - 120
8730342	JK9	LCS	Dissolved Iron (Fe)	2017/08/18		102	%	80 - 120
			Dissolved Lithium (Li)	2017/08/18		100	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/18		98	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/18		99	%	80 - 120
			Dissolved Potassium (K)	2017/08/18		101	%	80 - 120
			Dissolved Sodium (Na)	2017/08/18		103	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/18		96	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/18		99	%	80 - 120
			Dissolved Barium (Ba)	2017/08/18		97	%	80 - 120
			Dissolved Silicon (Si)	2017/08/18		103	%	80 - 120
			Dissolved Boron (B)	2017/08/18		104	%	80 - 120
			Dissolved Calcium (Ca)	2017/08/18		96	%	80 - 120
8731484	YY	LCS	Phenols	2017/08/19		89	%	80 - 120
8729114	NP4	SRM	Dissolved Mercury (Hg)	2017/08/17		102	%	80 - 120

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

LCS: 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.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B768369
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



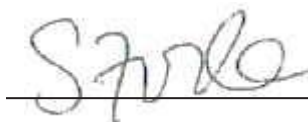
Daniel Reslan, cCT, QP, Organics Supervisor



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

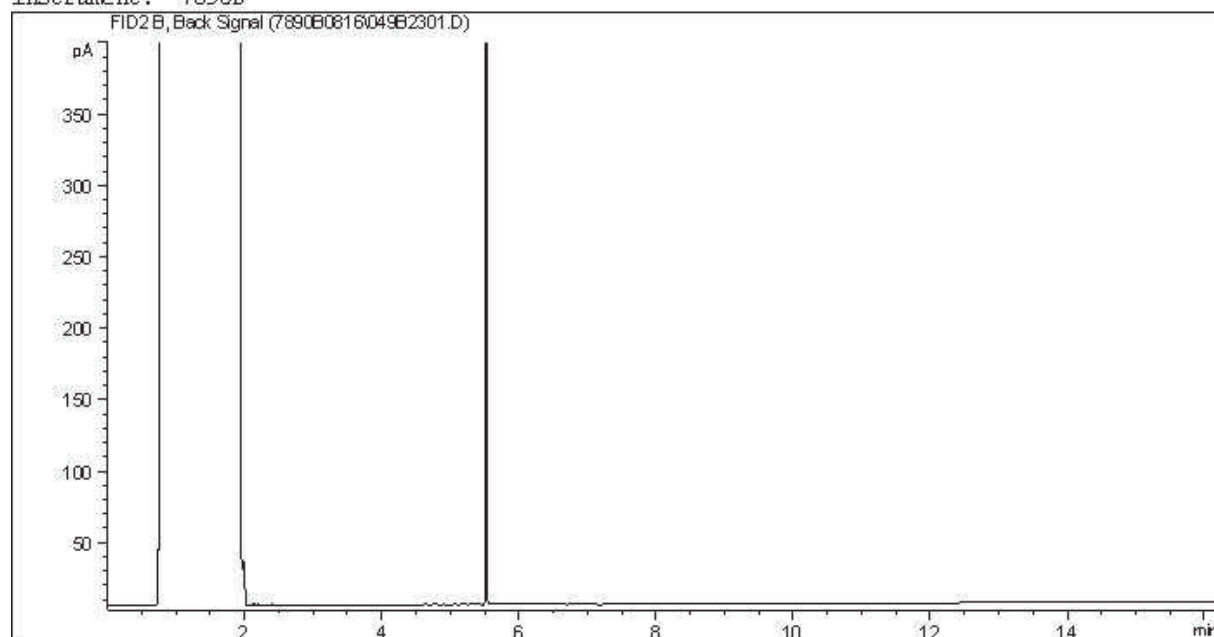


Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

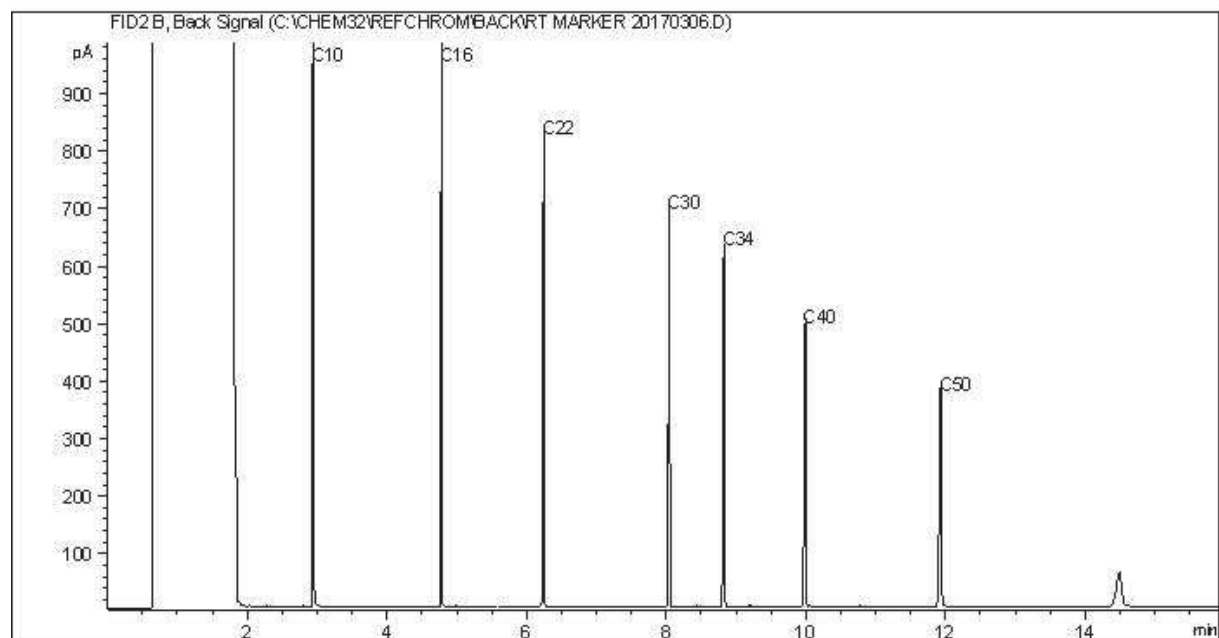
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



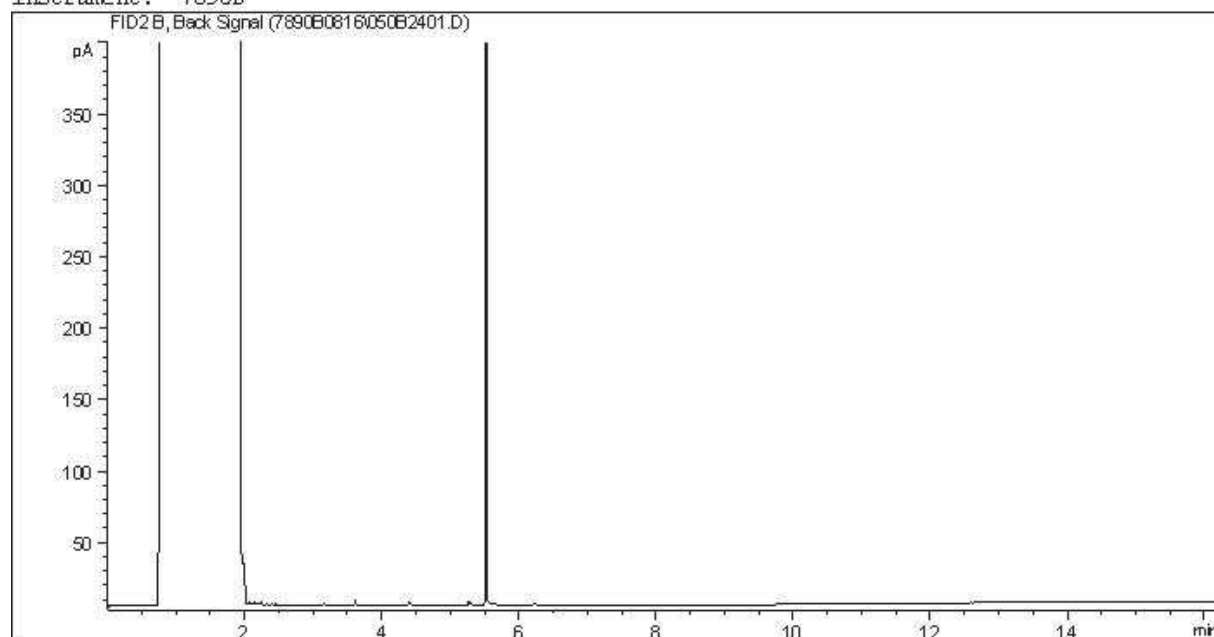
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

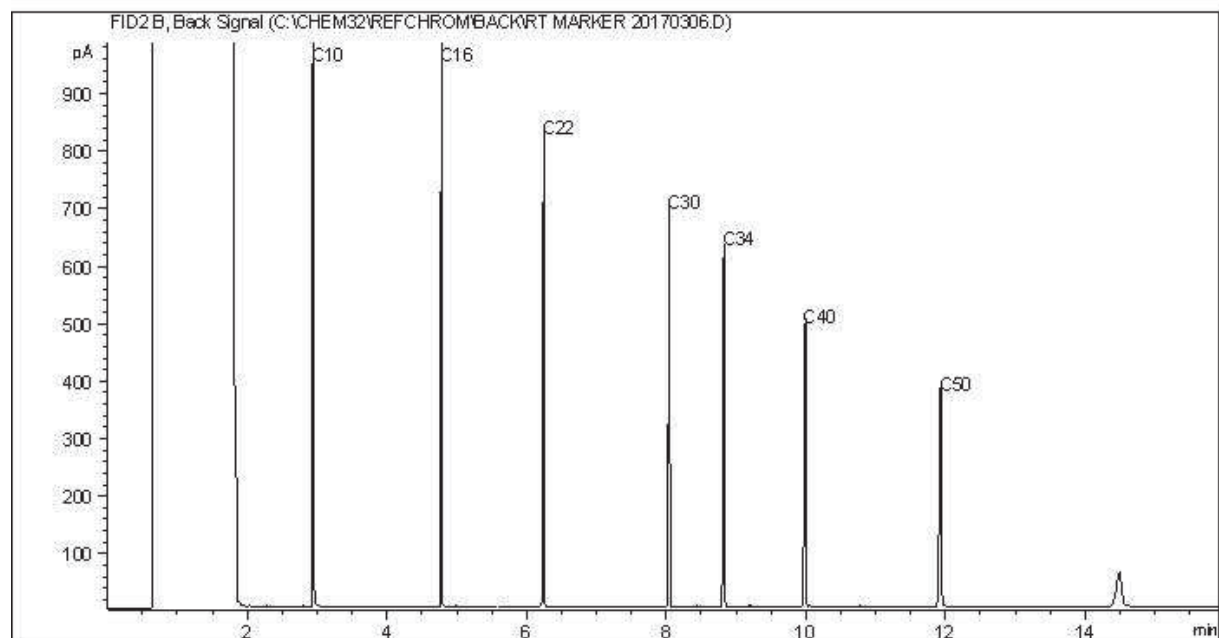
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



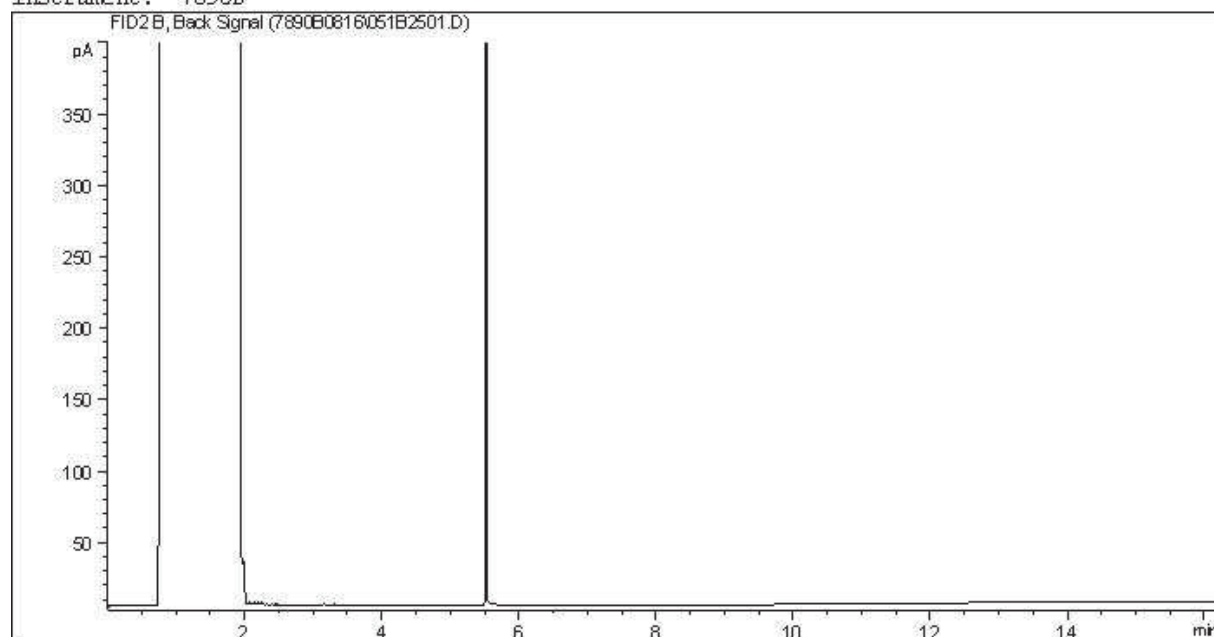
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

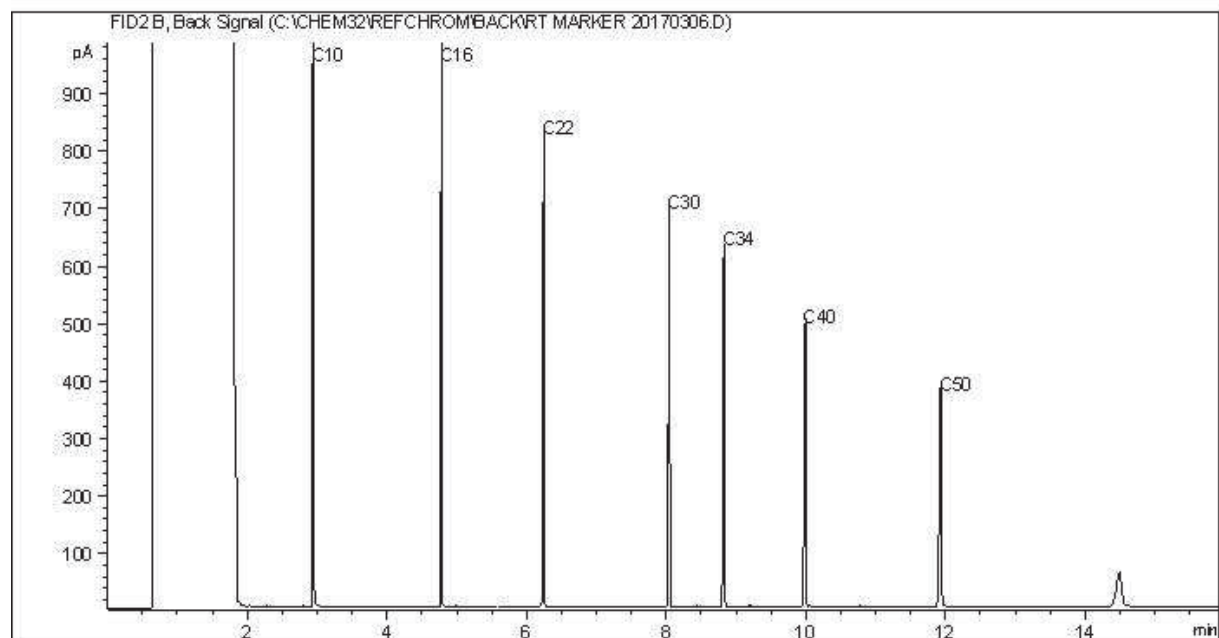
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED												TURNAROUND TIME						
Company Name: ☒ Imperial Oil ☐ ExxonMobil				Company Name: WorleyParsons																Standard (5 days)						
Contact Name: Sloan Leavitt				Contact Name: Stacy Gibbo																Rush (3 days)						
Address: Bag Service 5000 Norman Wells, NT X0E 0V0				Address: Suite 500, 151 Canada Olympic Rd SW Calgary, AB T3B 6B7																(2 days)						
Email: sloan.leavitt@esso.ca				Email: stacy.gibbo@advisian.com																(1 day)						
Ph: 583-476-4449				Ph: 403-247-0200																(same day)						
Sampler Name (Print): Melissa Lord, Douglas Haney, Melanie Jones, Michelle Lokaty				Consultant Project #: 407074-00028.400																						
FIELD SAMPLE ID				MATRIX		SAMPLING																				
				GROUND WATER	SURFACE WATER	SOIL	OTHER	# CONTAINERS	DATE (YYYY/MM/DD)	TIME (24 HR)	LAB FILTERED & PRESERVED	LAB FILTRATION REQUIRED														
1 C38 08-1-4				X				9	2017/08/12	10:25	X															
2 MEBG-10-1-3				X				11	09:00	X																
3 ARB-12-3-3				X				9	08:15	X																
4																										
5																										
6																										
7																										
8																										
9																										
10																										
IOL SITE LOCATION				REGULATORY CRITERIA / DETECTION LIMITS:				SPECIAL INSTRUCTIONS also email:				# IARS USED & NOT SUBMITTED				TURNAROUND TIME										
Norman Wells, NT				☐ Alberta Tier 1 ☐ CDWG ☐ NoSC (SK) ☐ Other				-Standard Norman Wells email list -melissa.lord@advisian.com				Enter N/A for Water				Standard (5 days)										
IOL PROJECT # (if applicable)				☒ SEQG (SK) ☐ CCME (incl. level)				Only 1 dissolved metal bottle for samples with dissolved metal & routine potability				N/A				Rush (3 days)										
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM				FAL												(2 days)										
4502 488 789 + 00010																(1 day)										
																(same day)										
YES				NO				COOLER ID #				YES				NO										
SEAL PRESENT				SEAL PRESENT				SEAL PRESENT				SEAL PRESENT				SEAL PRESENT										
SEAL INTACT				SEAL INTACT				SEAL INTACT				SEAL INTACT				SEAL INTACT										
COOLING MEDIA PRESENT				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT										
RELINQUISHED BY:				DATE:				RECEIVED BY:				DATE:				TIME (24 HR)										
1. Melissa Lord				2017/08/13 08:00				1. Danielle Boivert				2017/08/14 0940				B3768369										
2.								2.								SAMPLES										
3.								3.								LABELED BY: 358										
																VERIFIED BY: D-1										

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 12-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B768369

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			Laboratory control sample recovery of Indeno(1,2,3-cd)pyrene (133%) and Dibenzo(a,h)anthracene (133%) did not meet acceptance criteria (50-130%). All other laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery	x			
Lab Control Sample Recovery		x		

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	No field QC samples submitted.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 12-Sep-17

Data Reviewed by (Signature): 

Attention: Stacy Gibb

WorleyParsons
Suite 500
151 Canada Olympic Road SW
CALGARY, AB
CANADA T3B5R5

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294860

Report Date: 2017/08/24
Report #: R2433512
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769645

Received: 2017/08/17, 09:35

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	2	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	2	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	2	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	2	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS m
Hardness	2	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	2	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	2	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	2	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	2	AB WI-00065	Auto Calc
Nitrate and Nitrite	2	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	2	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	2	AB SOP-00023	SM 22 4110 B m
Phenols (4-AAP)	2	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	2	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	2	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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.

Attention: Stacy Gibb

WorleyParsons
Suite 500
151 Canada Olympic Road SW
CALGARY, AB
CANADA T3B5R5

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294860

Report Date: 2017/08/24
Report #: R2433512
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769645

Received: 2017/08/17, 09:35

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved > Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Rhécie Phayouphone
Project Manager
24 Aug 2017 17:01:24

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Kandise Wilson, B.Sc, Project Manager

Email: KWilson@maxxam.ca

Phone# (780)577-7109

=====

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.

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT3495	RT3496		
Sampling Date		2017/08/14 12:40	2017/08/14 13:00		
COC Number		294860	294860		
	UNITS	BI SS2 09-DP-1	BI SS2 09-DP-2	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8730086
Volatiles					
Benzene	ug/L	<0.40	<0.40	0.40	8730130
Toluene	ug/L	1.2	<0.40	0.40	8730130
Ethylbenzene	ug/L	<0.40	<0.40	0.40	8730130
m & p-Xylene	ug/L	<0.80	<0.80	0.80	8730130
o-Xylene	ug/L	<0.40	<0.40	0.40	8730130
Xylenes (Total)	ug/L	<0.80	<0.80	0.80	8730130
F1 (C6-C10) - BTEX	ug/L	<100	<100	100	8730130
F1 (C6-C10)	ug/L	<100	<100	100	8730130
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	98	97		8730086
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	101	101		8730130
4-Bromofluorobenzene (sur.)	%	103	103		8730130
D4-1,2-Dichloroethane (sur.)	%	105	105		8730130
RDL = Reportable Detection Limit					

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT3495	RT3496		
Sampling Date		2017/08/14 12:40	2017/08/14 13:00		
COC Number		294860	294860		
	UNITS	BI SS2 09-DP-1	BI SS2 09-DP-2	RDL	QC Batch
Low Level Elements					
Dissolved Cadmium (Cd)	ug/L	<0.020	0.15	0.020	8729385
Elements					
Dissolved Aluminum (Al)	mg/L	0.0084	0.0062	0.0030	8731767
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	0.00060	8731767
Dissolved Arsenic (As)	mg/L	0.0071	0.00075	0.00020	8731767
Dissolved Barium (Ba)	mg/L	0.46	0.47	0.010	8733233
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	0.0010	8731767
Dissolved Boron (B)	mg/L	<0.020	<0.020	0.020	8733233
Dissolved Calcium (Ca)	mg/L	140	250	0.30	8733233
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	0.0010	8731767
Dissolved Cobalt (Co)	mg/L	0.0035	0.0068	0.00030	8731767
Dissolved Copper (Cu)	mg/L	<0.00020	0.0011	0.00020	8731767
Dissolved Iron (Fe)	mg/L	9.0	2.2	0.060	8733233
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	0.00020	8731767
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	0.020	8733233
Dissolved Magnesium (Mg)	mg/L	22	40	0.20	8733233
Dissolved Manganese (Mn)	mg/L	0.89	4.5	0.0040	8733233
Dissolved Molybdenum (Mo)	mg/L	0.0017	0.0013	0.00020	8731767
Dissolved Nickel (Ni)	mg/L	0.0070	0.013	0.00050	8731767
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	0.10	8733233
Dissolved Potassium (K)	mg/L	1.6	1.0	0.30	8733233
Dissolved Selenium (Se)	mg/L	<0.00020	<0.00020	0.00020	8731767
Dissolved Silicon (Si)	mg/L	3.4	4.9	0.10	8733233
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	0.00010	8731767
Dissolved Sodium (Na)	mg/L	6.8	7.7	0.50	8733233
Dissolved Strontium (Sr)	mg/L	0.55	1.2	0.020	8733233
Dissolved Sulphur (S)	mg/L	15	44	0.20	8733233
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	0.00020	8731767
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	0.0010	8731767
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	0.0010	8731767
RDL = Reportable Detection Limit					

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT3495	RT3496		
Sampling Date		2017/08/14 12:40	2017/08/14 13:00		
COC Number		294860	294860		
	UNITS	BI SS2 09-DP-1	BI SS2 09-DP-2	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0023	0.0072	0.00010	8731767
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	0.0010	8731767
Dissolved Zinc (Zn)	mg/L	0.0087	0.010	0.0030	8731767
Low Level Elements					
Dissolved Mercury (Hg)	ug/L	<0.0020	<0.0020	0.0020	8734001
RDL = Reportable Detection Limit					

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT3495		RT3496		
Sampling Date		2017/08/14 12:40		2017/08/14 13:00		
COC Number		294860		294860		
	UNITS	BI SS2 09-DP-1	QC Batch	BI SS2 09-DP-2	RDL	QC Batch
Calculated Parameters						
Hardness (CaCO ₃)	mg/L	440	8729389	780	0.50	8729642
Ion Balance (% Difference)	%	2.9	8729390	1.6	N/A	8729645
Dissolved Nitrate (NO ₃)	mg/L	0.85	8729392	0.30	0.044	8729392
Nitrate plus Nitrite (N)	mg/L	0.19	8729648	0.068	0.014	8729648
Dissolved Nitrite (NO ₂)	mg/L	<0.033	8729392	<0.033	0.033	8729392
Misc. Inorganics						
Conductivity	uS/cm	790	8731246	1300	1.0	8731246
Total Dissolved Solids	mg/L	500	8730593	870	10	8730593
Anions						
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	8731243	<0.50	0.50	8731243
Alkalinity (Total as CaCO ₃)	mg/L	400	8731243	650	0.50	8731243
Bicarbonate (HCO ₃)	mg/L	490	8731243	790	0.50	8731243
Carbonate (CO ₃)	mg/L	<0.50	8731243	<0.50	0.50	8731243
Hydroxide (OH)	mg/L	<0.50	8731243	<0.50	0.50	8731243
Dissolved Sulphate (SO ₄)	mg/L	38	8730124	120	1.0	8730124
Dissolved Chloride (Cl)	mg/L	3.9	8730122	4.3	1.0	8730122
Nutrients						
Dissolved Nitrite (N)	mg/L	<0.010	8729709	<0.010	0.010	8729709
Dissolved Nitrate (N)	mg/L	0.19	8729709	0.068	0.010	8729709
Misc. Organics						
Phenols	mg/L	0.0092	8735489	0.013	0.0020	8735489
RDL = Reportable Detection Limit N/A = Not Applicable						

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RT3495
Sample ID: BI SS2 09-DP-1
Matrix: Water

Collected: 2017/08/14
Relinquished: 2017/08/15
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730130	N/A	2017/08/17	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8730122	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730086	2017/08/18	2017/08/19	Kelsey Holt
Hardness	CALC	8729389	N/A	2017/08/22	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8733233	N/A	2017/08/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8731767	N/A	2017/08/21	Julie Harrison
Ion Balance	CALC	8729390	N/A	2017/08/18	Automated Statchk
Nitrate and Nitrite	CALC	8729392	N/A	2017/08/19	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729648	N/A	2017/08/19	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8729709	N/A	2017/08/18	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8730124	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8730593	2017/08/18	2017/08/22	Kruti Patel

Maxxam ID: RT3496
Sample ID: BI SS2 09-DP-2
Matrix: Water

Collected: 2017/08/14
Relinquished: 2017/08/15
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730130	N/A	2017/08/17	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8730122	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730086	2017/08/18	2017/08/19	Kelsey Holt
Hardness	CALC	8729642	N/A	2017/08/22	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8733233	N/A	2017/08/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8731767	N/A	2017/08/21	Julie Harrison
Ion Balance	CALC	8729645	N/A	2017/08/18	Automated Statchk
Nitrate and Nitrite	CALC	8729392	N/A	2017/08/19	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729648	N/A	2017/08/19	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8729709	N/A	2017/08/18	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8730124	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8730593	2017/08/18	2017/08/22	Kruti Patel

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.0°C

Sample RT3495 [BI SS2 09-DP-1] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT3496 [BI SS2 09-DP-2] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8729709	MSD	Method Blank	Dissolved Nitrite (N)	2017/08/18	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/08/18	<0.010		mg/L	
8730086	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/19		104	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19	<0.10		mg/L	
8730122	CH7	Method Blank	Dissolved Chloride (Cl)	2017/08/23	<1.0		mg/L	
8730124	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/08/23	<1.0		mg/L	
8730130	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/17		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/17		103	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/17		101	%	70 - 130
			Benzene	2017/08/17	<0.40		ug/L	
			Toluene	2017/08/17	<0.40		ug/L	
			Ethylbenzene	2017/08/17	<0.40		ug/L	
			m & p-Xylene	2017/08/17	<0.80		ug/L	
			o-Xylene	2017/08/17	<0.40		ug/L	
			Xylenes (Total)	2017/08/17	<0.80		ug/L	
			F1 (C6-C10) - BTEX	2017/08/17	<100		ug/L	
			F1 (C6-C10)	2017/08/17	<100		ug/L	
8730593	KPG	Method Blank	Total Dissolved Solids	2017/08/22	<10		mg/L	
8731243	AF6	Method Blank	Alkalinity (Total as CaCO3)	2017/08/18	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/18	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/18	<0.50		mg/L	
			Carbonate (CO3)	2017/08/18	<0.50		mg/L	
			Hydroxide (OH)	2017/08/18	<0.50		mg/L	
8731246	AF6	Method Blank	Conductivity	2017/08/18	<1.0		uS/cm	
8731767	JHS	Method Blank	Dissolved Aluminum (Al)	2017/08/22	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/22	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/22	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/22	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/22	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/22	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/22	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/22	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/22	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/22	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/22	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/22	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/22	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/22	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/22	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/22	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/22	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/22	<0.0010		mg/L	
8733233	JK9	Method Blank	Dissolved Iron (Fe)	2017/08/21	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/21	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/21	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/21	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/21	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/21	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/21	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/21	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/21	<0.10		mg/L	

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8734001	NP4	Method Blank	Dissolved Barium (Ba)	2017/08/21	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/21	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/21	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/21	<0.30		mg/L	
8735489	YY	Method Blank	Dissolved Mercury (Hg)	2017/08/22	<0.0020		ug/L	
8729709	MSD	LCS	Phenols	2017/08/23	<0.0020		mg/L	
8730086	KHO	LCS	Dissolved Nitrite (N)	2017/08/18		101	%	80 - 120
			Dissolved Nitrate (N)	2017/08/18		101	%	80 - 120
			O-TERPHENYL (sur.)	2017/08/19		96	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19		107	%	70 - 130
8730122	CH7	LCS	Dissolved Chloride (Cl)	2017/08/23		105	%	80 - 120
8730124	CH7	LCS	Dissolved Sulphate (SO4)	2017/08/23		107	%	80 - 120
8730130	YZ3	LCS	1,4-Difluorobenzene (sur.)	2017/08/17		97	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/17		101	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/17		101	%	70 - 130
			Benzene	2017/08/17		103	%	70 - 130
			Toluene	2017/08/17		96	%	70 - 130
			Ethylbenzene	2017/08/17		103	%	70 - 130
			m & p-Xylene	2017/08/17		103	%	70 - 130
			o-Xylene	2017/08/17		100	%	70 - 130
			F1 (C6-C10)	2017/08/17		101	%	70 - 130
8730593	KPG	LCS	Total Dissolved Solids	2017/08/22		95	%	80 - 120
8731243	AF6	LCS	Alkalinity (Total as CaCO3)	2017/08/18		98	%	80 - 120
8731246	AF6	LCS	Conductivity	2017/08/18		98	%	90 - 110
8731767	JHS	LCS	Dissolved Aluminum (Al)	2017/08/22		97	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/22		99	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/22		98	%	80 - 120
			Dissolved Copper (Cu)	2017/08/22		99	%	80 - 120
			Dissolved Lead (Pb)	2017/08/22		97	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/22		96	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/22		97	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/22		97	%	80 - 120
			Dissolved Selenium (Se)	2017/08/22		100	%	80 - 120
			Dissolved Silver (Ag)	2017/08/22		98	%	80 - 120
			Dissolved Arsenic (As)	2017/08/22		98	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/22		98	%	80 - 120
			Dissolved Tin (Sn)	2017/08/22		95	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/22		97	%	80 - 120
			Dissolved Uranium (U)	2017/08/22		94	%	80 - 120
			Dissolved Vanadium (V)	2017/08/22		100	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/22		100	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/22		101	%	80 - 120
8733233	JK9	LCS	Dissolved Iron (Fe)	2017/08/21		103	%	80 - 120
			Dissolved Lithium (Li)	2017/08/21		104	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/21		104	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/21		96	%	80 - 120
			Dissolved Potassium (K)	2017/08/21		104	%	80 - 120
			Dissolved Sodium (Na)	2017/08/21		106	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/21		103	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/21		102	%	80 - 120
			Dissolved Barium (Ba)	2017/08/21		102	%	80 - 120

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Silicon (Si)	2017/08/21		107	%	80 - 120
			Dissolved Boron (B)	2017/08/21		102	%	80 - 120
			Dissolved Calcium (Ca)	2017/08/21		97	%	80 - 120
8734001	NP4	LCS	Dissolved Mercury (Hg)	2017/08/22		100	%	80 - 120
8735489	YY	LCS	Phenols	2017/08/23		85	%	80 - 120
8734001	NP4	SRM	Dissolved Mercury (Hg)	2017/08/22		103	%	80 - 120

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

LCS: 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.

Maxxam Job #: B769645
Report Date: 2017/08/24

WorleyParsons
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

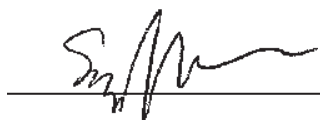
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor



Sandy Yuan, M.Sc., 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.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED														TURNAROUND TIME									
Company Name: Maxxam				Company Name: WorleyParsons				☒ Routine Potability ☐ EC ☐ Alkalinity ☐ pH ☐ Fertilizer Soil ☐ Fertilizer Water ☐ Nutrients Soil ☐ Routine Potability ☐ Basic Class II Landfill PKG ☐ Phenols ☐ Limited Sample - missing & partial bottles ☐ Sediment in sample														Standard (5 days) Rush (3 days) (2 days) (1 day) (same day)									
Contact Name: Joan Leavitt				Contact Name: Stacy Gibb																		LAB USE ONLY									
Address: Bag Service 5000				Address: Suite 500																		MAXXAM JOB #									
Norman Wells, NT X0E0V0				Calgary, AB T3B 6B7																		8769645									
Email: joan.n.leavitt@esd.ca				Email: stacy.gibb@advisian.com																		SAMPLES									
Ph: 587-476-4449				Ph: 403-577-6200																		LABELED BY: KVT									
Sampler Name (Print): Melissa Jones, Michelle Volakaty				Consultant Project #: 407074-00828-400																		VERIFIED BY: LMN									
FIELD SAMPLE ID				MATRIX		SAMPLING																									
				GROUND WATER		DATE																									
				SURFACE WATER		TIME																									
				OTHER		(YYYY/MM/DD)																									
1 B1 SS2 09-DP-1				X		9 2017/08/14 12:40																									
2 B1 SS2 09-DP-2				X		6 2017/08/14 13:00																									
3																															
4																															
5																															
6																															
7																															
8																															
9																															
10																															
IOL SITE LOCATION Norman Wells, NT								SPECIAL INSTRUCTIONS also email: -Standard Norman Wells email list -melissa.lord@advisian.com *Only dissolved metals bottle provided for samples with routine potability dissolved metals request								# JARS USED & NOT SUBMITTED Enter N/A for Water								TURNAROUND TIME Standard (5 days) Rush (3 days) (2 days) (1 day) (same day)							
IOL PROJECT # (if applicable) N/A								REGULATORY CRITERIA / DETECTION LIMITS: ☐ Alberta Tier 1 ☐ SEGQ (SK) ☒ CCME FAL (incl. level)								YES NO COOLER ID # SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT								DATE: 2017/08/14 TIME (24 HR): 09:35							
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM 4502488 789 +00010								RECEIVED BY: 1. Melissa Lord printed name 2. [Signature] signature 3. [Signature] signature								DATE: 2017/08/15 TIME (24 HR): 08:00 1. Danielle Boiret printed name 2. [Signature] signature 3. [Signature] signature								DATE: 2017/08/15 TIME (24 HR): 09:35 1. [Signature] signature 2. [Signature] signature 3. [Signature] signature							

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: <u>Advisian</u>	Sampling Date: <u>14-Aug-17</u>
Location: <u>Norman Wells</u>	Laboratory: <u>Maxxam Edmonton</u>
Consultant Project Number: <u>407074-00828.400</u>	Sample Submission Number: <u>B769645</u>

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	No field QC samples submitted.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?: Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?: Yes

Were all samples analyzed within hold times (Yes/No)?: Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?: n/a

Is Chain of Custody completed and signed (Yes/No)?: Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?: Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?: No

Date Issued: n/a Date of Response: n/a

Is data considered to be reliable (Yes/No)?: Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): <u>Vivian Baptista</u>	Data Reviewed by (Signature): <u></u>
Date: <u>12-Sep-17</u>	

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294859

Report Date: 2017/08/26

Report #: R2434803

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B770630

Received: 2017/08/20, 09:40

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	5	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	5	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	5	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	5	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	5	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	5	AB SOP-00037	CCME PHC-CWS m
Hardness	5	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	5	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	5	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	5	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	5	AB WI-00065	Auto Calc
Nitrate and Nitrite	5	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	5	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	5	AB SOP-00023	SM 22 4110 B m
Phenols (4-AAP)	5	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	5	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	5	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294859

Report Date: 2017/08/26

Report #: R2434803

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B770630

Received: 2017/08/20, 09:40

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Rhécie Phayouphone
Project Manager
28 Aug 2017 16:28:27

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178



=====

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.

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT9592	RT9592	RT9593	RT9594	RT9595	RT9596		
Sampling Date		2017/08/17 11:00	2017/08/17 11:00	2017/08/17 11:05	2017/08/17 11:15	2017/08/17 12:20	2017/08/17 13:45		
COC Number		294859	294859	294859	294859	294859	294859		
	UNITS	CPF 97-7-5	CPF 97-7-5 Lab-Dup	NWD 17-45	TF 03-12-3	CPF 98-8-3	MTF 97-1-5	RDL	QC Batch
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8733019
Volatiles									
Benzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8733408
Toluene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8733408
Ethylbenzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8733408
m & p-Xylene	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8733408
o-Xylene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8733408
Xylenes (Total)	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8733408
F1 (C6-C10) - BTEX	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8733408
F1 (C6-C10)	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8733408
Extraction Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	100	112	106	101	100	104		8733019
Instrument Surrogate Recovery (%)									
1,4-Difluorobenzene (sur.)	%	103		102	101	100	100		8733408
4-Bromofluorobenzene (sur.)	%	103		100	102	101	101		8733408
D4-1,2-Dichloroethane (sur.)	%	102		102	108	102	104		8733408
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate									

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT9592	RT9593	RT9594	RT9595	RT9596		
Sampling Date		2017/08/17 11:00	2017/08/17 11:05	2017/08/17 11:15	2017/08/17 12:20	2017/08/17 13:45		
COC Number		294859	294859	294859	294859	294859		
	UNITS	CPF 97-7-5	NWD 17-45	TF 03-12-3	CPF 98-8-3	MTF 97-1-5	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	0.000033	0.000043	0.00011	0.000084	0.00013	0.000020	8732560
Elements								
Dissolved Aluminum (Al)	mg/L	0.032	0.025	0.011	0.045	0.0030	0.0030	8737497
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	0.0011	<0.00060	0.0011	0.00060	8737497
Dissolved Arsenic (As)	mg/L	0.00042	0.00039	0.0039	0.00032	0.00026	0.00020	8737497
Dissolved Barium (Ba)	mg/L	0.059	0.059	0.068	0.16	0.019	0.010	8738760
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8737497
Dissolved Boron (B)	mg/L	0.055	0.051	0.044	0.030	<0.020	0.020	8738760
Dissolved Calcium (Ca)	mg/L	310	310	190	150	160	0.30	8738760
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8737497
Dissolved Cobalt (Co)	mg/L	0.0038	0.0037	0.0031	0.00032	<0.00030	0.00030	8737497
Dissolved Copper (Cu)	mg/L	0.00076	0.00094	0.00085	0.0025	0.0028	0.00020	8737497
Dissolved Iron (Fe)	mg/L	1.8	1.8	1.8	0.081	<0.060	0.060	8738760
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	0.00024	0.00021	<0.00020	0.00020	8737497
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	8738760
Dissolved Magnesium (Mg)	mg/L	66	66	77	30	40	0.20	8738760
Dissolved Manganese (Mn)	mg/L	1.7	1.7	0.25	0.14	<0.0040	0.0040	8738760
Dissolved Molybdenum (Mo)	mg/L	0.0058	0.0061	0.23	0.0012	0.043	0.00020	8737497
Dissolved Nickel (Ni)	mg/L	0.0090	0.0087	0.023	0.0023	0.0072	0.00050	8737497
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8738760
Dissolved Potassium (K)	mg/L	4.5	4.5	5.0	2.5	1.0	0.30	8738760
Dissolved Selenium (Se)	mg/L	0.00056	0.00062	0.0044	0.00024	0.078	0.00020	8737497
Dissolved Silicon (Si)	mg/L	4.4	4.5	13	3.8	6.9	0.10	8738760
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	8737497
Dissolved Sodium (Na)	mg/L	9.1	9.0	60	10	4.5	0.50	8738760
Dissolved Strontium (Sr)	mg/L	1.3	1.4	0.75	0.55	0.38	0.020	8738760
Dissolved Sulphur (S)	mg/L	250	250	56	65	120	0.20	8738760
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	0.0016	<0.00020	<0.00020	0.00020	8737497
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8737497
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	0.0045	<0.0010	<0.0010	0.0010	8737497
RDL = Reportable Detection Limit								

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT9592	RT9593	RT9594	RT9595	RT9596		
Sampling Date		2017/08/17 11:00	2017/08/17 11:05	2017/08/17 11:15	2017/08/17 12:20	2017/08/17 13:45		
COC Number		294859	294859	294859	294859	294859		
	UNITS	CPF 97-7-5	NWD 17-45	TF 03-12-3	CPF 98-8-3	MTF 97-1-5	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0035	0.0035	0.020	0.00042	0.023	0.00010	8737497
Dissolved Vanadium (V)	mg/L	0.0019	0.0017	0.0059	0.0015	0.0012	0.0010	8737497
Dissolved Zinc (Zn)	mg/L	0.014	0.012	0.0074	0.012	0.0049	0.0030	8737497
Low Level Elements								
Dissolved Mercury (Hg)	mg/L	<0.0000020	0.0000021	0.0000029	<0.0000020	0.0000042	0.0000020	8734001
RDL = Reportable Detection Limit								

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT9592		RT9593		RT9594		RT9595		
Sampling Date		2017/08/17 11:00		2017/08/17 11:05		2017/08/17 11:15		2017/08/17 12:20		
COC Number		294859		294859		294859		294859		
	UNITS	CPF 97-7-5	QC Batch	NWD 17-45	RDL	TF 03-12-3	RDL	CPF 98-8-3	RDL	QC Batch
Calculated Parameters										
Hardness (CaCO ₃)	mg/L	1000	8732561	1000	0.50	800	0.50	490	0.50	8732561
Ion Balance (% Difference)	%	0.37	8732562	0.44	N/A	1.9	N/A	1.3	N/A	8732562
Dissolved Nitrate (NO ₃)	mg/L	<0.044	8732563	<0.044	0.044	0.15	0.044	0.36	0.044	8732563
Nitrate plus Nitrite (N)	mg/L	<0.014	8732564	<0.014	0.014	0.034	0.014	0.081	0.014	8732564
Dissolved Nitrite (NO ₂)	mg/L	<0.033	8732563	<0.033	0.033	<0.033	0.033	<0.033	0.033	8732563
Misc. Inorganics										
Conductivity	uS/cm	1700	8733964	1700	1.0	1700	1.0	890	1.0	8733579
Total Dissolved Solids	mg/L	1400	8734121	1400	10	1200 (1)	50	640	10	8734121
Anions										
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	8733963	<0.50	0.50	<0.50	0.50	<0.50	0.50	8733582
Alkalinity (Total as CaCO ₃)	mg/L	290	8733963	290	0.50	570	0.50	310	0.50	8733582
Bicarbonate (HCO ₃)	mg/L	360	8733963	350	0.50	700	0.50	370	0.50	8733582
Carbonate (CO ₃)	mg/L	<0.50	8733963	<0.50	0.50	<0.50	0.50	<0.50	0.50	8733582
Hydroxide (OH)	mg/L	<0.50	8733963	<0.50	0.50	<0.50	0.50	<0.50	0.50	8733582
Dissolved Sulphate (SO ₄)	mg/L	730 (2)	8735019	720 (2)	5.0	170	1.0	180	1.0	8735019
Dissolved Chloride (Cl)	mg/L	19	8735006	19	1.0	160	1.0	9.4	1.0	8735006
Nutrients										
Dissolved Nitrite (N)	mg/L	<0.010	8732610	<0.010	0.010	<0.010	0.010	<0.010	0.010	8732610
Dissolved Nitrate (N)	mg/L	<0.010	8732610	<0.010	0.010	0.034	0.010	0.081	0.010	8732610
Misc. Organics										
Phenols	mg/L	0.0033	8736997	0.0027	0.0020	0.011	0.0020	0.0073	0.0020	8736997
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis. (2) Detection limits raised due to dilution to bring analyte within the calibrated range.										

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT9596		
Sampling Date		2017/08/17 13:45		
COC Number		294859		
	UNITS	MTF 97-1-5	RDL	QC Batch
Calculated Parameters				
Hardness (CaCO ₃)	mg/L	570	0.50	8732561
Ion Balance (% Difference)	%	6.1	N/A	8732562
Dissolved Nitrate (NO ₃)	mg/L	10	0.044	8732563
Nitrate plus Nitrite (N)	mg/L	2.3	0.014	8732564
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	8732563
Misc. Inorganics				
Conductivity	uS/cm	1100	1.0	8733579
Total Dissolved Solids	mg/L	920	10	8734121
Anions				
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	8733582
Alkalinity (Total as CaCO ₃)	mg/L	210	0.50	8733582
Bicarbonate (HCO ₃)	mg/L	260	0.50	8733582
Carbonate (CO ₃)	mg/L	<0.50	0.50	8733582
Hydroxide (OH)	mg/L	<0.50	0.50	8733582
Dissolved Sulphate (SO ₄)	mg/L	420 (1)	5.0	8735019
Dissolved Chloride (Cl)	mg/L	1.5	1.0	8735006
Nutrients				
Dissolved Nitrite (N)	mg/L	<0.010	0.010	8732610
Dissolved Nitrate (N)	mg/L	2.3	0.010	8732610
Misc. Organics				
Phenols	mg/L	0.0041	0.0020	8736997
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RT9592
Sample ID: CPF 97-7-5
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733963	N/A	2017/08/22	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Sandy Yuan
Chloride by Automated Colourimetry	KONE	8735006	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733964	N/A	2017/08/22	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8737497	N/A	2017/08/25	Andrew Payne
Ion Balance	CALC	8732562	N/A	2017/08/21	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/21	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/21	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732610	N/A	2017/08/21	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8736997	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8735019	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734121	2017/08/22	2017/08/23	Kruti Patel

Maxxam ID: RT9592 Dup
Sample ID: CPF 97-7-5
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur

Maxxam ID: RT9593
Sample ID: NWD 17-45
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733582	N/A	2017/08/21	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Sandy Yuan
Chloride by Automated Colourimetry	KONE	8735006	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733579	N/A	2017/08/21	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8737497	N/A	2017/08/25	Andrew Payne
Ion Balance	CALC	8732562	N/A	2017/08/21	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/21	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/21	Automated Statchk

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RT9593
Sample ID: NWD 17-45
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732610	N/A	2017/08/21	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8736997	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8735019	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734121	2017/08/22	2017/08/23	Kruti Patel

Maxxam ID: RT9594
Sample ID: TF 03-12-3
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733582	N/A	2017/08/21	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Sandy Yuan
Chloride by Automated Colourimetry	KONE	8735006	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733579	N/A	2017/08/21	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8737497	N/A	2017/08/25	Andrew Payne
Ion Balance	CALC	8732562	N/A	2017/08/21	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/21	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/21	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732610	N/A	2017/08/21	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8736997	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8735019	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734121	2017/08/22	2017/08/23	Kruti Patel

Maxxam ID: RT9595
Sample ID: CPF 98-8-3
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733582	N/A	2017/08/21	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Sandy Yuan
Chloride by Automated Colourimetry	KONE	8735006	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733579	N/A	2017/08/21	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8737497	N/A	2017/08/25	Andrew Payne

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RT9595
Sample ID: CPF 98-8-3
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Ion Balance	CALC	8732562	N/A	2017/08/21	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/21	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/21	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732610	N/A	2017/08/21	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8736997	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8735019	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734121	2017/08/22	2017/08/23	Kruti Patel

Maxxam ID: RT9596
Sample ID: MTF 97-1-5
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733582	N/A	2017/08/21	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Sandy Yuan
Chloride by Automated Colourimetry	KONE	8735006	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733579	N/A	2017/08/21	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8737497	N/A	2017/08/25	Andrew Payne
Ion Balance	CALC	8732562	N/A	2017/08/21	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/21	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/21	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732610	N/A	2017/08/21	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8736997	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8735019	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734121	2017/08/22	2017/08/23	Kruti Patel

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Sample RT9592 [CPF 97-7-5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT9593 [NWD 17-45] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT9594 [TF 03-12-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT9595 [CPF 98-8-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT9596 [MTF 97-1-5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8732610	KD5	Method Blank	Dissolved Nitrite (N)	2017/08/21	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/08/21	<0.010		mg/L	
8733019	KK5	Method Blank	O-TERPHENYL (sur.)	2017/08/22		101	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/22	<0.10		mg/L	
8733408	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/22		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/22		99	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/22		103	%	70 - 130
			Benzene	2017/08/22	<0.00040		mg/L	
			Toluene	2017/08/22	<0.00040		mg/L	
			Ethylbenzene	2017/08/22	<0.00040		mg/L	
			m & p-Xylene	2017/08/22	<0.00080		mg/L	
			o-Xylene	2017/08/22	<0.00040		mg/L	
			Xylenes (Total)	2017/08/22	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/22	<0.10		mg/L	
			F1 (C6-C10)	2017/08/22	<0.10		mg/L	
8733579	AF6	Method Blank	Conductivity	2017/08/21	<1.0		uS/cm	
8733582	AF6	Method Blank	Alkalinity (Total as CaCO3)	2017/08/21	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/21	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/21	<0.50		mg/L	
			Carbonate (CO3)	2017/08/21	<0.50		mg/L	
			Hydroxide (OH)	2017/08/21	<0.50		mg/L	
8733963	CH7	Method Blank	Alkalinity (Total as CaCO3)	2017/08/22	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/22	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/22	<0.50		mg/L	
			Carbonate (CO3)	2017/08/22	<0.50		mg/L	
			Hydroxide (OH)	2017/08/22	<0.50		mg/L	
8733964	CH7	Method Blank	Conductivity	2017/08/22	<1.0		uS/cm	
8734001	NP4	Method Blank	Dissolved Mercury (Hg)	2017/08/22	<0.0000020		mg/L	
8734121	KPG	Method Blank	Total Dissolved Solids	2017/08/23	<10		mg/L	
8735006	CH7	Method Blank	Dissolved Chloride (Cl)	2017/08/24	<1.0		mg/L	
8735019	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/08/24	<1.0		mg/L	
8736997	YY	Method Blank	Phenols	2017/08/24	<0.0020		mg/L	
8737497	APY	Method Blank	Dissolved Aluminum (Al)	2017/08/26	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/26	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/26	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/26	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/26	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/26	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/26	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/26	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/26	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/26	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/26	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/26	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/26	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/26	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/26	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/26	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/26	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/26	<0.0010		mg/L	
8738760	BAH	Method Blank	Dissolved Iron (Fe)	2017/08/25	<0.060		mg/L	

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Lithium (Li)	2017/08/25	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/25	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/25	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/25	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/25	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/25	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/25	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/25	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/25	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/25	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/25	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/25	<0.30		mg/L	
8733019	KK5	RPD [RT9592-05]	F2 (C10-C16 Hydrocarbons)	2017/08/22	NC		%	30
8733019	KK5	Matrix Spike [RT9593-05]	O-TERPHENYL (sur.)	2017/08/22		99	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/22		104	%	60 - 130
8733408	SES	Matrix Spike [RT9594-06]	1,4-Difluorobenzene (sur.)	2017/08/23		96	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/23		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/23		107	%	70 - 130
			Benzene	2017/08/23		100	%	70 - 130
			Toluene	2017/08/23		93	%	70 - 130
			Ethylbenzene	2017/08/23		95	%	70 - 130
			m & p-Xylene	2017/08/23		97	%	70 - 130
			o-Xylene	2017/08/23		94	%	70 - 130
			F1 (C6-C10)	2017/08/23		77	%	70 - 130
8732610	KD5	LCS	Dissolved Nitrite (N)	2017/08/20		101	%	80 - 120
			Dissolved Nitrate (N)	2017/08/20		101	%	80 - 120
8733019	KK5	LCS	O-TERPHENYL (sur.)	2017/08/22		103	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/22		109	%	70 - 130
8733408	SES	LCS	1,4-Difluorobenzene (sur.)	2017/08/22		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/22		97	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/22		106	%	70 - 130
			Benzene	2017/08/22		103	%	70 - 130
			Toluene	2017/08/22		97	%	70 - 130
			Ethylbenzene	2017/08/22		105	%	70 - 130
			m & p-Xylene	2017/08/22		103	%	70 - 130
			o-Xylene	2017/08/22		98	%	70 - 130
			F1 (C6-C10)	2017/08/22		109	%	70 - 130
8733579	AF6	LCS	Conductivity	2017/08/21		99	%	90 - 110
8733582	AF6	LCS	Alkalinity (Total as CaCO3)	2017/08/21		98	%	80 - 120
8733963	CH7	LCS	Alkalinity (Total as CaCO3)	2017/08/22		101	%	80 - 120
8733964	CH7	LCS	Conductivity	2017/08/22		99	%	90 - 110
8734001	NP4	LCS	Dissolved Mercury (Hg)	2017/08/22		100	%	80 - 120
8734121	KPG	LCS	Total Dissolved Solids	2017/08/23		99	%	80 - 120
8735006	CH7	LCS	Dissolved Chloride (Cl)	2017/08/24		107	%	80 - 120
8735019	CH7	LCS	Dissolved Sulphate (SO4)	2017/08/24		104	%	80 - 120
8736997	YY	LCS	Phenols	2017/08/24		86	%	80 - 120
8737497	APY	LCS	Dissolved Aluminum (Al)	2017/08/25		98	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/25		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/25		99	%	80 - 120
			Dissolved Copper (Cu)	2017/08/25		98	%	80 - 120
			Dissolved Lead (Pb)	2017/08/25		94	%	80 - 120

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8738760	BAH	LCS	Dissolved Antimony (Sb)	2017/08/25		91	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/25		102	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/25		97	%	80 - 120
			Dissolved Selenium (Se)	2017/08/25		100	%	80 - 120
			Dissolved Silver (Ag)	2017/08/25		101	%	80 - 120
			Dissolved Arsenic (As)	2017/08/25		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/25		99	%	80 - 120
			Dissolved Tin (Sn)	2017/08/25		100	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/25		96	%	80 - 120
			Dissolved Uranium (U)	2017/08/25		98	%	80 - 120
			Dissolved Vanadium (V)	2017/08/25		98	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/25		98	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/25		99	%	80 - 120
			Dissolved Iron (Fe)	2017/08/25		102	%	80 - 120
			Dissolved Lithium (Li)	2017/08/25		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/25		99	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/25		97	%	80 - 120
			Dissolved Potassium (K)	2017/08/25		96	%	80 - 120
			Dissolved Sodium (Na)	2017/08/25		96	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/25		96	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/25		98	%	80 - 120
			Dissolved Barium (Ba)	2017/08/25		94	%	80 - 120
			Dissolved Silicon (Si)	2017/08/25		103	%	80 - 120
			Dissolved Boron (B)	2017/08/25		100	%	80 - 120
			Dissolved Calcium (Ca)	2017/08/25		96	%	80 - 120
8734001	NP4	SRM	Dissolved Mercury (Hg)	2017/08/22		103	%	80 - 120

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.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

LCS: 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).

Maxxam Job #: B770630
Report Date: 2017/08/26

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

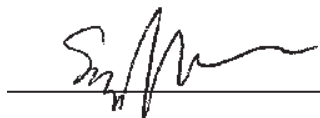
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

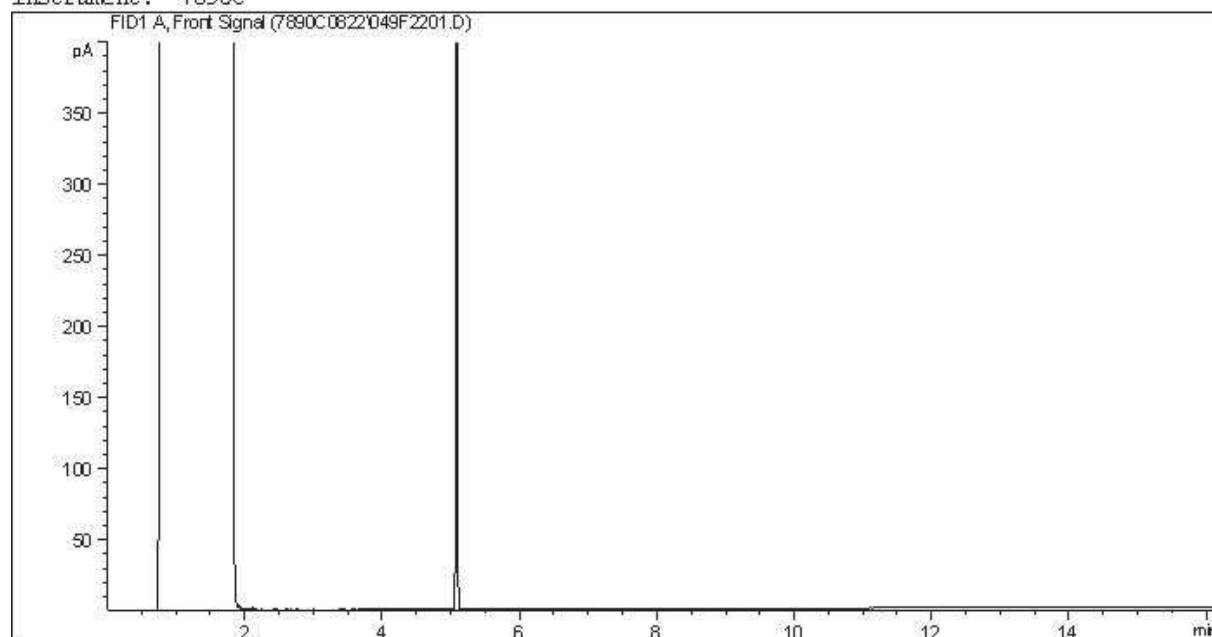


Sandy Yuan, M.Sc., Scientific Specialist

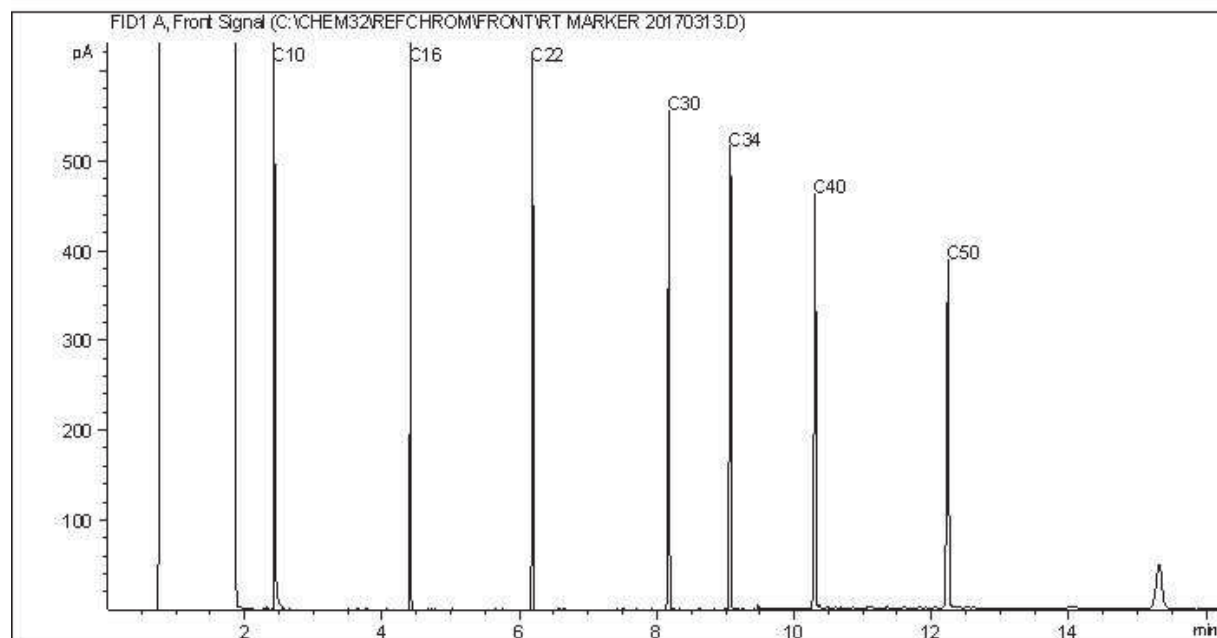
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

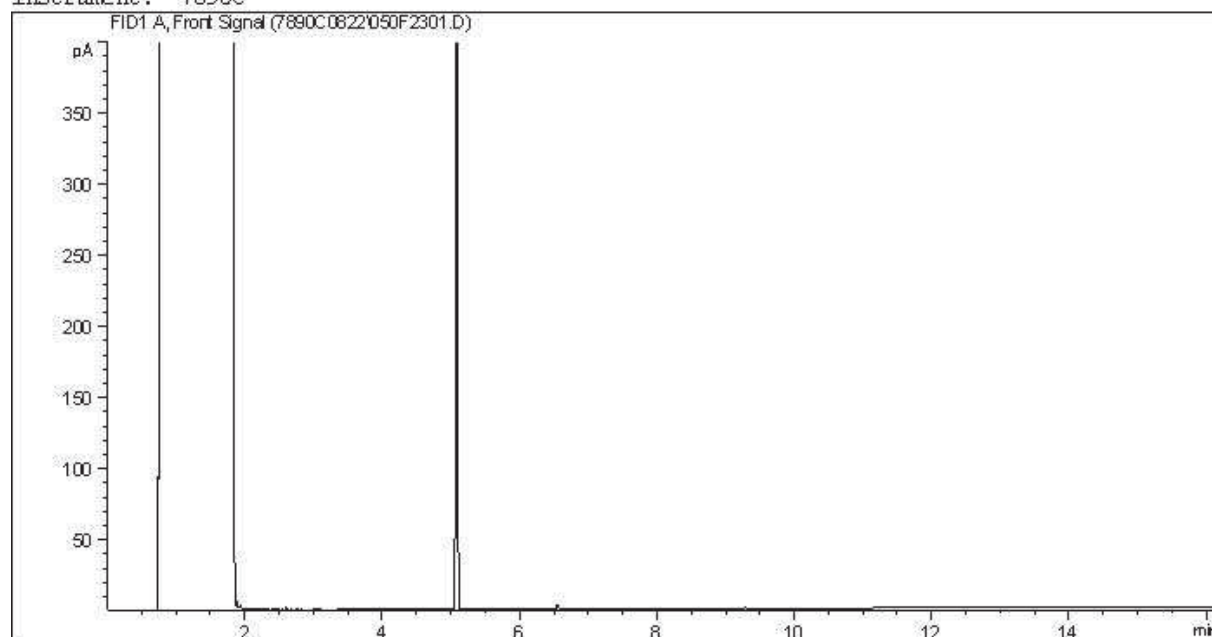
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B770630
Report Date: 2017/08/26
Maxxam Sample: RT9592 Lab-Dup

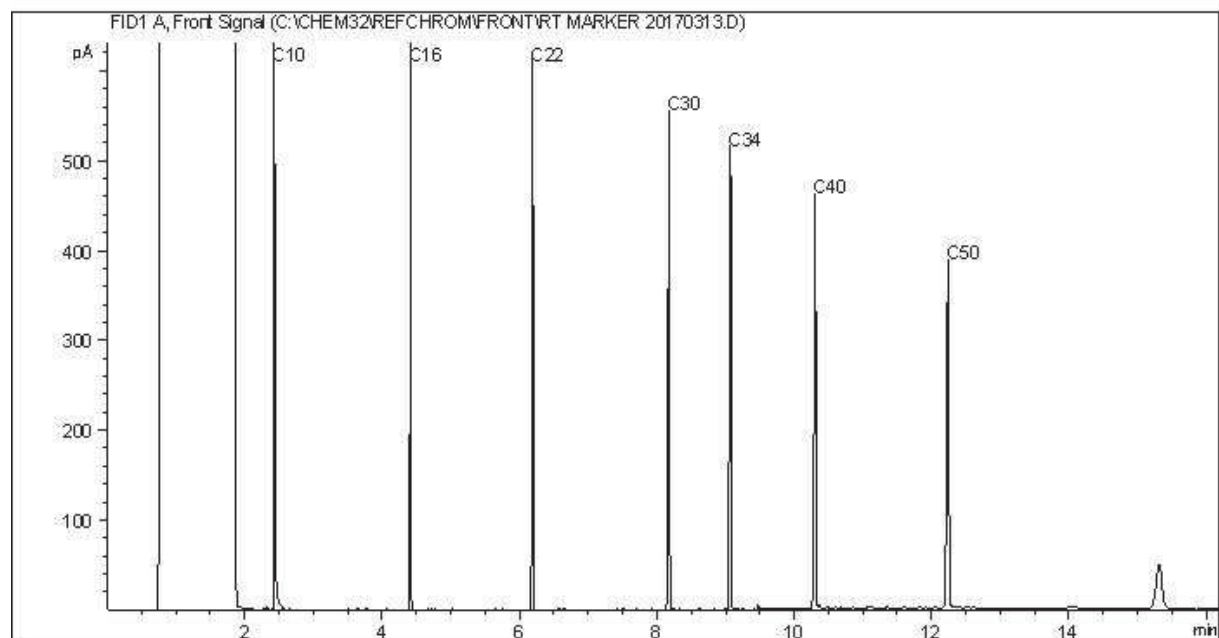
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: CPF 97-7-5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

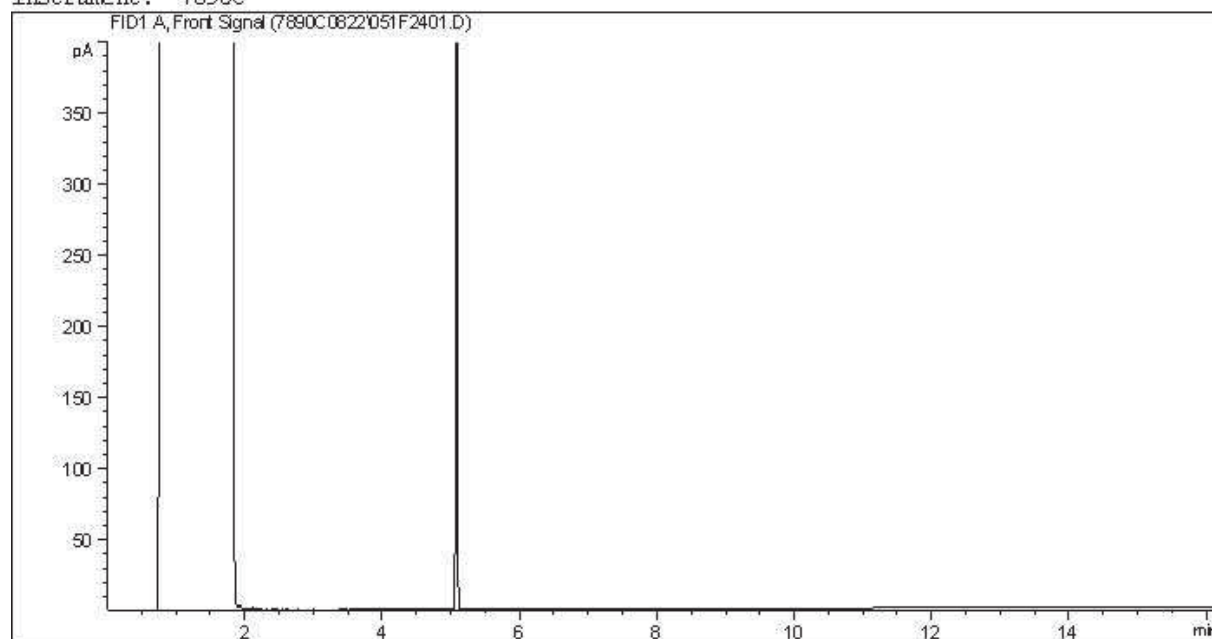
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B770630
Report Date: 2017/08/26
Maxxam Sample: RT9593

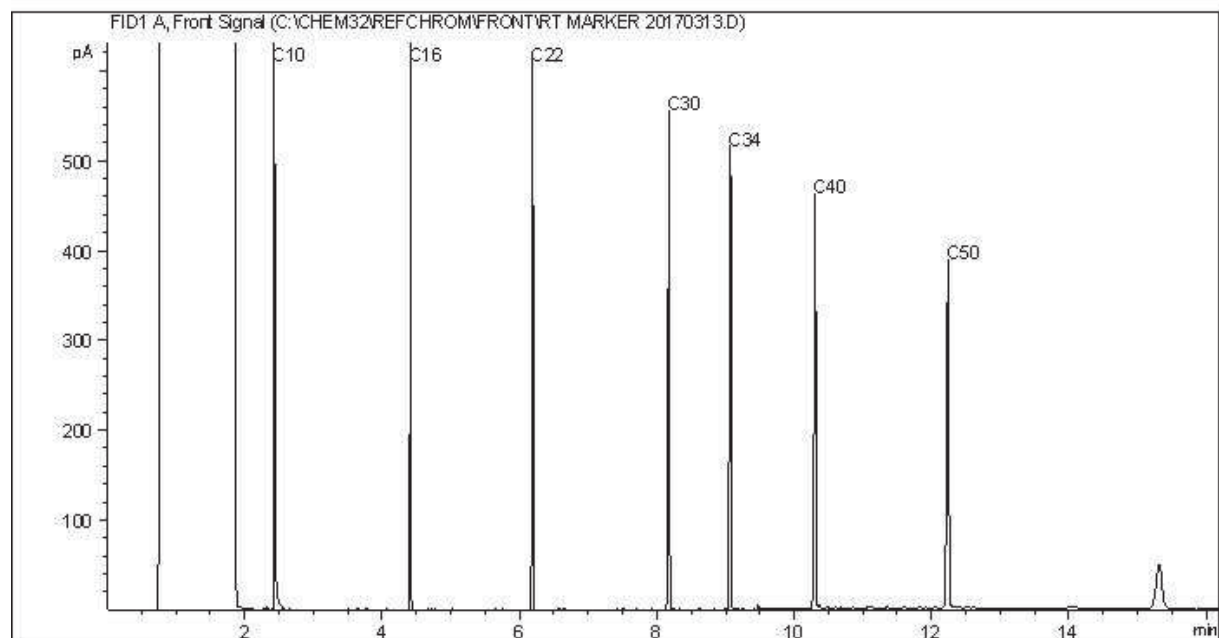
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: NWD 17-45

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

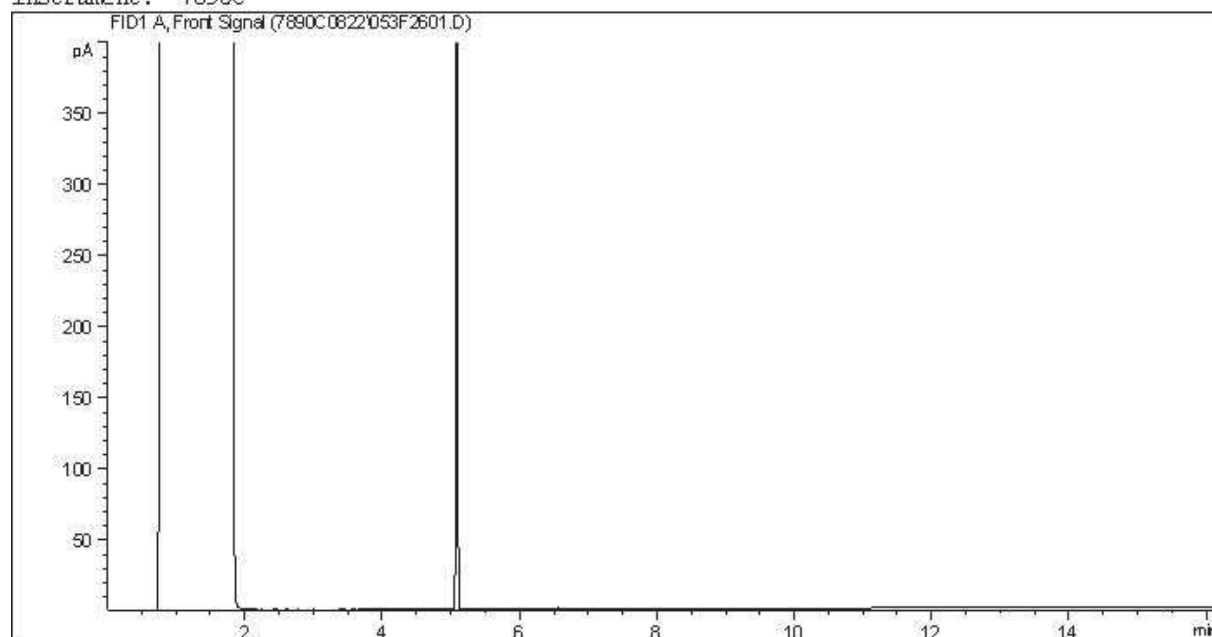
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B770630
Report Date: 2017/08/26
Maxxam Sample: RT9594

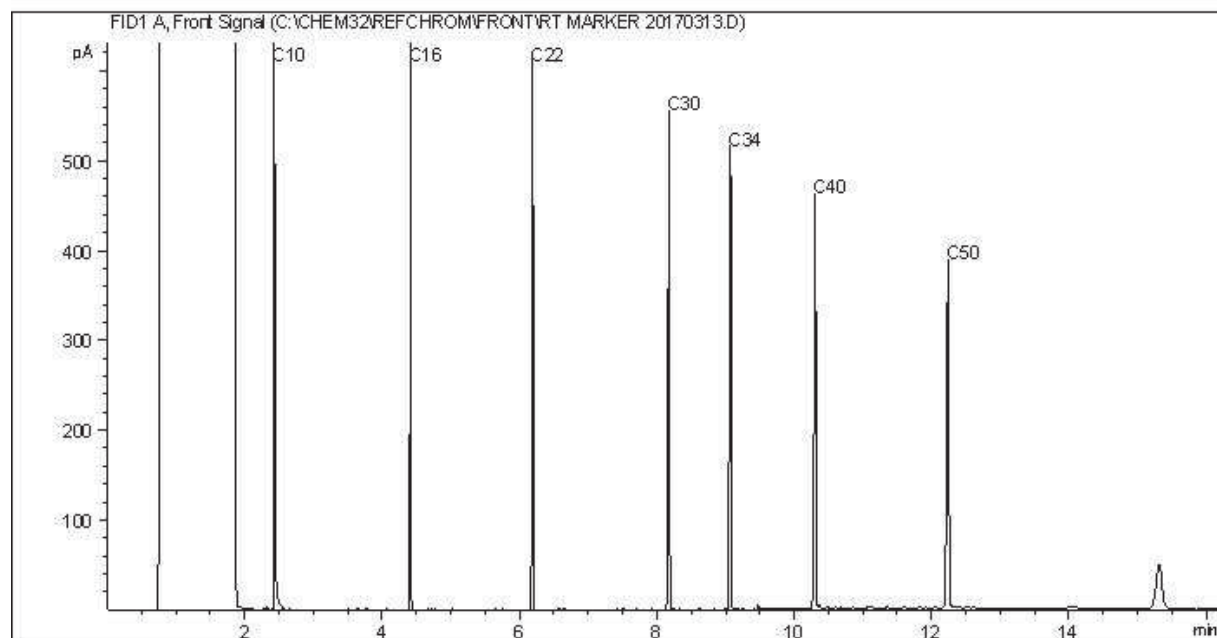
WORLEY PARSONS
Task Order#: 450248878910 Line Item: 10
Site#: N/A
Site Location: Norman Wells
Client ID: TF 03-12-3

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

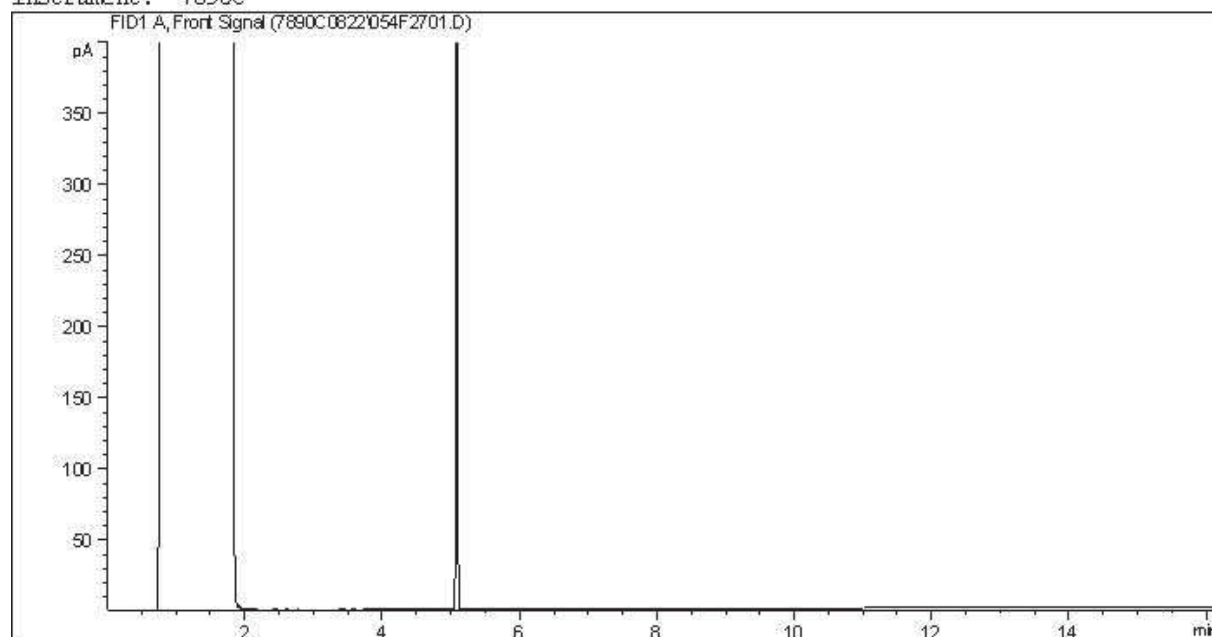
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B770630
Report Date: 2017/08/26
Maxxam Sample: RT9595

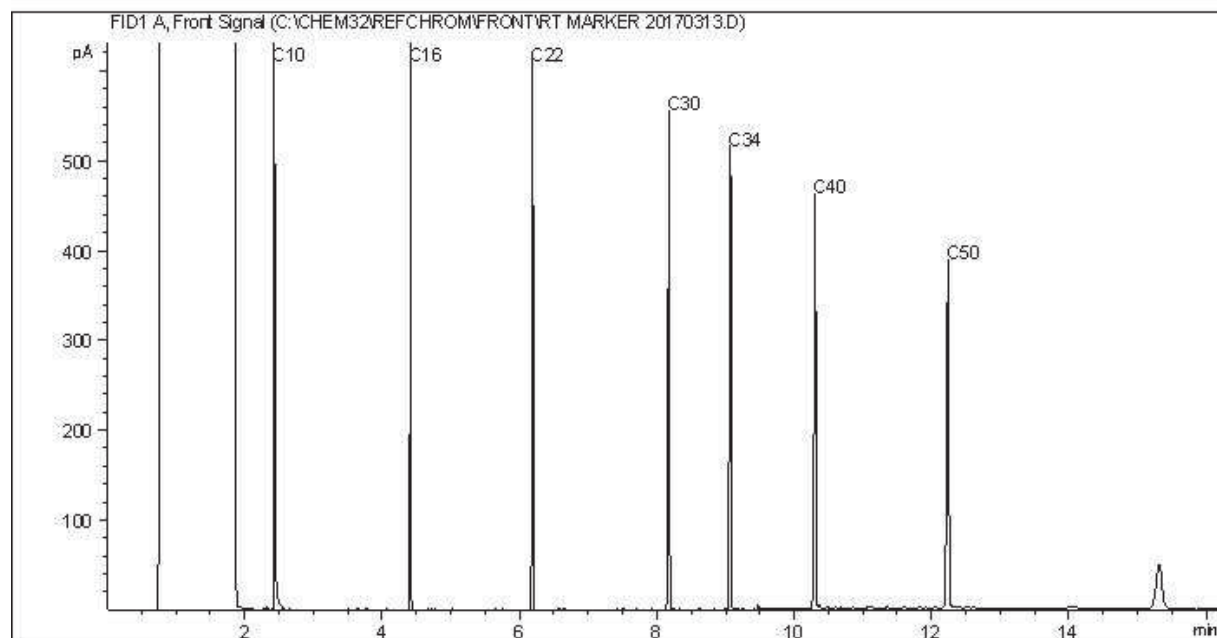
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: CPF 98-8-3

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

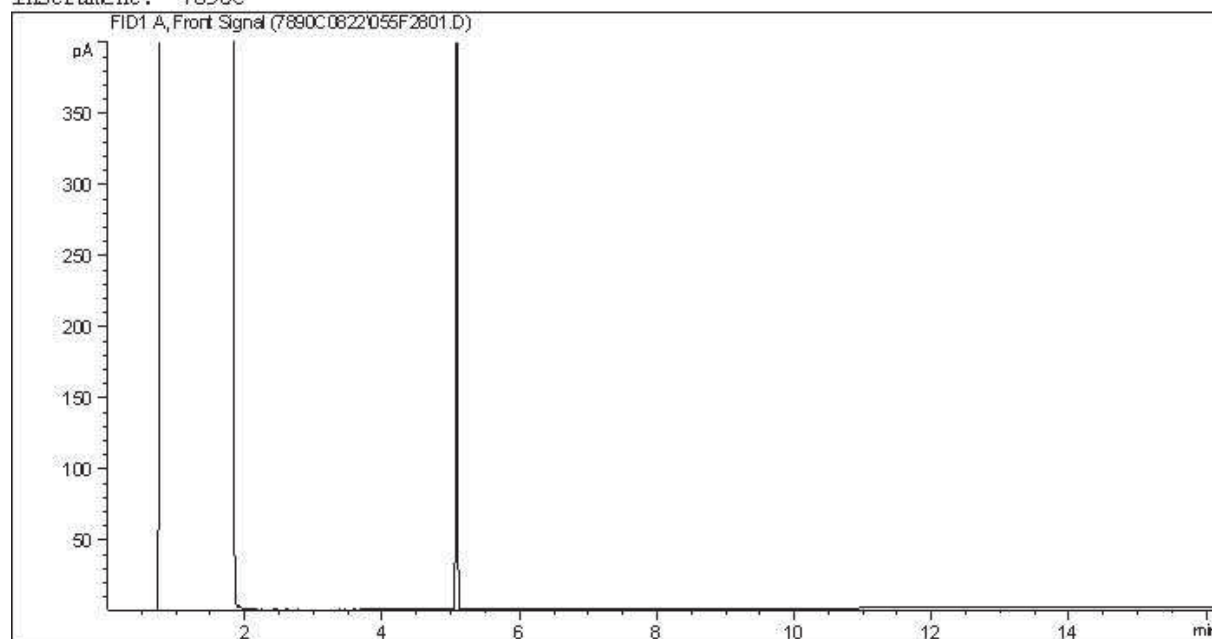
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B770630
Report Date: 2017/08/26
Maxxam Sample: RT9596

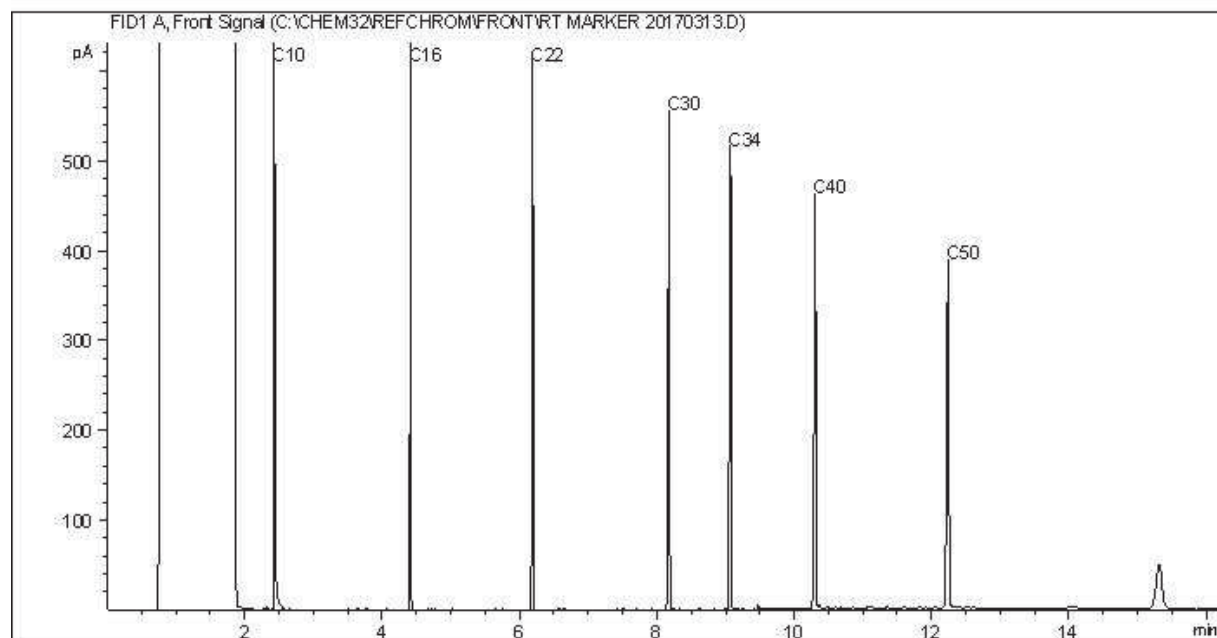
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: MTF 97-1-5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.



Calgary
4000 10th St. NE, T2E 6P8
Phone: (403) 291-3077
Fax: (403) 735-2240
Toll Free: (800) 386-7247

Edmonton
8331 - 40th Street, T6B 2R4
Phone: (780) 577-7100
Fax: (780) 450-4187
Toll Free: (800) 386-7247

EXXON MOBIL/IMPERIAL OIL - MAXXAM
CHAIN-OF-CUSTODY RECORD

Page 1 of 1
C of C # 294859

INVOICE INFORMATION										REPORT INFORMATION										ANALYSIS REQUESTED																			
Company Name: ☒ Imperial Oil ☐ ExxonMobil					Company Name: WorleyParsons					Company Name: WorleyParsons					Company Name: WorleyParsons					Company Name: WorleyParsons																			
Contact Name: Sloan Leavitt					Contact Name: Stacy Gibb					Contact Name: Stacy Gibb					Contact Name: Stacy Gibb					Contact Name: Stacy Gibb																			
Address: Bay Service 5000					Address: Suite 500					Address: Suite 500					Address: Suite 500					Address: Suite 500																			
Norman Wells, NT XOE 0V0					Calgary, AB T3B 6B7					Calgary, AB T3B 6B7					Calgary, AB T3B 6B7					Calgary, AB T3B 6B7																			
Email: Sloan.N.Leavitt@esso.ca					Email: stacy.gibb@advisian.com					Email: stacy.gibb@advisian.com					Email: stacy.gibb@advisian.com					Email: stacy.gibb@advisian.com																			
Ph: 587-446-4449					Ph: 403-247-0200					Ph: 403-247-0200					Ph: 403-247-0200					Ph: 403-247-0200																			
Sampler Name (Print):					Consultant Project #:					Consultant Project #:					Consultant Project #:					Consultant Project #:																			
Melanie Jones, Michelle Volzky					407074-00828.400					407074-00828.400					407074-00828.400					407074-00828.400																			
FIELD SAMPLE ID		MATRIX		SAMPLING		LAB FILTERED & PRESERVED		TIME (24 HR)		DATE (YYYY/MM/DD)		TIME (24 HR)		DATE (YYYY/MM/DD)		TIME (24 HR)		DATE (YYYY/MM/DD)																					
1	CPF 97-7-5	X	GROUND WATER	OTHER	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE	TIME	DATE																					
2	NWD 17-45	X	SURFACE WATER		11:00	2017/08/17	11:00	2017/08/17	11:00	2017/08/17	11:00	2017/08/17	11:00	2017/08/17	11:00	2017/08/17	11:00	2017/08/17																					
3	TF 03-12-3	X	SOIL		11:05	2017/08/17	11:05	2017/08/17	11:05	2017/08/17	11:05	2017/08/17	11:05	2017/08/17	11:05	2017/08/17	11:05	2017/08/17																					
4	CPF 98-8-3	X	GROUND WATER		12:20	2017/08/17	12:20	2017/08/17	12:20	2017/08/17	12:20	2017/08/17	12:20	2017/08/17	12:20	2017/08/17	12:20	2017/08/17																					
5	MTF 97-1-5	X	GROUND WATER		13:45	2017/08/17	13:45	2017/08/17	13:45	2017/08/17	13:45	2017/08/17	13:45	2017/08/17	13:45	2017/08/17	13:45	2017/08/17																					
6			GROUND WATER			2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17																					
7			SURFACE WATER			2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17																					
8			SOIL			2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17																					
9			GROUND WATER			2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17																					
10			GROUND WATER			2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17		2017/08/17																					
IOL SITE LOCATION Norman Wells, NT IOL PROJECT # (if applicable) N/A										REGULATORY CRITERIA / DETECTION LIMITS: ☐ Alberta Tier 1 ☐ SEQ (SK) ☒ COME (incl. level) FAL										SPECIAL INSTRUCTIONS also email: Standard Norman Wells email list - melissa.lopez@advisian.com * only 1 dissolved metal bottle provided for samples with routine potability & dissolved metals requested.*										# JARS USED & NOT SUBMITTED Enter N/A for Water Standard ☒ (5 days) Rush ☐ (3 days) ☐ (2 days) ☐ (1 day) ☐ (same day)									
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM 4502 488 789+00010										YES NO COOLER ID # SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT										DATE: 2017/08/17 TIME (24 HR) 08:00 RECEIVED BY: 1. Melanie Jones 2. [Signature] 3. [Signature]										DATE: 2017/08/17 TIME (24 HR) 09:46 RECEIVED BY: 1. [Signature] 2. [Signature] 3. [Signature]									
RELINQUISHED BY: 1. Melanie Jones										DATE: 2017/08/17 TIME (24 HR) 08:00 RECEIVED BY: 1. Melanie Jones 2. [Signature] 3. [Signature]										DATE: 2017/08/17 TIME (24 HR) 09:46 RECEIVED BY: 1. [Signature] 2. [Signature] 3. [Signature]										DATE: 2017/08/17 TIME (24 HR) 09:46 RECEIVED BY: 1. [Signature] 2. [Signature] 3. [Signature]									
SEAL PRESENT										SEAL PRESENT										SEAL PRESENT										SEAL PRESENT									
SEAL INTACT										SEAL INTACT										SEAL INTACT										SEAL INTACT									
COOLING MEDIA PRESENT										COOLING MEDIA PRESENT										COOLING MEDIA PRESENT										COOLING MEDIA PRESENT									
MAXXAM JOB #										MAXXAM JOB #										MAXXAM JOB #										MAXXAM JOB #									
B770630										B770630										B770630										B770630									
LABORATORY										LABORATORY										LABORATORY										LABORATORY									
Labeled BY: WSA										Labeled BY: WSA										Labeled BY: WSA										Labeled BY: WSA									
Verified BY: DW2										Verified BY: DW2										Verified BY: DW2										Verified BY: DW2									

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 17-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B770630

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	All field QC samples met alert limits.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD	x			

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

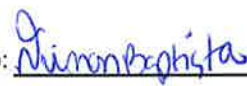
Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 12-Sep-17

Data Reviewed by (Signature): 

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294874

Report Date: 2017/08/27

Report #: R2434838

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B770635

Received: 2017/08/20, 09:40

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	1	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	1	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	1	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	1	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	1	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	1	AB SOP-00037	CCME PHC-CWS m
Hardness	1	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	1	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	1	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	1	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	1	AB WI-00065	Auto Calc
Nitrate and Nitrite	1	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	1	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	1	AB SOP-00023	SM 22 4110 B m
Phenols (4-AAP)	1	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	1	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	1	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400
Your C.O.C. #: 294874

Report Date: 2017/08/27

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Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B770635

Received: 2017/08/20, 09:40

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Rhécie Phayouphone
Project Manager
28 Aug 2017 16:53:38

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178



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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.

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT9624		
Sampling Date		2017/08/18 08:45		
COC Number		294874		
	UNITS	WSY 97-1-5	RDL	QC Batch
Ext. Pet. Hydrocarbon				
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	0.10	8733019
Volatiles				
Benzene	mg/L	<0.00040	0.00040	8733404
Toluene	mg/L	<0.00040	0.00040	8733404
Ethylbenzene	mg/L	<0.00040	0.00040	8733404
m & p-Xylene	mg/L	<0.00080	0.00080	8733404
o-Xylene	mg/L	<0.00040	0.00040	8733404
Xylenes (Total)	mg/L	<0.00080	0.00080	8733404
F1 (C6-C10) - BTEX	mg/L	<0.10	0.10	8733404
F1 (C6-C10)	mg/L	<0.10	0.10	8733404
Extraction Surrogate Recovery (%)				
O-TERPHENYL (sur.)	%	100		8733019
Instrument Surrogate Recovery (%)				
1,4-Difluorobenzene (sur.)	%	101		8733404
4-Bromofluorobenzene (sur.)	%	101		8733404
D4-1,2-Dichloroethane (sur.)	%	107		8733404
RDL = Reportable Detection Limit				

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT9624		
Sampling Date		2017/08/18 08:45		
COC Number		294874		
	UNITS	WSY 97-1-5	RDL	QC Batch
Low Level Elements				
Dissolved Cadmium (Cd)	mg/L	0.000069	0.000020	8732560
Elements				
Dissolved Aluminum (Al)	mg/L	0.0086	0.0030	8735600
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	8735600
Dissolved Arsenic (As)	mg/L	0.00049	0.00020	8735600
Dissolved Barium (Ba)	mg/L	0.053	0.010	8738760
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	8735600
Dissolved Boron (B)	mg/L	0.11	0.020	8738760
Dissolved Calcium (Ca)	mg/L	350	0.30	8738760
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	8735600
Dissolved Cobalt (Co)	mg/L	0.00035	0.00030	8735600
Dissolved Copper (Cu)	mg/L	0.0020	0.00020	8735600
Dissolved Iron (Fe)	mg/L	0.22	0.060	8738760
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	8735600
Dissolved Lithium (Li)	mg/L	<0.020	0.020	8738760
Dissolved Magnesium (Mg)	mg/L	69	0.20	8738760
Dissolved Manganese (Mn)	mg/L	0.11	0.0040	8738760
Dissolved Molybdenum (Mo)	mg/L	0.012	0.00020	8735600
Dissolved Nickel (Ni)	mg/L	0.0033	0.00050	8735600
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	8738760
Dissolved Potassium (K)	mg/L	2.1	0.30	8738760
Dissolved Selenium (Se)	mg/L	0.0033	0.00020	8735600
Dissolved Silicon (Si)	mg/L	5.3	0.10	8738760
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	8735600
Dissolved Sodium (Na)	mg/L	13	0.50	8738760
Dissolved Strontium (Sr)	mg/L	0.92	0.020	8738760
Dissolved Sulphur (S)	mg/L	280	0.20	8738760
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	8735600
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	8735600
Dissolved Titanium (Ti)	mg/L	<0.0010	0.0010	8735600
RDL = Reportable Detection Limit				

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RT9624		
Sampling Date		2017/08/18 08:45		
COC Number		294874		
	UNITS	WSY 97-1-5	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0065	0.00010	8735600
Dissolved Vanadium (V)	mg/L	<0.0010	0.0010	8735600
Dissolved Zinc (Zn)	mg/L	0.019	0.0030	8735600
Low Level Elements				
Dissolved Mercury (Hg)	mg/L	<0.0000020	0.0000020	8734001
RDL = Reportable Detection Limit				

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT9624		
Sampling Date		2017/08/18 08:45		
COC Number		294874		
	UNITS	WSY 97-1-5	RDL	QC Batch
Calculated Parameters				
Hardness (CaCO ₃)	mg/L	1100	0.50	8732561
Ion Balance (% Difference)	%	3.8	N/A	8732562
Dissolved Nitrate (NO ₃)	mg/L	<0.044	0.044	8732563
Nitrate plus Nitrite (N)	mg/L	<0.014	0.014	8732564
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	8732563
Misc. Inorganics				
Conductivity	uS/cm	1700	1.0	8733964
Total Dissolved Solids	mg/L	1600	10	8734130
Anions				
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	8733963
Alkalinity (Total as CaCO ₃)	mg/L	290	0.50	8733963
Bicarbonate (HCO ₃)	mg/L	360	0.50	8733963
Carbonate (CO ₃)	mg/L	<0.50	0.50	8733963
Hydroxide (OH)	mg/L	<0.50	0.50	8733963
Dissolved Sulphate (SO ₄)	mg/L	750 (1)	5.0	8734986
Dissolved Chloride (Cl)	mg/L	15	1.0	8734981
Nutrients				
Dissolved Nitrite (N)	mg/L	<0.010	0.010	8733427
Dissolved Nitrate (N)	mg/L	<0.010	0.010	8733427
Misc. Organics				
Phenols	mg/L	0.0035	0.0020	8737527
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range.				

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RT9624
Sample ID: WSY 97-1-5
Matrix: Water

Collected: 2017/08/18
Relinquished: 2017/08/19
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8733963	N/A	2017/08/22	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733404	N/A	2017/08/21	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8732560	N/A	2017/08/26	Automated Statchk
Chloride by Automated Colourimetry	KONE	8734981	N/A	2017/08/24	Chelsea Harmatys
Conductivity @25C	COND	8733964	N/A	2017/08/22	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8733019	2017/08/22	2017/08/22	Kanveet Kaur
Hardness	CALC	8732561	N/A	2017/08/26	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8734001	2017/08/22	2017/08/22	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8738760	N/A	2017/08/25	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8735600	N/A	2017/08/24	Andrew Payne
Ion Balance	CALC	8732562	N/A	2017/08/22	Automated Statchk
Nitrate and Nitrite	CALC	8732563	N/A	2017/08/23	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8732564	N/A	2017/08/23	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8733427	N/A	2017/08/21	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8737527	N/A	2017/08/24	Ying Yang
Sulphate by Automated Colourimetry	KONE	8734986	N/A	2017/08/24	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8734130	2017/08/22	2017/08/23	Kruti Patel

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.3°C

Results relate only to the items tested.

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8733019	KK5	Method Blank	O-TERPHENYL (sur.)	2017/08/22		101	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/22	<0.10		mg/L	
8733404	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/21		105	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/21		98	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/21		103	%	70 - 130
			Benzene	2017/08/21	<0.00040		mg/L	
			Toluene	2017/08/21	<0.00040		mg/L	
			Ethylbenzene	2017/08/21	<0.00040		mg/L	
			m & p-Xylene	2017/08/21	<0.00080		mg/L	
			o-Xylene	2017/08/21	<0.00040		mg/L	
			Xylenes (Total)	2017/08/21	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/21	<0.10		mg/L	
			F1 (C6-C10)	2017/08/21	<0.10		mg/L	
8733427	MSD	Method Blank	Dissolved Nitrite (N)	2017/08/21	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/08/21	<0.010		mg/L	
8733963	CH7	Method Blank	Alkalinity (Total as CaCO3)	2017/08/22	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/22	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/22	<0.50		mg/L	
			Carbonate (CO3)	2017/08/22	<0.50		mg/L	
			Hydroxide (OH)	2017/08/22	<0.50		mg/L	
8733964	CH7	Method Blank	Conductivity	2017/08/22	<1.0		uS/cm	
8734001	NP4	Method Blank	Dissolved Mercury (Hg)	2017/08/22	<0.0000020		mg/L	
8734130	KPG	Method Blank	Total Dissolved Solids	2017/08/23	<10		mg/L	
8734981	CH7	Method Blank	Dissolved Chloride (Cl)	2017/08/24	<1.0		mg/L	
8734986	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/08/24	<1.0		mg/L	
8735600	APY	Method Blank	Dissolved Aluminum (Al)	2017/08/24	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/24	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/24	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/24	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/24	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/24	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/24	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/24	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/24	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/24	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/24	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/24	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/24	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/24	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/24	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/24	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/24	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/24	<0.0010		mg/L	
8737527	YY	Method Blank	Phenols	2017/08/24	<0.0020		mg/L	
8738760	BAH	Method Blank	Dissolved Iron (Fe)	2017/08/25	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/25	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/25	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/25	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/25	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/25	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/25	<0.020		mg/L	

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8733019	KK5	LCS	Dissolved Sulphur (S)	2017/08/25	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/25	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/25	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/25	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/25	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/25	<0.30		mg/L	
8733404	SES	LCS	O-TERPHENYL (sur.)	2017/08/22		103	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/22		109	%	70 - 130
8733427	MSD	LCS	1,4-Difluorobenzene (sur.)	2017/08/21		101	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/21		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/21		109	%	70 - 130
			Benzene	2017/08/21		107	%	70 - 130
			Toluene	2017/08/21		99	%	70 - 130
			Ethylbenzene	2017/08/21		106	%	70 - 130
			m & p-Xylene	2017/08/21		105	%	70 - 130
			o-Xylene	2017/08/21		102	%	70 - 130
			F1 (C6-C10)	2017/08/21		99	%	70 - 130
			Dissolved Nitrite (N)	2017/08/21		101	%	80 - 120
8733963	CH7	LCS	Dissolved Nitrate (N)	2017/08/21		101	%	80 - 120
			Alkalinity (Total as CaCO3)	2017/08/22		101	%	80 - 120
8733964	CH7	LCS	Conductivity	2017/08/22		99	%	90 - 110
8734001	NP4	LCS	Dissolved Mercury (Hg)	2017/08/22		100	%	80 - 120
8734130	KPG	LCS	Total Dissolved Solids	2017/08/23		99	%	80 - 120
8734981	CH7	LCS	Dissolved Chloride (Cl)	2017/08/24		102	%	80 - 120
8734986	CH7	LCS	Dissolved Sulphate (SO4)	2017/08/24		101	%	80 - 120
8735600	APY	LCS	Dissolved Aluminum (Al)	2017/08/24		99	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/24		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/24		97	%	80 - 120
			Dissolved Copper (Cu)	2017/08/24		96	%	80 - 120
			Dissolved Lead (Pb)	2017/08/24		98	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/24		99	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/24		100	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/24		96	%	80 - 120
			Dissolved Selenium (Se)	2017/08/24		100	%	80 - 120
			Dissolved Silver (Ag)	2017/08/24		101	%	80 - 120
			Dissolved Arsenic (As)	2017/08/24		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/24		98	%	80 - 120
			Dissolved Tin (Sn)	2017/08/24		99	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/24		99	%	80 - 120
			Dissolved Uranium (U)	2017/08/24		97	%	80 - 120
			Dissolved Vanadium (V)	2017/08/24		98	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/24		100	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/24		100	%	80 - 120
8737527	YY	LCS	Phenols	2017/08/24		90	%	80 - 120
8738760	BAH	LCS	Dissolved Iron (Fe)	2017/08/25		102	%	80 - 120
			Dissolved Lithium (Li)	2017/08/25		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/25		99	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/25		97	%	80 - 120
			Dissolved Potassium (K)	2017/08/25		96	%	80 - 120
			Dissolved Sodium (Na)	2017/08/25		96	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/25		96	%	80 - 120

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8734001	NP4	SRM	Dissolved Phosphorus (P)	2017/08/25		98	%	80 - 120
			Dissolved Barium (Ba)	2017/08/25		94	%	80 - 120
			Dissolved Silicon (Si)	2017/08/25		103	%	80 - 120
			Dissolved Boron (B)	2017/08/25		100	%	80 - 120
			Dissolved Calcium (Ca)	2017/08/25		96	%	80 - 120
			Dissolved Mercury (Hg)	2017/08/22		103	%	80 - 120
QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.								
LCS: 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.								

Maxxam Job #: B770635
Report Date: 2017/08/27

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

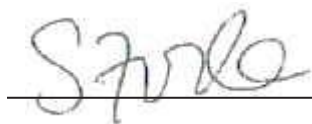
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor



Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

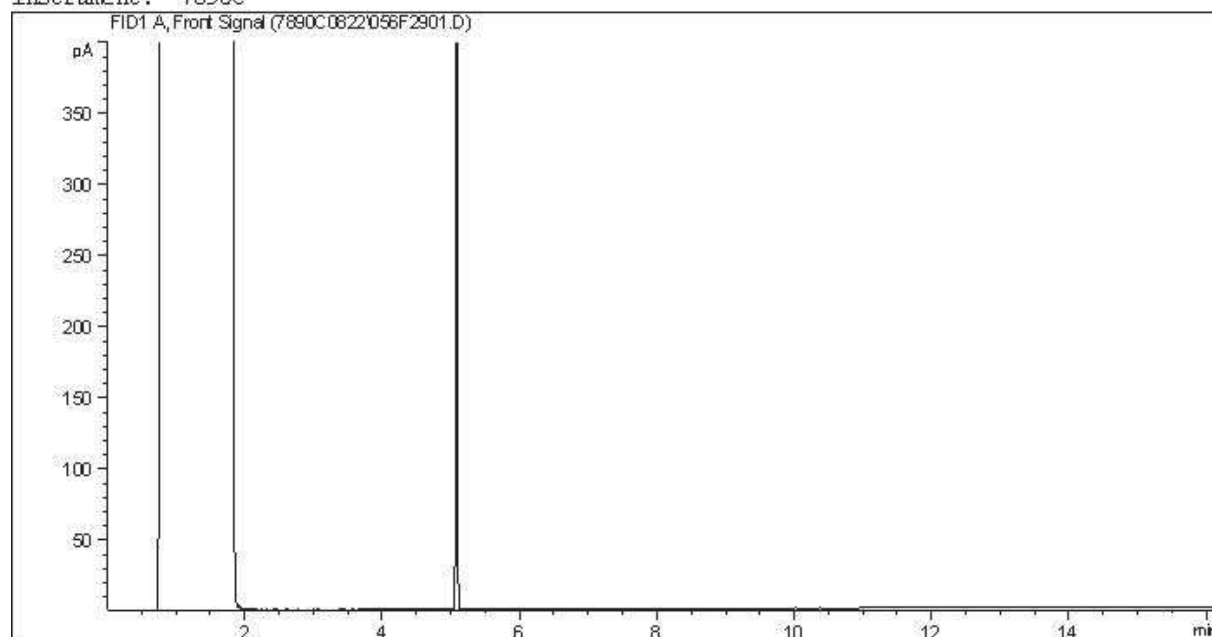
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B770635
Report Date: 2017/08/27
Maxxam Sample: RT9624

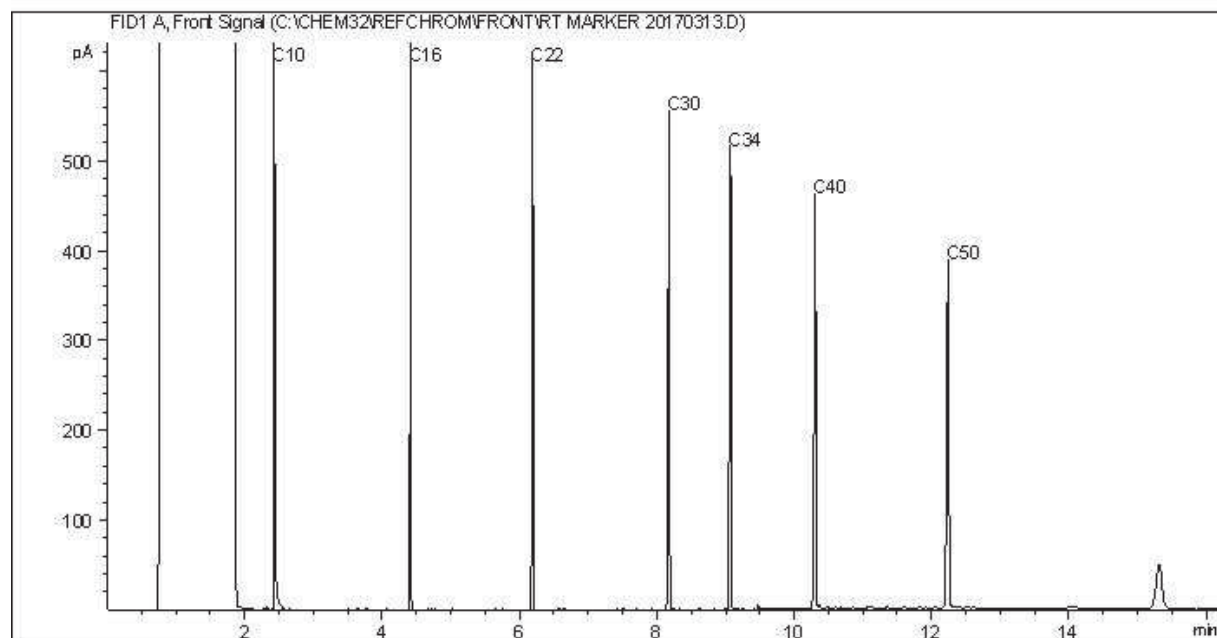
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: WSY 97-1-5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 18-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B770635

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	No field QC samples submitted.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 12-Sep-17

Data Reviewed by (Signature):

Vivian Baptista

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294875

Report Date: 2017/08/30

Report #: R2436438

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B771326

Received: 2017/08/22, 15:15

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	3	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	3	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	3	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	3	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	3	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	3	AB SOP-00037	CCME PHC-CWS m
Hardness	3	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	3	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	3	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	3	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	3	AB WI-00065	Auto Calc
Nitrate and Nitrite	3	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	3	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	3	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (3)	2	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	2	AB SOP-00037 / AB SOP-00003	EPA 3510C/8270D m
Phenols (4-AAP)	3	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	3	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	3	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294875

Report Date: 2017/08/30

Report #: R2436438

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B771326

Received: 2017/08/22, 15:15

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

(3) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key



Jenna Chernuka
Project Manager
30 Aug 2017 11:15:24

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RU2859		RU2860		RU2861		
Sampling Date		2017/08/20 09:20		2017/08/20 09:20		2017/08/20 09:22		
COC Number		294875		294875		294875		
	UNITS	GIBG-10-2-3	QC Batch	GIQ8-10-2-4	QC Batch	NWD 17-47	RDL	QC Batch
Ext. Pet. Hydrocarbon								
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	8736079	<0.10	8736108	<0.10	0.10	8736079
Volatiles								
Benzene	mg/L	<0.00040	8735467	<0.00040	8735467	<0.00040	0.00040	8735467
Toluene	mg/L	<0.00040	8735467	<0.00040	8735467	<0.00040	0.00040	8735467
Ethylbenzene	mg/L	<0.00040	8735467	<0.00040	8735467	<0.00040	0.00040	8735467
m & p-Xylene	mg/L	<0.00080	8735467	<0.00080	8735467	<0.00080	0.00080	8735467
o-Xylene	mg/L	<0.00040	8735467	<0.00040	8735467	<0.00040	0.00040	8735467
Xylenes (Total)	mg/L	<0.00080	8735467	<0.00080	8735467	<0.00080	0.00080	8735467
F1 (C6-C10) - BTEX	mg/L	<0.10	8735467	<0.10	8735467	<0.10	0.10	8735467
F1 (C6-C10)	mg/L	<0.10	8735467	<0.10	8735467	<0.10	0.10	8735467
Extraction Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	95	8736079	103	8736108	100		8736079
Instrument Surrogate Recovery (%)								
1,4-Difluorobenzene (sur.)	%	98	8735467	100	8735467	98		8735467
4-Bromofluorobenzene (sur.)	%	101	8735467	102	8735467	97		8735467
D4-1,2-Dichloroethane (sur.)	%	100	8735467	100	8735467	99		8735467
RDL = Reportable Detection Limit								

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RU2859	RU2859	RU2860	RU2861		
Sampling Date		2017/08/20 09:20	2017/08/20 09:20	2017/08/20 09:20	2017/08/20 09:22		
COC Number		294875	294875	294875	294875		
	UNITS	GIBG-10-2-3	GIBG-10-2-3 Lab-Dup	GIQ8-10-2-4	NWD 17-47	RDL	QC Batch
Low Level Elements							
Dissolved Cadmium (Cd)	mg/L	0.00017		0.00026	0.00016	0.000020	8734438
Elements							
Dissolved Aluminum (Al)	mg/L	0.0059	0.0062	0.012	0.0055	0.0030	8738714
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	0.00060	8738714
Dissolved Arsenic (As)	mg/L	0.00065	0.00061	0.00097	0.00060	0.00020	8738714
Dissolved Barium (Ba)	mg/L	0.20		0.16	0.20	0.010	8739479
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8738714
Dissolved Boron (B)	mg/L	0.036		0.033	0.030	0.020	8739479
Dissolved Calcium (Ca)	mg/L	130		140	130	0.30	8739479
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8738714
Dissolved Cobalt (Co)	mg/L	0.0036	0.0035	0.0053	0.0036	0.00030	8738714
Dissolved Copper (Cu)	mg/L	0.0014	0.0013	0.0022	0.0018	0.00020	8738714
Dissolved Iron (Fe)	mg/L	0.43		2.7	0.44	0.060	8739479
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8738714
Dissolved Lithium (Li)	mg/L	<0.020		<0.020	<0.020	0.020	8739479
Dissolved Magnesium (Mg)	mg/L	24		28	24	0.20	8739479
Dissolved Manganese (Mn)	mg/L	1.7		1.5	1.7	0.0040	8739479
Dissolved Molybdenum (Mo)	mg/L	0.0014	0.0013	0.00061	0.0013	0.00020	8738714
Dissolved Nickel (Ni)	mg/L	0.0066	0.0065	0.011	0.0068	0.00050	8738714
Dissolved Phosphorus (P)	mg/L	<0.10		<0.10	<0.10	0.10	8739479
Dissolved Potassium (K)	mg/L	2.9		2.8	2.9	0.30	8739479
Dissolved Selenium (Se)	mg/L	0.00033	0.00035	0.00029	<0.00020	0.00020	8738714
Dissolved Silicon (Si)	mg/L	4.4		4.6	4.4	0.10	8739479
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	8738714
Dissolved Sodium (Na)	mg/L	30		8.5	29	0.50	8739479
Dissolved Strontium (Sr)	mg/L	0.71		0.70	0.71	0.020	8739479
Dissolved Sulphur (S)	mg/L	42		27	42	0.20	8739479
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8738714
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8738714
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8738714
RDL = Reportable Detection Limit							
Lab-Dup = Laboratory Initiated Duplicate							

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RU2859	RU2859	RU2860	RU2861		
Sampling Date		2017/08/20 09:20	2017/08/20 09:20	2017/08/20 09:20	2017/08/20 09:22		
COC Number		294875	294875	294875	294875		
	UNITS	GIBG-10-2-3	GIBG-10-2-3 Lab-Dup	GIQ8-10-2-4	NWD 17-47	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0056	0.0054	0.0019	0.0054	0.00010	8738714
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8738714
Dissolved Zinc (Zn)	mg/L	0.0094	0.0094	0.015	0.0097	0.0030	8738714
Low Level Elements							
Dissolved Mercury (Hg)	mg/L	<0.0000020		0.0000020	<0.0000020	0.0000020	8736470
RDL = Reportable Detection Limit							
Lab-Dup = Laboratory Initiated Duplicate							

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RU2859	RU2859		RU2860		RU2861		
Sampling Date		2017/08/20 09:20	2017/08/20 09:20		2017/08/20 09:20		2017/08/20 09:22		
COC Number		294875	294875		294875		294875		
	UNITS	GIBG-10-2-3	GIBG-10-2-3 Lab-Dup	QC Batch	GIQ8-10-2-4	QC Batch	NWD 17-47	RDL	QC Batch
Calculated Parameters									
Hardness (CaCO ₃)	mg/L	430		8734873	460	8734873	430	0.50	8734873
Ion Balance (% Difference)	%	4.3		8734967	2.5	8734967	1.8	N/A	8734967
Dissolved Nitrate (NO ₃)	mg/L	0.58		8735103	0.089	8735103	0.50	0.044	8735103
Nitrate plus Nitrite (N)	mg/L	0.13		8735104	0.020	8735104	0.11	0.014	8735104
Dissolved Nitrite (NO ₂)	mg/L	<0.033		8735103	<0.033	8735103	<0.033	0.033	8735103
Misc. Inorganics									
Conductivity	uS/cm	810		8735678	820	8735678	840	1.0	8735678
Total Dissolved Solids	mg/L	560 (1)		8736054	560 (1)	8735944	560 (1)	25	8736054
Anions									
Alkalinity (PP as CaCO ₃)	mg/L	<0.50		8735677	<0.50	8735677	<0.50	0.50	8735677
Alkalinity (Total as CaCO ₃)	mg/L	310		8735677	370	8735677	340	0.50	8735677
Bicarbonate (HCO ₃)	mg/L	370		8735677	450	8735677	410	0.50	8735677
Carbonate (CO ₃)	mg/L	<0.50		8735677	<0.50	8735677	<0.50	0.50	8735677
Hydroxide (OH)	mg/L	<0.50		8735677	<0.50	8735677	<0.50	0.50	8735677
Dissolved Sulphate (SO ₄)	mg/L	140		8736412	91	8736412	130	1.0	8736412
Dissolved Chloride (Cl)	mg/L	2.4		8736411	5.8	8736411	2.3	1.0	8736411
Nutrients									
Dissolved Nitrite (N)	mg/L	<0.010	<0.010	8735679	<0.010	8735679	<0.010	0.010	8735679
Dissolved Nitrate (N)	mg/L	0.13	0.13	8735679	0.020	8735679	0.11	0.010	8735679
Misc. Organics									
Phenols	mg/L	0.0026		8738506	0.0066	8738506	0.0038	0.0020	8738506
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis.									

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		RU2859	RU2861		
Sampling Date		2017/08/20 09:20	2017/08/20 09:22		
COC Number		294875	294875		
	UNITS	GIBG-10-2-3	NWD 17-47	RDL	QC Batch
Polycyclic Aromatics					
Benzo[a]pyrene equivalency	mg/L	<0.000010	<0.000010	0.000010	8734973
Acenaphthene	mg/L	<0.00010	<0.00010	0.00010	8736056
Acenaphthylene	mg/L	<0.00010	<0.00010	0.00010	8736056
Acridine	mg/L	<0.000050	<0.000050	0.000050	8736056
Anthracene	mg/L	<0.000010	<0.000010	0.000010	8736056
Benzo(a)anthracene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
Benzo(b&j)fluoranthene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
Benzo(k)fluoranthene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
Benzo(g,h,i)perylene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
Benzo(c)phenanthrene	mg/L	<0.000050	<0.000050	0.000050	8736056
Benzo(a)pyrene	mg/L	<0.0000075	<0.0000075	0.0000075	8736056
Benzo[e]pyrene	mg/L	<0.000050	<0.000050	0.000050	8736056
Chrysene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
Dibenz(a,h)anthracene	mg/L	<0.0000075	<0.0000075	0.0000075	8736056
Fluoranthene	mg/L	<0.000010	<0.000010	0.000010	8736056
Fluorene	mg/L	<0.000050	<0.000050	0.000050	8736056
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	<0.0000085	0.0000085	8736056
2-Methylnaphthalene	mg/L	<0.00010	<0.00010	0.00010	8736056
Naphthalene	mg/L	<0.00010	<0.00010	0.00010	8736056
Phenanthrene	mg/L	0.000053	<0.000050	0.000050	8736056
Perylene	mg/L	<0.000050	<0.000050	0.000050	8736056
Pyrene	mg/L	<0.000020	<0.000020	0.000020	8736056
Quinoline	mg/L	<0.00020	<0.00020	0.00020	8736056
Extraction Surrogate Recovery (%)					
D10-ANTHRACENE (sur.)	%	65	92		8736056
D8-ACENAPHTHYLENE (sur.)	%	97	102		8736056
D8-NAPHTHALENE (sur.)	%	106	108		8736056
TERPHENYL-D14 (sur.)	%	53	69		8736056
RDL = Reportable Detection Limit					

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RU2859
Sample ID: GIBG-10-2-3
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8735677	N/A	2017/08/23	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8735467	N/A	2017/08/23	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8734438	N/A	2017/08/28	Automated Statchk
Chloride by Automated Colourimetry	KONE	8736411	N/A	2017/08/26	Chelsea Harmatys
Conductivity @25C	COND	8735678	N/A	2017/08/23	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8736079	2017/08/23	2017/08/25	Kelsey Holt
Hardness	CALC	8734873	N/A	2017/08/28	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8736470	2017/08/24	2017/08/25	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8739479	N/A	2017/08/26	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8738714	N/A	2017/08/26	Andrew Payne
Ion Balance	CALC	8734967	N/A	2017/08/23	Automated Statchk
Nitrate and Nitrite	CALC	8735103	N/A	2017/08/24	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8735104	N/A	2017/08/24	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8735679	N/A	2017/08/23	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8734973	N/A	2017/08/25	Automated Statchk
PAH in Water by GC/MS	GC/MS	8736056	2017/08/23	2017/08/24	Bert Chi
Phenols (4-AAP)	TECH/4AAP	8738506	N/A	2017/08/25	Ying Yang
Sulphate by Automated Colourimetry	KONE	8736412	N/A	2017/08/26	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8736054	2017/08/23	2017/08/24	Luminita Chiosa

Maxxam ID: RU2859 Dup
Sample ID: GIBG-10-2-3
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Elements by ICPMS - Dissolved	ICPM	8738714	N/A	2017/08/26	Andrew Payne
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8735679	N/A	2017/08/23	Mahesh Ranjan

Maxxam ID: RU2860
Sample ID: GIQ8-10-2-4
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8735677	N/A	2017/08/23	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8735467	N/A	2017/08/23	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8734438	N/A	2017/08/28	Automated Statchk
Chloride by Automated Colourimetry	KONE	8736411	N/A	2017/08/26	Chelsea Harmatys
Conductivity @25C	COND	8735678	N/A	2017/08/23	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8736108	2017/08/24	2017/08/25	Kanveet Kaur
Hardness	CALC	8734873	N/A	2017/08/28	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8736470	2017/08/24	2017/08/25	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8739479	N/A	2017/08/26	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8738714	N/A	2017/08/26	Andrew Payne

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RU2860
Sample ID: GIQ8-10-2-4
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Ion Balance	CALC	8734967	N/A	2017/08/23	Automated Statchk
Nitrate and Nitrite	CALC	8735103	N/A	2017/08/24	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8735104	N/A	2017/08/24	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8735679	N/A	2017/08/23	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8738506	N/A	2017/08/25	Ying Yang
Sulphate by Automated Colourimetry	KONE	8736412	N/A	2017/08/26	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8735944	2017/08/23	2017/08/24	Luminita Chiosa

Maxxam ID: RU2861
Sample ID: NWD 17-47
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8735677	N/A	2017/08/23	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8735467	N/A	2017/08/23	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8734438	N/A	2017/08/28	Automated Statchk
Chloride by Automated Colourimetry	KONE	8736411	N/A	2017/08/26	Chelsea Harmatys
Conductivity @25C	COND	8735678	N/A	2017/08/23	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8736079	2017/08/23	2017/08/25	Kelsey Holt
Hardness	CALC	8734873	N/A	2017/08/28	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8736470	2017/08/24	2017/08/25	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8739479	N/A	2017/08/26	Mahboubah Bahadori
Elements by ICPMS - Dissolved	ICPM	8738714	N/A	2017/08/26	Andrew Payne
Ion Balance	CALC	8734967	N/A	2017/08/23	Automated Statchk
Nitrate and Nitrite	CALC	8735103	N/A	2017/08/24	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8735104	N/A	2017/08/24	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8735679	N/A	2017/08/23	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8734973	N/A	2017/08/25	Automated Statchk
PAH in Water by GC/MS	GC/MS	8736056	2017/08/23	2017/08/24	Bert Chi
Phenols (4-AAP)	TECH/4AAP	8738506	N/A	2017/08/25	Ying Yang
Sulphate by Automated Colourimetry	KONE	8736412	N/A	2017/08/26	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8736054	2017/08/23	2017/08/24	Luminita Chiosa

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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Results relate only to the items tested.

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WORLEY PARSONS
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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8735467	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/24		105	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/24		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/24		101	%	70 - 130
			Benzene	2017/08/24	<0.00040		mg/L	
			Toluene	2017/08/24	<0.00040		mg/L	
			Ethylbenzene	2017/08/24	<0.00040		mg/L	
			m & p-Xylene	2017/08/24	<0.00080		mg/L	
			o-Xylene	2017/08/24	<0.00040		mg/L	
			Xylenes (Total)	2017/08/24	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/24	<0.10		mg/L	
			F1 (C6-C10)	2017/08/24	<0.10		mg/L	
8735677	AF6	Method Blank	Alkalinity (Total as CaCO3)	2017/08/23	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/23	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/23	<0.50		mg/L	
			Carbonate (CO3)	2017/08/23	<0.50		mg/L	
			Hydroxide (OH)	2017/08/23	<0.50		mg/L	
8735678	AF6	Method Blank	Conductivity	2017/08/23	<1.0		uS/cm	
8735679	MSD	Method Blank	Dissolved Nitrite (N)	2017/08/23	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/08/23	<0.010		mg/L	
8735944	LCA	Method Blank	Total Dissolved Solids	2017/08/24	<10		mg/L	
8736054	LCA	Method Blank	Total Dissolved Solids	2017/08/24	<10		mg/L	
8736056	BC5	Method Blank	D10-ANTHRACENE (sur.)	2017/08/24		62	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/24		77	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/24		58	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/24		57	%	50 - 130
			Acenaphthene	2017/08/24	<0.00010		mg/L	
			Acenaphthylene	2017/08/24	<0.00010		mg/L	
			Acridine	2017/08/24	<0.000050		mg/L	
			Anthracene	2017/08/24	<0.000010		mg/L	
			Benzo(a)anthracene	2017/08/24	<0.0000085		mg/L	
			Benzo(b&j)fluoranthene	2017/08/24	<0.0000085		mg/L	
			Benzo(k)fluoranthene	2017/08/24	<0.0000085		mg/L	
			Benzo(g,h,i)perylene	2017/08/24	<0.0000085		mg/L	
			Benzo(c)phenanthrene	2017/08/24	<0.000050		mg/L	
			Benzo(a)pyrene	2017/08/24	<0.0000075		mg/L	
			Benzo[e]pyrene	2017/08/24	<0.000050		mg/L	
			Chrysene	2017/08/24	<0.0000085		mg/L	
			Dibenz(a,h)anthracene	2017/08/24	<0.0000075		mg/L	
			Fluoranthene	2017/08/24	<0.000010		mg/L	
			Fluorene	2017/08/24	<0.000050		mg/L	
			Indeno(1,2,3-cd)pyrene	2017/08/24	<0.0000085		mg/L	
			2-Methylnaphthalene	2017/08/24	<0.00010		mg/L	
			Naphthalene	2017/08/24	<0.00010		mg/L	
			Phenanthrene	2017/08/24	<0.000050		mg/L	
			Perylene	2017/08/24	<0.000050		mg/L	
			Pyrene	2017/08/24	<0.000020		mg/L	
			Quinoline	2017/08/24	<0.00020		mg/L	
8736079	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/25		96	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/25	<0.10		mg/L	
8736108	KK5	Method Blank	O-TERPHENYL (sur.)	2017/08/25		111	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/25	<0.10		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8736411	CH7	Method Blank	Dissolved Chloride (Cl)	2017/08/26	<1.0		mg/L	
8736412	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/08/26	<1.0		mg/L	
8736470	NP4	Method Blank	Dissolved Mercury (Hg)	2017/08/25	<0.0000020		mg/L	
8738506	YY	Method Blank	Phenols	2017/08/25	<0.0020		mg/L	
8738714	APY	Method Blank	Dissolved Aluminum (Al)	2017/08/26	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/26	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/26	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/26	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/26	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/26	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/26	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/26	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/26	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/26	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/26	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/26	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/26	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/26	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/26	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/26	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/26	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/26	<0.0010		mg/L	
8739479	BAH	Method Blank	Dissolved Iron (Fe)	2017/08/26	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/26	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/26	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/26	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/26	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/26	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/26	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/26	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/26	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/26	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/26	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/26	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/26	<0.30		mg/L	
8735679	MSD	RPD [RU2859-01]	Dissolved Nitrite (N)	2017/08/23	NC		%	20
			Dissolved Nitrate (N)	2017/08/23	0.34		%	20
8738714	APY	RPD [RU2859-03]	Dissolved Aluminum (Al)	2017/08/26	4.6		%	20
			Dissolved Chromium (Cr)	2017/08/26	NC		%	20
			Dissolved Cobalt (Co)	2017/08/26	3.9		%	20
			Dissolved Copper (Cu)	2017/08/26	6.6		%	20
			Dissolved Lead (Pb)	2017/08/26	NC		%	20
			Dissolved Antimony (Sb)	2017/08/26	NC		%	20
			Dissolved Molybdenum (Mo)	2017/08/26	3.8		%	20
			Dissolved Nickel (Ni)	2017/08/26	0.79		%	20
			Dissolved Selenium (Se)	2017/08/26	6.4		%	20
			Dissolved Silver (Ag)	2017/08/26	NC		%	20
			Dissolved Arsenic (As)	2017/08/26	7.1		%	20
			Dissolved Thallium (Tl)	2017/08/26	NC		%	20
			Dissolved Tin (Sn)	2017/08/26	NC		%	20
			Dissolved Titanium (Ti)	2017/08/26	NC		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8735679	MSD	Matrix Spike [RU2859-01]	Dissolved Uranium (U)	2017/08/26	2.6		%	20
			Dissolved Vanadium (V)	2017/08/26	NC		%	20
			Dissolved Zinc (Zn)	2017/08/26	0.28		%	20
			Dissolved Beryllium (Be)	2017/08/26	NC		%	20
			Dissolved Nitrite (N)	2017/08/23		100	%	80 - 120
8738714	APY	Matrix Spike [RU2859-03]	Dissolved Nitrate (N)	2017/08/23		100	%	80 - 120
			Dissolved Aluminum (Al)	2017/08/26	97		%	80 - 120
			Dissolved Chromium (Cr)	2017/08/26	98		%	80 - 120
			Dissolved Cobalt (Co)	2017/08/26	96		%	80 - 120
			Dissolved Copper (Cu)	2017/08/26	94		%	80 - 120
			Dissolved Lead (Pb)	2017/08/26	96		%	80 - 120
			Dissolved Antimony (Sb)	2017/08/26	98		%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/26	102		%	80 - 120
			Dissolved Nickel (Ni)	2017/08/26	95		%	80 - 120
			Dissolved Selenium (Se)	2017/08/26	99		%	80 - 120
			Dissolved Silver (Ag)	2017/08/26	98		%	80 - 120
			Dissolved Arsenic (As)	2017/08/26	100		%	80 - 120
			Dissolved Thallium (Tl)	2017/08/26	97		%	80 - 120
			Dissolved Tin (Sn)	2017/08/26	98		%	80 - 120
			Dissolved Titanium (Ti)	2017/08/26	101		%	80 - 120
			Dissolved Uranium (U)	2017/08/26	97		%	80 - 120
			Dissolved Vanadium (V)	2017/08/26	100		%	80 - 120
			Dissolved Zinc (Zn)	2017/08/26	96		%	80 - 120
			Dissolved Beryllium (Be)	2017/08/26	100		%	80 - 120
8735467	SES	LCS	1,4-Difluorobenzene (sur.)	2017/08/23	94		%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/23	98		%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/23	98		%	70 - 130
			Benzene	2017/08/23	101		%	70 - 130
			Toluene	2017/08/23	97		%	70 - 130
			Ethylbenzene	2017/08/23	103		%	70 - 130
			m & p-Xylene	2017/08/23	103		%	70 - 130
			o-Xylene	2017/08/23	100		%	70 - 130
			F1 (C6-C10)	2017/08/23	103		%	70 - 130
8735677	AF6	LCS	Alkalinity (Total as CaCO3)	2017/08/23	100		%	80 - 120
8735678	AF6	LCS	Conductivity	2017/08/23	99		%	90 - 110
8735679	MSD	LCS	Dissolved Nitrite (N)	2017/08/23	101		%	80 - 120
			Dissolved Nitrate (N)	2017/08/23	101		%	80 - 120
8735944	LCA	LCS	Total Dissolved Solids	2017/08/24	99		%	80 - 120
8736054	LCA	LCS	Total Dissolved Solids	2017/08/24	101		%	80 - 120
8736056	BC5	LCS	D10-ANTHRACENE (sur.)	2017/08/24	81		%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/24	106		%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/24	82		%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/24	85		%	50 - 130
			Acenaphthene	2017/08/24	93		%	50 - 130
			Acenaphthylene	2017/08/24	90		%	50 - 130
			Acridine	2017/08/24	76		%	50 - 130
			Anthracene	2017/08/24	92		%	50 - 130
			Benzo(a)anthracene	2017/08/24	123		%	50 - 130
			Benzo(b&j)fluoranthene	2017/08/24	120		%	50 - 130
			Benzo(k)fluoranthene	2017/08/24	132 (1)		%	50 - 130
			Benzo(g,h,i)perylene	2017/08/24	123		%	50 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8736079	KHO	LCS	Benzo(c)phenanthrene	2017/08/24		128	%	50 - 130
			Benzo(a)pyrene	2017/08/24		111	%	50 - 130
			Benzo[e]pyrene	2017/08/24		123	%	50 - 130
			Chrysene	2017/08/24		125	%	50 - 130
			Dibenz(a,h)anthracene	2017/08/24		125	%	50 - 130
			Fluoranthene	2017/08/24		105	%	50 - 130
			Fluorene	2017/08/24		90	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2017/08/24		122	%	50 - 130
			2-Methylnaphthalene	2017/08/24		94	%	50 - 130
			Naphthalene	2017/08/24		91	%	50 - 130
			Phenanthrene	2017/08/24		93	%	50 - 130
			Perylene	2017/08/24		121	%	50 - 130
			Pyrene	2017/08/24		100	%	50 - 130
			Quinoline	2017/08/24		116	%	50 - 130
			O-TERPHENYL (sur.)	2017/08/24		94	%	60 - 130
8736108	KK5	LCS	F2 (C10-C16 Hydrocarbons)	2017/08/24		103	%	70 - 130
			O-TERPHENYL (sur.)	2017/08/25		102	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/25		117	%	70 - 130
8736411	CH7	LCS	Dissolved Chloride (Cl)	2017/08/26		102	%	80 - 120
8736412	CH7	LCS	Dissolved Sulphate (SO4)	2017/08/26		102	%	80 - 120
8736470	NP4	LCS	Dissolved Mercury (Hg)	2017/08/25		98	%	80 - 120
8738506	YY	LCS	Phenols	2017/08/25		94	%	80 - 120
8738714	APY	LCS	Dissolved Aluminum (Al)	2017/08/27		103	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/27		102	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/27		101	%	80 - 120
			Dissolved Copper (Cu)	2017/08/27		100	%	80 - 120
			Dissolved Lead (Pb)	2017/08/27		101	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/27		98	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/27		102	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/27		101	%	80 - 120
			Dissolved Selenium (Se)	2017/08/27		103	%	80 - 120
			Dissolved Silver (Ag)	2017/08/27		102	%	80 - 120
			Dissolved Arsenic (As)	2017/08/27		102	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/27		100	%	80 - 120
			Dissolved Tin (Sn)	2017/08/27		100	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/27		100	%	80 - 120
			Dissolved Uranium (U)	2017/08/27		99	%	80 - 120
			Dissolved Vanadium (V)	2017/08/27		103	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/27		102	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/27		103	%	80 - 120
8739479	BAH	LCS	Dissolved Iron (Fe)	2017/08/26		104	%	80 - 120
			Dissolved Lithium (Li)	2017/08/26		102	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/26		102	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/26		101	%	80 - 120
			Dissolved Potassium (K)	2017/08/26		100	%	80 - 120
			Dissolved Sodium (Na)	2017/08/26		101	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/26		101	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/26		104	%	80 - 120
			Dissolved Barium (Ba)	2017/08/26		100	%	80 - 120
			Dissolved Silicon (Si)	2017/08/26		106	%	80 - 120
			Dissolved Boron (B)	2017/08/26		104	%	80 - 120

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8736470	NP4	SRM	Dissolved Calcium (Ca)	2017/08/26		100	%	80 - 120
			Dissolved Mercury (Hg)	2017/08/25		95	%	80 - 120
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.								
QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.								
LCS: 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.								

Maxxam Job #: B771326
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

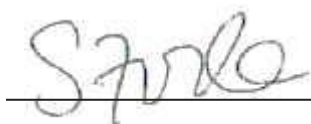
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Daniel Reslan, cCT, QP, Organics Supervisor



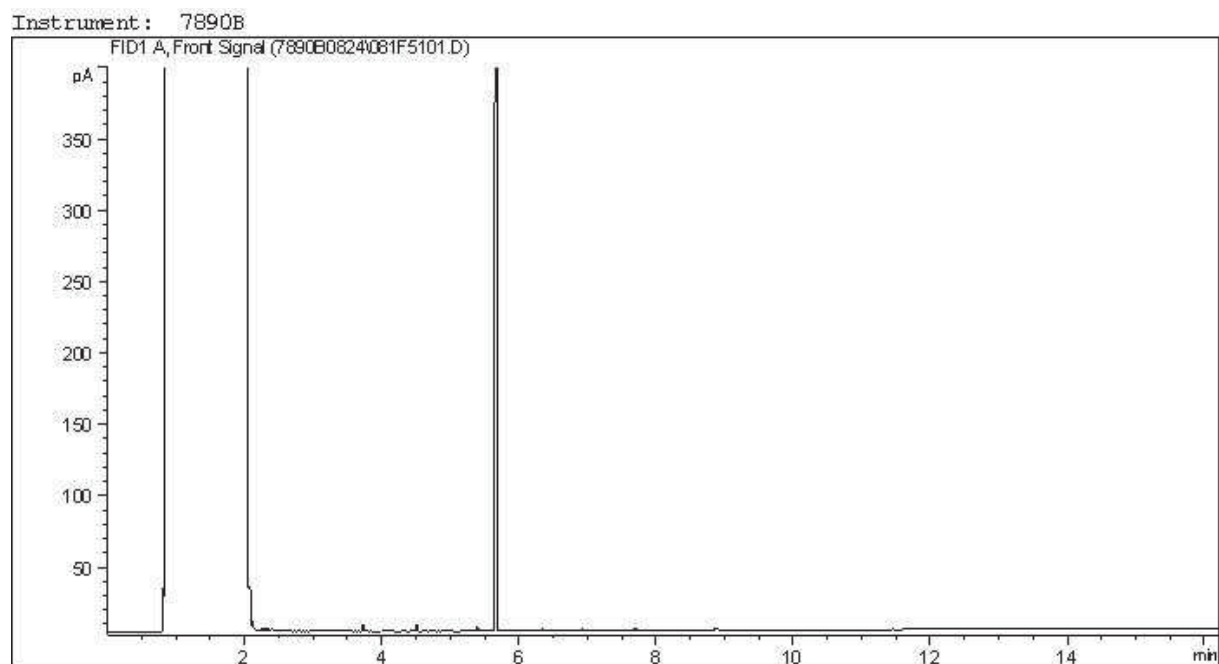
Poonam Sharma, cCT, Organics Supervisor



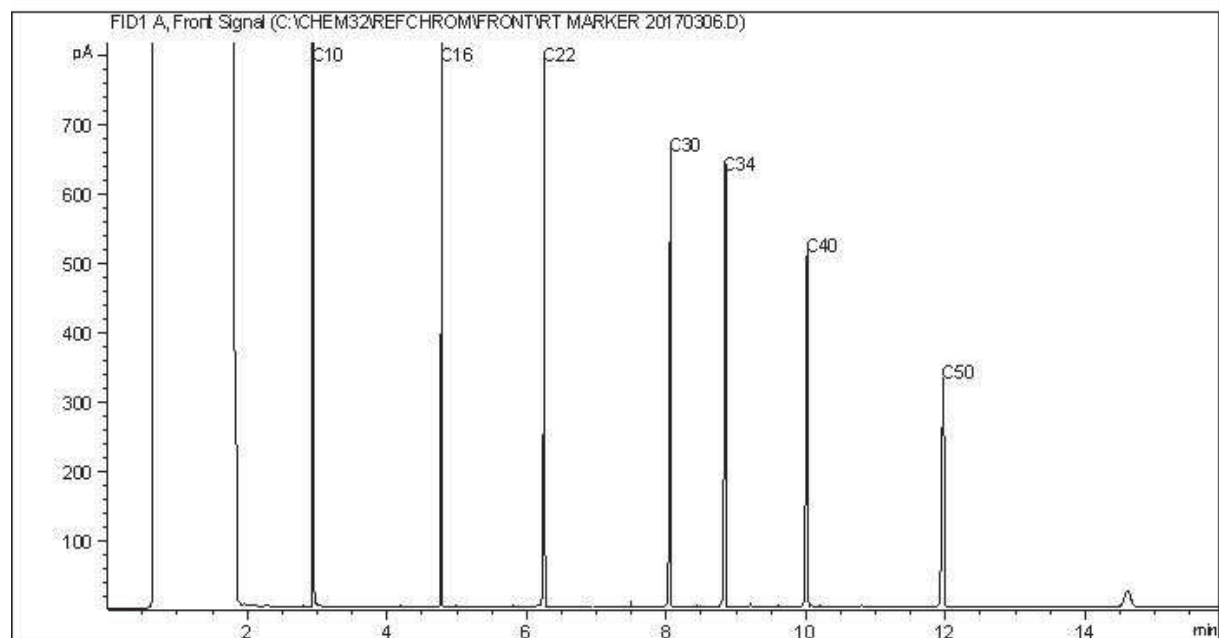
Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

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 Hydrocarbons in Water (F2; C10-C16) Chromatogram



Carbon Range Distribution - Reference Chromatogram



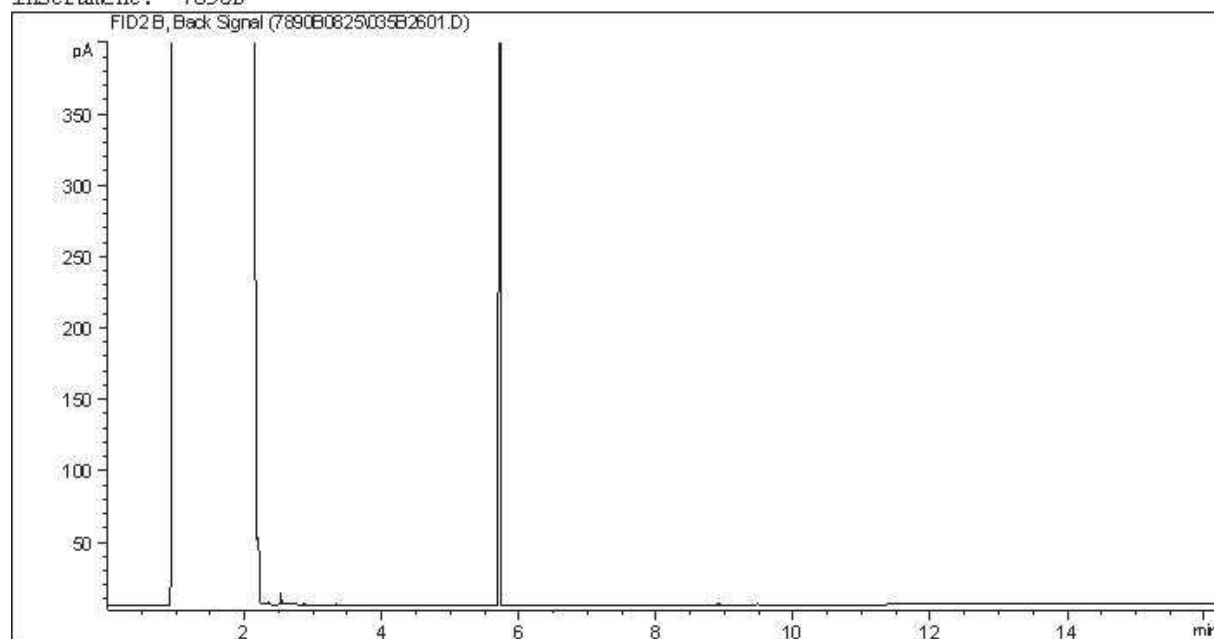
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

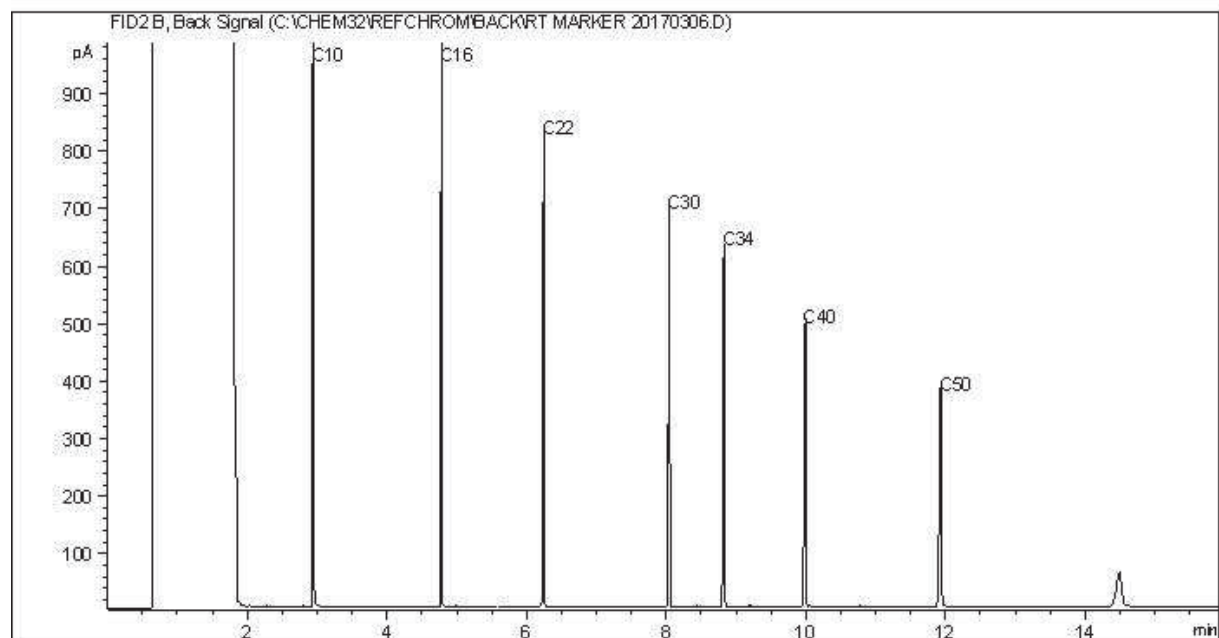
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



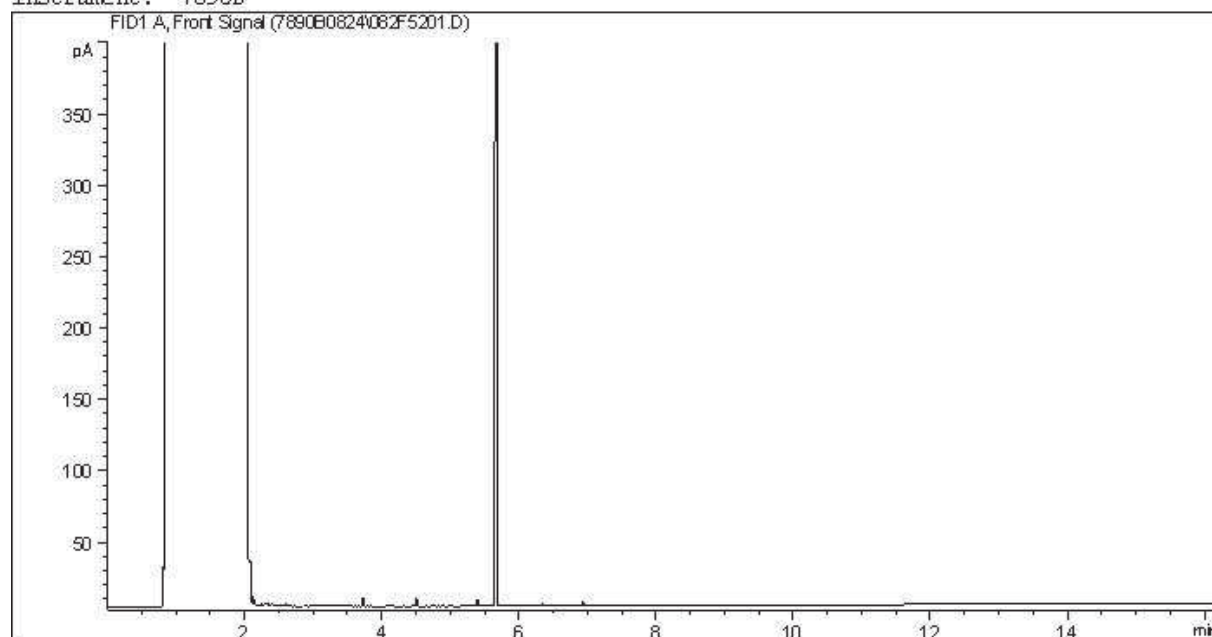
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

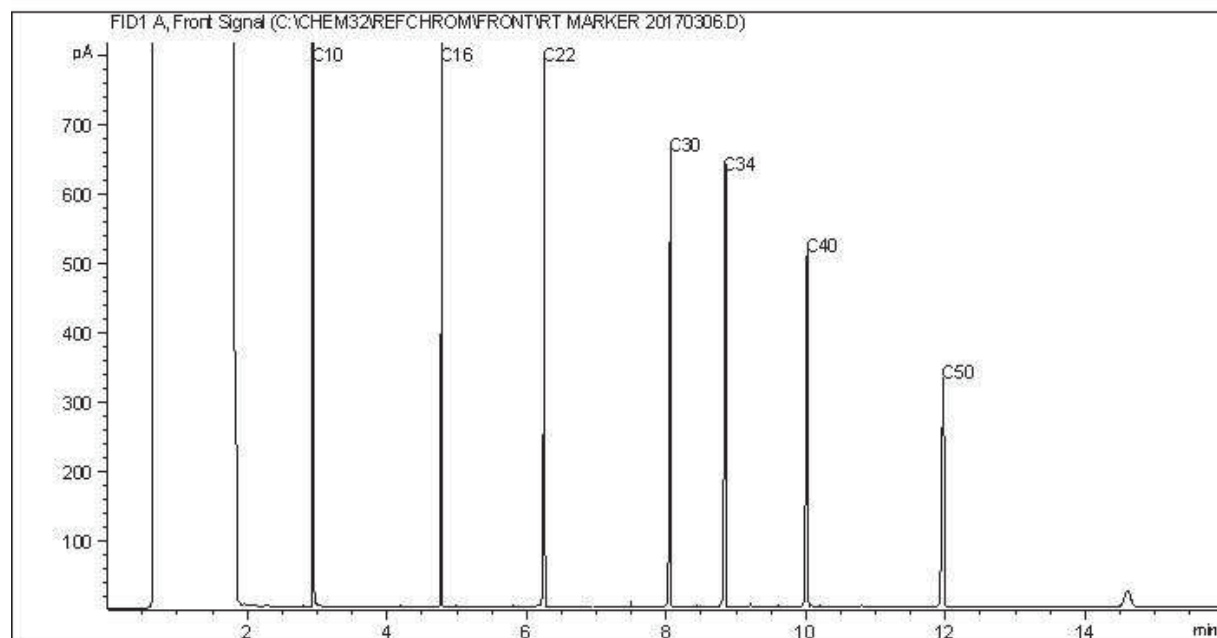
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 20-Aug-17

Location: Norman Wells

Laboratory: Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B771326

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			Laboratory control sample recovery of Benzo(k)fluoranthene (132%) did not meet acceptance criteria (50-130%). All other laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery		x		

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	All field QC samples met alert limits.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD	x			

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 20-Sep-17

Data Reviewed by (Signature):

Vivian Baptista

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294882

Report Date: 2017/10/11
Report #: R2457657
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B780015

Received: 2017/09/16, 09:18

Sample Matrix: Water
Samples Received: 7

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	6	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	7	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	6	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	6	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	6	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	7	AB SOP-00037	CCME PHC-CWS m
Hardness	6	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	6	EENSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	6	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	6	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	6	AB WI-00065	Auto Calc
Nitrate and Nitrite	6	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	6	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	6	AB SOP-00023	SM 23 4110 B m
Phenols (4-AAP)	6	EENSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	6	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	6	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 294882

Report Date: 2017/10/11
Report #: R2457657
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B780015

Received: 2017/09/16, 09:18

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Jenna Chernuka
Project Manager
11 Oct 2017 11:11:57

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RZ2231	RZ2231	RZ2232	RZ2233	RZ2234	RZ2235		
Sampling Date		2017/09/12 17:40	2017/09/12 17:40	2017/09/12 16:35	2017/09/12 10:15	2017/09/12 16:55	2017/09/12 09:50		
COC Number		294882	294882	294882	294882	294882	294882		
	UNITS	WSY 97-1-5	WSY 97-1-5 Lab-Dup	MEBG-10-1-3	GIBG-10-2-3	CPF 97-7-5	GIQ8-10-2-4	RDL	QC Batch
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8763774
Volatiles									
Benzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Toluene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Ethylbenzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
m & p-Xylene	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8763437
o-Xylene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Xylenes (Total)	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8763437
F1 (C6-C10) - BTEX	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8763437
F1 (C6-C10)	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8763437
Extraction Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	99	99	96	97	97	97		8763774
Instrument Surrogate Recovery (%)									
1,4-Difluorobenzene (sur.)	%	102		99	98	104	99		8763437
4-Bromofluorobenzene (sur.)	%	107		105	87	103	103		8763437
D4-1,2-Dichloroethane (sur.)	%	120		119	106	121	118		8763437
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate									

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RZ2236	RZ2237		
Sampling Date		2017/09/12 16:35	2017/09/12 18:00		
COC Number		294882	294882		
	UNITS	SNP-DUP1	SNP-DUP2	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8763774
Volatiles					
Benzene	mg/L	<0.00040	<0.00040	0.00040	8763437
Toluene	mg/L	<0.00040	<0.00040	0.00040	8763437
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8763437
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8763437
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8763437
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8763437
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8763437
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8763437
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	94	109		8763774
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	99	102		8763437
4-Bromofluorobenzene (sur.)	%	104	103		8763437
D4-1,2-Dichloroethane (sur.)	%	126	122		8763437
RDL = Reportable Detection Limit					

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2231	RZ2231	RZ2232	RZ2233	RZ2234		
Sampling Date		2017/09/12 17:40	2017/09/12 17:40	2017/09/12 16:35	2017/09/12 10:15	2017/09/12 16:55		
COC Number		294882	294882	294882	294882	294882		
	UNITS	WSY 97-1-5	WSY 97-1-5 Lab-Dup	MEBG-10-1-3	GIBG-10-2-3	CPF 97-7-5	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	<0.000020		0.000034	0.00073	0.000023	0.000020	8760258
Elements								
Dissolved Aluminum (Al)	mg/L	0.016	0.016	0.0067	0.0042	0.034	0.0030	8763776
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	0.00060	8763776
Dissolved Arsenic (As)	mg/L	0.0016	0.0017	0.0014	0.00026	0.00060	0.00020	8763776
Dissolved Barium (Ba)	mg/L	0.060		0.40	0.20	0.056	0.010	8765489
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763776
Dissolved Boron (B)	mg/L	0.20		0.025	0.036	0.038	0.020	8765489
Dissolved Calcium (Ca)	mg/L	300		220	190	310	0.30	8765489
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763776
Dissolved Cobalt (Co)	mg/L	0.0012	0.0013	0.0023	<0.00030	0.0046	0.00030	8763776
Dissolved Copper (Cu)	mg/L	0.0019	0.0023	0.00057	0.0032	0.0014	0.00020	8763776
Dissolved Iron (Fe)	mg/L	2.3		3.6	<0.060	5.2	0.060	8765489
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8763776
Dissolved Lithium (Li)	mg/L	<0.020		<0.020	0.026	<0.020	0.020	8765489
Dissolved Magnesium (Mg)	mg/L	82		51	35	73	0.20	8765489
Dissolved Manganese (Mn)	mg/L	1.4		1.2	0.83	1.9	0.0040	8765489
Dissolved Molybdenum (Mo)	mg/L	0.0086	0.0085	0.0022	0.0014	0.0075	0.00020	8763776
Dissolved Nickel (Ni)	mg/L	0.0039	0.0038	0.0057	0.011	0.011	0.00050	8763776
Dissolved Phosphorus (P)	mg/L	<0.10		<0.10	<0.10	<0.10	0.10	8765489
Dissolved Potassium (K)	mg/L	3.2		1.7	3.7	4.5	0.30	8765489
Dissolved Selenium (Se)	mg/L	0.0014	0.0014	0.00026	<0.00020	0.00028	0.00020	8763776
Dissolved Silicon (Si)	mg/L	5.2		5.4	6.3	5.6	0.10	8765489
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	8763776
Dissolved Sodium (Na)	mg/L	18		33	43	9.8	0.50	8765489
Dissolved Strontium (Sr)	mg/L	0.86		0.70	0.95	1.2	0.020	8765489
Dissolved Sulphur (S)	mg/L	250		64	65	250	0.20	8765489
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8763776
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763776
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2231	RZ2231	RZ2232	RZ2233	RZ2234		
Sampling Date		2017/09/12 17:40	2017/09/12 17:40	2017/09/12 16:35	2017/09/12 10:15	2017/09/12 16:55		
COC Number		294882	294882	294882	294882	294882		
	UNITS	WSY 97-1-5	WSY 97-1-5 Lab-Dup	MEBG-10-1-3	GIBG-10-2-3	CPF 97-7-5	RDL	QC Batch
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763776
Dissolved Uranium (U)	mg/L	0.0039	0.0039	0.0090	0.0093	0.0047	0.00010	8763776
Dissolved Vanadium (V)	mg/L	0.0010	0.0011	<0.0010	<0.0010	<0.0010	0.0010	8763776
Dissolved Zinc (Zn)	mg/L	0.0057	0.0060	0.0038	0.024	0.011	0.0030	8763776
Low Level Elements								
Dissolved Mercury (Hg)	mg/L	0.0000025	0.0000025	<0.0000020	<0.0000020	<0.0000020	0.0000020	8764836
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2235	RZ2236		
Sampling Date		2017/09/12 09:50	2017/09/12 16:35		
COC Number		294882	294882		
	UNITS	GIQ8-10-2-4	SNP-DUP1	RDL	QC Batch
Low Level Elements					
Dissolved Cadmium (Cd)	mg/L	0.00026	0.000034	0.000020	8760258
Elements					
Dissolved Aluminum (Al)	mg/L	0.0068	0.0071	0.0030	8763776
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	0.00060	8763776
Dissolved Arsenic (As)	mg/L	0.00030	0.0014	0.00020	8763776
Dissolved Barium (Ba)	mg/L	0.15	0.40	0.010	8765489
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	0.0010	8763776
Dissolved Boron (B)	mg/L	<0.020	0.027	0.020	8765489
Dissolved Calcium (Ca)	mg/L	150	220	0.30	8765489
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	0.0010	8763776
Dissolved Cobalt (Co)	mg/L	0.0031	0.0022	0.00030	8763776
Dissolved Copper (Cu)	mg/L	0.0022	0.0018	0.00020	8763776
Dissolved Iron (Fe)	mg/L	0.31	3.6	0.060	8765489
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	0.00020	8763776
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	0.020	8765489
Dissolved Magnesium (Mg)	mg/L	36	51	0.20	8765489
Dissolved Manganese (Mn)	mg/L	1.5	1.2	0.0040	8765489
Dissolved Molybdenum (Mo)	mg/L	0.00088	0.0021	0.00020	8763776
Dissolved Nickel (Ni)	mg/L	0.0081	0.0055	0.00050	8763776
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	0.10	8765489
Dissolved Potassium (K)	mg/L	2.3	1.7	0.30	8765489
Dissolved Selenium (Se)	mg/L	<0.00020	0.00021	0.00020	8763776
Dissolved Silicon (Si)	mg/L	3.7	5.4	0.10	8765489
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	0.00010	8763776
Dissolved Sodium (Na)	mg/L	11	33	0.50	8765489
Dissolved Strontium (Sr)	mg/L	0.67	0.69	0.020	8765489
Dissolved Sulphur (S)	mg/L	76	64	0.20	8765489
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	0.00020	8763776
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	0.0010	8763776
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	0.0010	8763776
RDL = Reportable Detection Limit					

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2235	RZ2236		
Sampling Date		2017/09/12 09:50	2017/09/12 16:35		
COC Number		294882	294882		
	UNITS	GIQ8-10-2-4	SNP-DUP1	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0037	0.0088	0.00010	8763776
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	0.0010	8763776
Dissolved Zinc (Zn)	mg/L	0.0058	0.0067	0.0030	8763776
Low Level Elements					
Dissolved Mercury (Hg)	mg/L	<0.0000020	<0.0000020	0.0000020	8764836
RDL = Reportable Detection Limit					

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RZ2231	RZ2231		RZ2232		RZ2233		RZ2234		
Sampling Date		2017/09/12 17:40	2017/09/12 17:40		2017/09/12 16:35		2017/09/12 10:15		2017/09/12 16:55		
COC Number		294882	294882		294882		294882		294882		
	UNITS	WSY 97-1-5	WSY 97-1-5 Lab-Dup	RDL	MEBG-10-1-3	RDL	GIBG-10-2-3	RDL	CPF 97-7-5	RDL	QC Batch
Calculated Parameters											
Hardness (CaCO ₃)	mg/L	1100		0.50	770	0.50	630	0.50	1100	0.50	8760361
Ion Balance (% Difference)	%	2.6		N/A	2.4	N/A	1.5	N/A	4.2	N/A	8760362
Dissolved Nitrate (NO ₃)	mg/L	<0.044		0.044	0.41	0.044	0.44	0.044	<0.044	0.044	8760364
Nitrate plus Nitrite (N)	mg/L	<0.014		0.014	0.091	0.014	0.10	0.014	<0.014	0.014	8760365
Dissolved Nitrite (NO ₂)	mg/L	<0.033		0.033	<0.033	0.033	<0.033	0.033	<0.033	0.033	8760364
Misc. Inorganics											
Conductivity	uS/cm	1800		1.0	1300	1.0	1200	1.0	1700	1.0	8760642
Total Dissolved Solids	mg/L	1400		10	910	10	740 (1)	25	1400	10	8761474
Anions											
Alkalinity (PP as CaCO ₃)	mg/L	<0.50		0.50	<0.50	0.50	<0.50	0.50	<0.50	0.50	8760638
Alkalinity (Total as CaCO ₃)	mg/L	360		0.50	620	0.50	520	0.50	310	0.50	8760638
Bicarbonate (HCO ₃)	mg/L	440		0.50	750	0.50	630	0.50	370	0.50	8760638
Carbonate (CO ₃)	mg/L	<0.50		0.50	<0.50	0.50	<0.50	0.50	<0.50	0.50	8760638
Hydroxide (OH)	mg/L	<0.50		0.50	<0.50	0.50	<0.50	0.50	<0.50	0.50	8760638
Dissolved Sulphate (SO ₄)	mg/L	660 (2)		5.0	180	1.0	180	1.0	660 (2)	5.0	8761012
Dissolved Chloride (Cl)	mg/L	26		1.0	2.4	1.0	2.9	1.0	18	1.0	8761011
Nutrients											
Dissolved Nitrite (N)	mg/L	<0.010		0.010	<0.010	0.010	<0.010	0.010	<0.010	0.010	8760606
Dissolved Nitrate (N)	mg/L	<0.010		0.010	0.091	0.010	0.10	0.010	<0.010	0.010	8760606
Misc. Organics											
Phenols	mg/L	0.0044	0.0039	0.0020	0.0026	0.0020	0.0027	0.0020	0.0026	0.0020	8766726

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Detection limit raised based on sample volume used for analysis.

(2) Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RZ2235		RZ2236		
Sampling Date		2017/09/12 09:50		2017/09/12 16:35		
COC Number		294882		294882		
	UNITS	GIQ8-10-2-4	RDL	SNP-DUP1	RDL	QC Batch
Calculated Parameters						
Hardness (CaCO ₃)	mg/L	520	0.50	760	0.50	8760361
Ion Balance (% Difference)	%	1.3	N/A	2.7	N/A	8760362
Dissolved Nitrate (NO ₃)	mg/L	0.090	0.044	0.38	0.044	8760364
Nitrate plus Nitrite (N)	mg/L	0.020	0.014	0.087	0.014	8760365
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	<0.033	0.033	8760364
Misc. Inorganics						
Conductivity	uS/cm	990	1.0	1300	1.0	8760642
Total Dissolved Solids	mg/L	740 (1)	25	900	10	8761474
Anions						
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	<0.50	0.50	8760638
Alkalinity (Total as CaCO ₃)	mg/L	320	0.50	610	0.50	8760638
Bicarbonate (HCO ₃)	mg/L	390	0.50	750	0.50	8760638
Carbonate (CO ₃)	mg/L	<0.50	0.50	<0.50	0.50	8760638
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	8760638
Dissolved Sulphate (SO ₄)	mg/L	220 (2)	5.0	180	1.0	8761012
Dissolved Chloride (Cl)	mg/L	9.4	1.0	2.3	1.0	8761011
Nutrients						
Dissolved Nitrite (N)	mg/L	<0.010	0.010	<0.010	0.010	8760606
Dissolved Nitrate (N)	mg/L	0.020	0.010	0.087	0.010	8760606
Misc. Organics						
Phenols	mg/L	0.0038	0.0020	0.0023	0.0020	8766726
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis. (2) Detection limits raised due to dilution to bring analyte within the calibrated range.						

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2231
Sample ID: WSY 97-1-5
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/21	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/22	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/16	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2231 Dup
Sample ID: WSY 97-1-5
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/22	Julie Harrison
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang

Maxxam ID: RZ2232
Sample ID: MEBG-10-1-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/21	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/21	Julie Harrison

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2232
Sample ID: MEBG-10-1-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/16	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2233
Sample ID: GIBG-10-2-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/16	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2234
Sample ID: CPF 97-7-5
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2234
Sample ID: CPF 97-7-5
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/16	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2235
Sample ID: GIQ8-10-2-4
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/16	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2236
Sample ID: SNP-DUP1
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2236
Sample ID: SNP-DUP1
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8764836	2017/09/20	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765489	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763776	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2237
Sample ID: SNP-DUP2
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo

Maxxam Job #: B780015
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.3°C

Report reissued to remove deficiency as per IOL.

Sample RZ2231 [WSY 97-1-5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2232 [MEBG-10-1-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2233 [GIBG-10-2-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2234 [CPF 97-7-5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2235 [GIQ8-10-2-4] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2236 [SNP-DUP1] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8760606	MSD	Method Blank	Dissolved Nitrite (N)	2017/09/16	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/09/16	<0.010		mg/L	
8760638	CH7	Method Blank	Alkalinity (Total as CaCO ₃)	2017/09/16	<0.50		mg/L	
			Alkalinity (PP as CaCO ₃)	2017/09/16	<0.50		mg/L	
			Bicarbonate (HCO ₃)	2017/09/16	<0.50		mg/L	
			Carbonate (CO ₃)	2017/09/16	<0.50		mg/L	
			Hydroxide (OH)	2017/09/16	<0.50		mg/L	
8760642	CH7	Method Blank	Conductivity	2017/09/16	<1.0		uS/cm	
8761011	CH7	Method Blank	Dissolved Chloride (Cl)	2017/09/19	<1.0		mg/L	
8761012	CH7	Method Blank	Dissolved Sulphate (SO ₄)	2017/09/19	<1.0		mg/L	
8761474	KPG	Method Blank	Total Dissolved Solids	2017/09/21	<10		mg/L	
8763437	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/09/21		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/21		106	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/21		117	%	70 - 130
			Benzene	2017/09/21	<0.00040		mg/L	
			Toluene	2017/09/21	<0.00040		mg/L	
			Ethylbenzene	2017/09/21	<0.00040		mg/L	
			m & p-Xylene	2017/09/21	<0.00080		mg/L	
			o-Xylene	2017/09/21	<0.00040		mg/L	
			Xylenes (Total)	2017/09/21	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/09/21	<0.10		mg/L	
			F1 (C6-C10)	2017/09/21	<0.10		mg/L	
8763774	GG3	Method Blank	O-TERPHENYL (sur.)	2017/09/21		107	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/09/21	<0.10		mg/L	
8763776	JHS	Method Blank	Dissolved Aluminum (Al)	2017/09/22	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/09/22	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/09/22	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/09/22	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/09/22	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/09/22	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/09/22	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/09/22	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/09/22	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/09/22	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/09/22	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/09/22	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/09/22	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/09/22	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/09/22	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/09/22	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/09/22	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/09/22	<0.0010		mg/L	
8764836	NP4	Method Blank	Dissolved Mercury (Hg)	2017/09/21	<0.0000020		mg/L	
8765489	JK9	Method Blank	Dissolved Iron (Fe)	2017/09/21	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/09/21	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/09/21	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/09/21	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/09/21	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/09/21	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/09/21	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/09/21	<0.20		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8766726	YY	Method Blank	Dissolved Phosphorus (P)	2017/09/21	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/09/21	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/09/21	<0.10		mg/L	
			Dissolved Boron (B)	2017/09/21	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/09/21	<0.30		mg/L	
8763774	GG3	RPD [RZ2231-01]	Phenols	2017/09/21	<0.0020		mg/L	
8763776	JHS	RPD [RZ2231-05]	F2 (C10-C16 Hydrocarbons)	2017/09/21	NC		%	30
8764836	NP4	RPD [RZ2231-06]	Dissolved Aluminum (Al)	2017/09/22	0.15		%	20
			Dissolved Chromium (Cr)	2017/09/22	NC		%	20
			Dissolved Cobalt (Co)	2017/09/22	6.3		%	20
			Dissolved Copper (Cu)	2017/09/22	19		%	20
			Dissolved Lead (Pb)	2017/09/22	NC		%	20
			Dissolved Antimony (Sb)	2017/09/22	NC		%	20
			Dissolved Molybdenum (Mo)	2017/09/22	1.4		%	20
			Dissolved Nickel (Ni)	2017/09/22	2.4		%	20
			Dissolved Selenium (Se)	2017/09/22	0.22		%	20
			Dissolved Silver (Ag)	2017/09/22	NC		%	20
			Dissolved Arsenic (As)	2017/09/22	5.7		%	20
			Dissolved Thallium (Tl)	2017/09/22	NC		%	20
			Dissolved Tin (Sn)	2017/09/22	NC		%	20
			Dissolved Titanium (Ti)	2017/09/22	NC		%	20
			Dissolved Uranium (U)	2017/09/22	0.93		%	20
			Dissolved Vanadium (V)	2017/09/22	9.1		%	20
			Dissolved Zinc (Zn)	2017/09/22	5.9		%	20
			Dissolved Beryllium (Be)	2017/09/22	NC		%	20
			Dissolved Mercury (Hg)	2017/09/21	0		%	20
			Phenols	2017/09/21	12		%	20
8766726	YY	RPD [RZ2231-07]	O-TERPHENYL (sur.)	2017/09/21		97	%	60 - 130
8763774	GG3	Matrix Spike [RZ2232-01]	F2 (C10-C16 Hydrocarbons)	2017/09/21		104	%	60 - 130
8763776	JHS	Matrix Spike [RZ2231-05]	Dissolved Aluminum (Al)	2017/09/21		87	%	80 - 120
			Dissolved Chromium (Cr)	2017/09/21		99	%	80 - 120
			Dissolved Cobalt (Co)	2017/09/21		96	%	80 - 120
			Dissolved Copper (Cu)	2017/09/21		94	%	80 - 120
			Dissolved Lead (Pb)	2017/09/21		97	%	80 - 120
			Dissolved Antimony (Sb)	2017/09/21		108	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/09/21		108	%	80 - 120
			Dissolved Nickel (Ni)	2017/09/21		98	%	80 - 120
			Dissolved Selenium (Se)	2017/09/21		101	%	80 - 120
			Dissolved Silver (Ag)	2017/09/21		80	%	80 - 120
			Dissolved Arsenic (As)	2017/09/21		101	%	80 - 120
			Dissolved Thallium (Tl)	2017/09/21		98	%	80 - 120
			Dissolved Tin (Sn)	2017/09/21		106	%	80 - 120
			Dissolved Titanium (Ti)	2017/09/21		100	%	80 - 120
			Dissolved Uranium (U)	2017/09/21		98	%	80 - 120
			Dissolved Vanadium (V)	2017/09/21		102	%	80 - 120
			Dissolved Zinc (Zn)	2017/09/21		95	%	80 - 120
			Dissolved Beryllium (Be)	2017/09/21		100	%	80 - 120
			Dissolved Mercury (Hg)	2017/09/21		100	%	80 - 120
			Phenols	2017/09/21		104	%	80 - 120
8760606	MSD	LCS	Dissolved Nitrite (N)	2017/09/16		100	%	80 - 120
			Dissolved Nitrate (N)	2017/09/16		100	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8760638	CH7	LCS	Alkalinity (Total as CaCO ₃)	2017/09/16		103	%	80 - 120
8760642	CH7	LCS	Conductivity	2017/09/16		100	%	90 - 110
8761011	CH7	LCS	Dissolved Chloride (Cl)	2017/09/19		103	%	80 - 120
8761012	CH7	LCS	Dissolved Sulphate (SO ₄)	2017/09/19		104	%	80 - 120
8761474	KPG	LCS	Total Dissolved Solids	2017/09/21		102	%	80 - 120
8763437	YZ3	LCS	1,4-Difluorobenzene (sur.)	2017/09/21		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/21		104	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/21		117	%	70 - 130
			Benzene	2017/09/21		98	%	70 - 130
			Toluene	2017/09/21		94	%	70 - 130
			Ethylbenzene	2017/09/21		100	%	70 - 130
			m & p-Xylene	2017/09/21		95	%	70 - 130
			o-Xylene	2017/09/21		102	%	70 - 130
			F1 (C6-C10)	2017/09/21		101	%	70 - 130
8763774	GG3	LCS	O-TERPHENYL (sur.)	2017/09/21		95	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/09/21		100	%	70 - 130
8763776	JHS	LCS	Dissolved Aluminum (Al)	2017/09/21		102	%	80 - 120
			Dissolved Chromium (Cr)	2017/09/21		99	%	80 - 120
			Dissolved Cobalt (Co)	2017/09/21		98	%	80 - 120
			Dissolved Copper (Cu)	2017/09/21		98	%	80 - 120
			Dissolved Lead (Pb)	2017/09/21		100	%	80 - 120
			Dissolved Antimony (Sb)	2017/09/21		102	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/09/21		102	%	80 - 120
			Dissolved Nickel (Ni)	2017/09/21		97	%	80 - 120
			Dissolved Selenium (Se)	2017/09/21		102	%	80 - 120
			Dissolved Silver (Ag)	2017/09/21		102	%	80 - 120
			Dissolved Arsenic (As)	2017/09/21		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/09/21		100	%	80 - 120
			Dissolved Tin (Sn)	2017/09/21		100	%	80 - 120
			Dissolved Titanium (Ti)	2017/09/21		95	%	80 - 120
			Dissolved Uranium (U)	2017/09/21		98	%	80 - 120
			Dissolved Vanadium (V)	2017/09/21		99	%	80 - 120
			Dissolved Zinc (Zn)	2017/09/21		100	%	80 - 120
			Dissolved Beryllium (Be)	2017/09/21		100	%	80 - 120
8764836	NP4	LCS	Dissolved Mercury (Hg)	2017/09/21		100	%	80 - 120
8765489	JK9	LCS	Dissolved Iron (Fe)	2017/09/21		99	%	80 - 120
			Dissolved Lithium (Li)	2017/09/21		95	%	80 - 120
			Dissolved Magnesium (Mg)	2017/09/21		103	%	80 - 120
			Dissolved Manganese (Mn)	2017/09/21		99	%	80 - 120
			Dissolved Potassium (K)	2017/09/21		100	%	80 - 120
			Dissolved Sodium (Na)	2017/09/21		102	%	80 - 120
			Dissolved Strontium (Sr)	2017/09/21		98	%	80 - 120
			Dissolved Phosphorus (P)	2017/09/21		104	%	80 - 120
			Dissolved Barium (Ba)	2017/09/21		99	%	80 - 120
			Dissolved Silicon (Si)	2017/09/21		108	%	80 - 120
			Dissolved Boron (B)	2017/09/21		106	%	80 - 120
			Dissolved Calcium (Ca)	2017/09/21		98	%	80 - 120
8766726	YY	LCS	Phenols	2017/09/21		99	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8764836	NP4	SRM	Dissolved Mercury (Hg)	2017/09/21		99	%	80 - 120
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. QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy. LCS: 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).								

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VALIDATION SIGNATURE PAGE

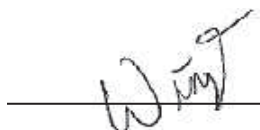
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

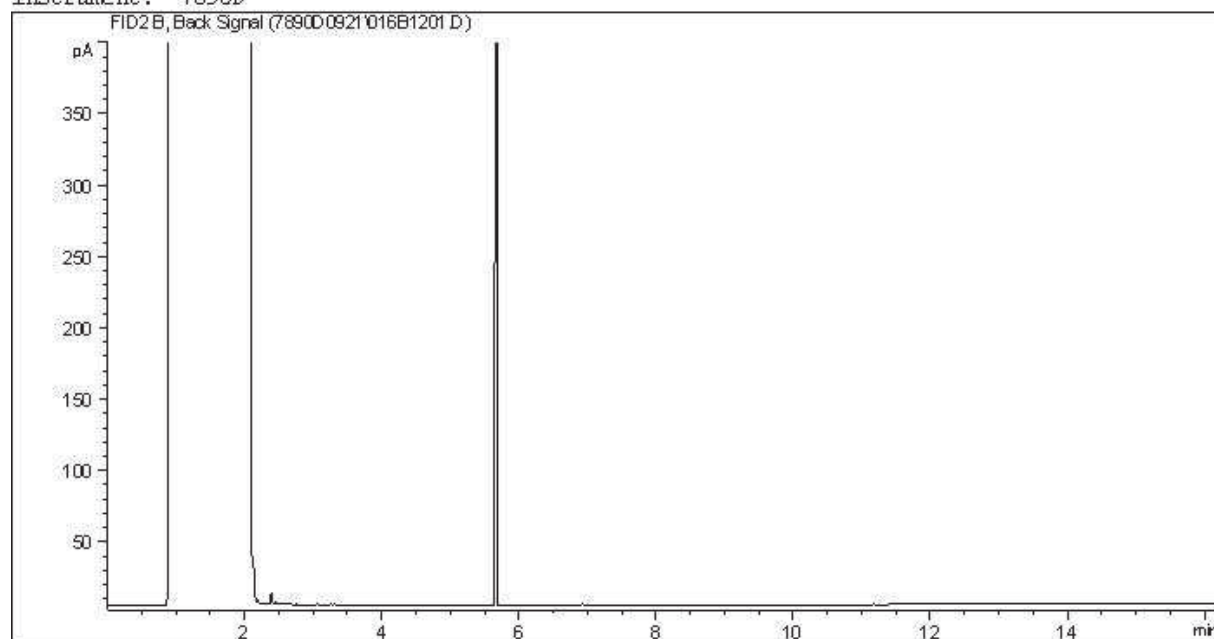


Winnie Au, B.Sc., QP, Scientific Specialist

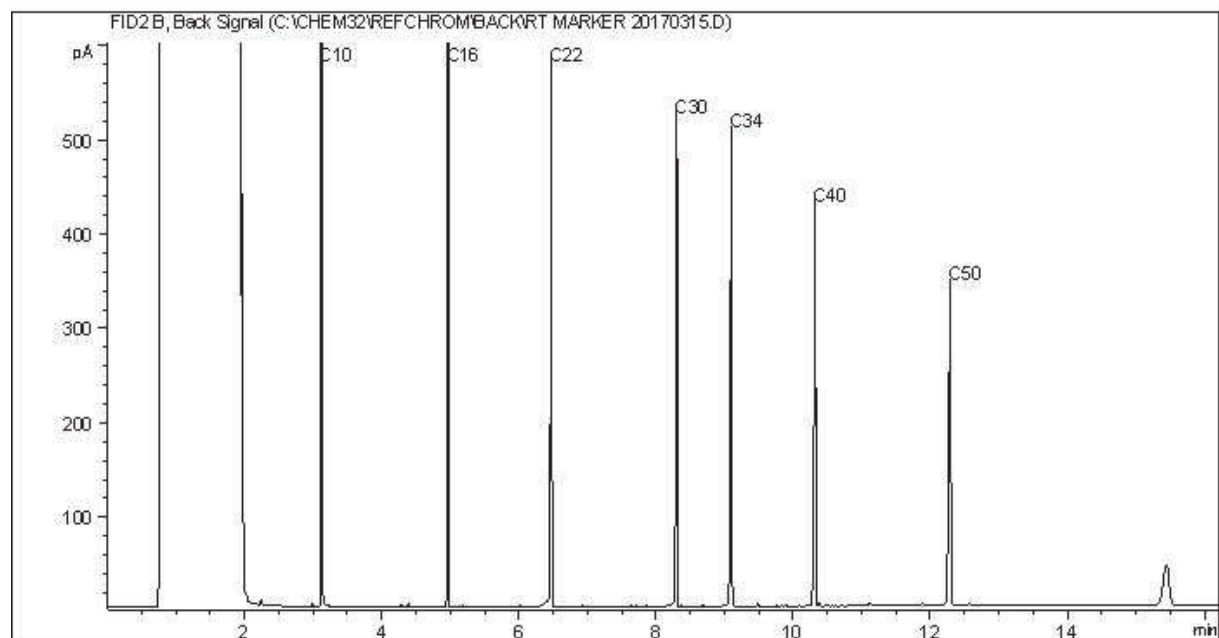
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
 Varsol: C8 - C12
 Kerosene: C7 - C16

Diesel: C8 - C22
 Lubricating Oils: C20 - C40
 Crude Oils: C3 - C60+

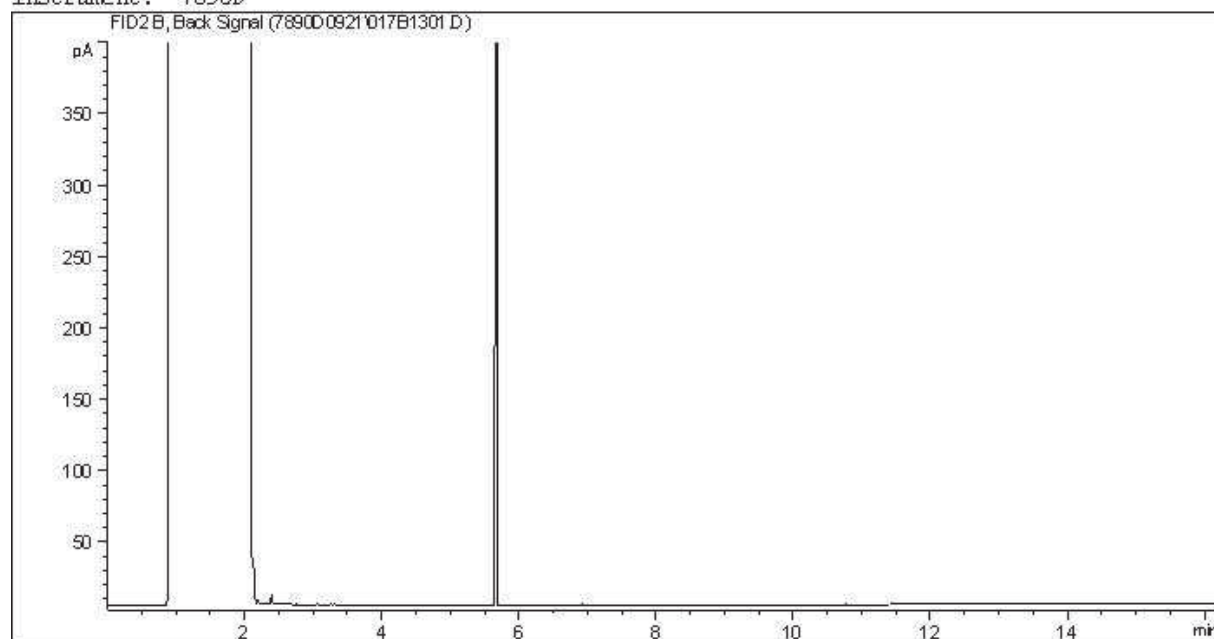
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B780015
Report Date: 2017/10/11
Maxxam Sample: RZ2231 Lab-Dup

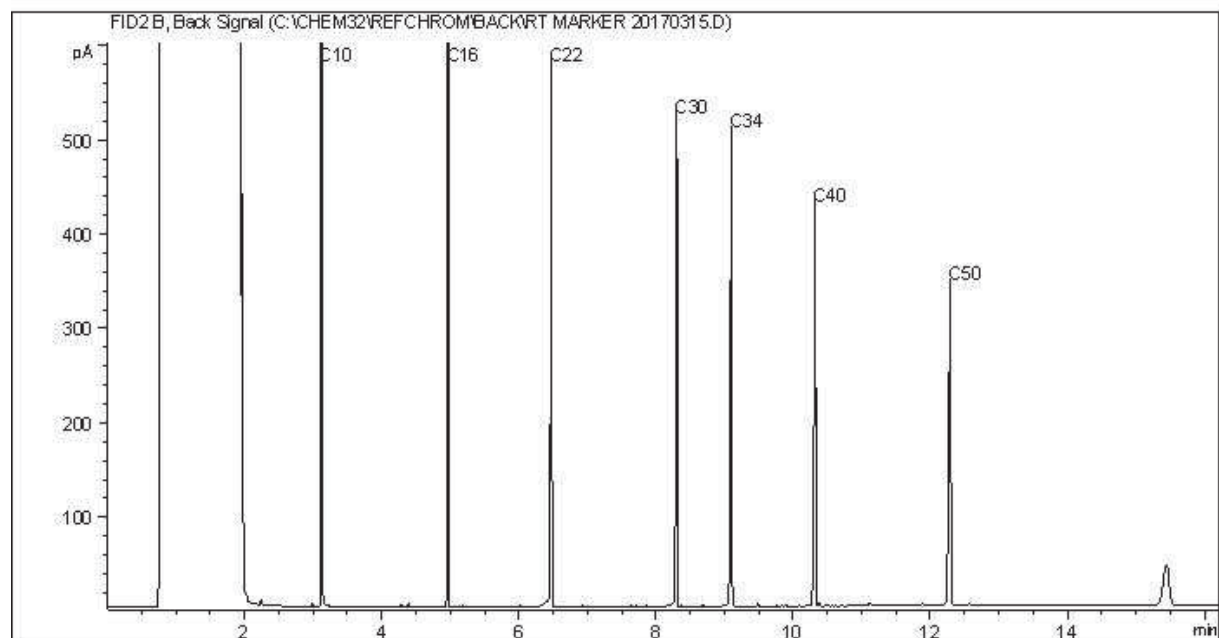
WORLEY PARSONS
Task Order#: 450248878910 Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Client ID: WSY 97-1-5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

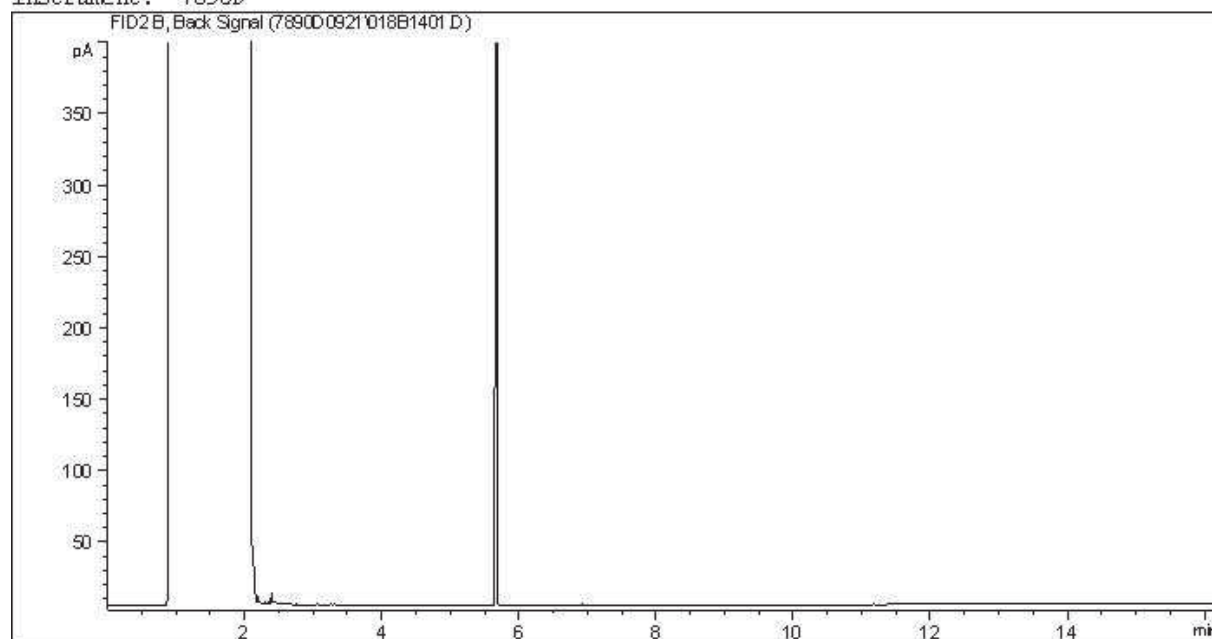
Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

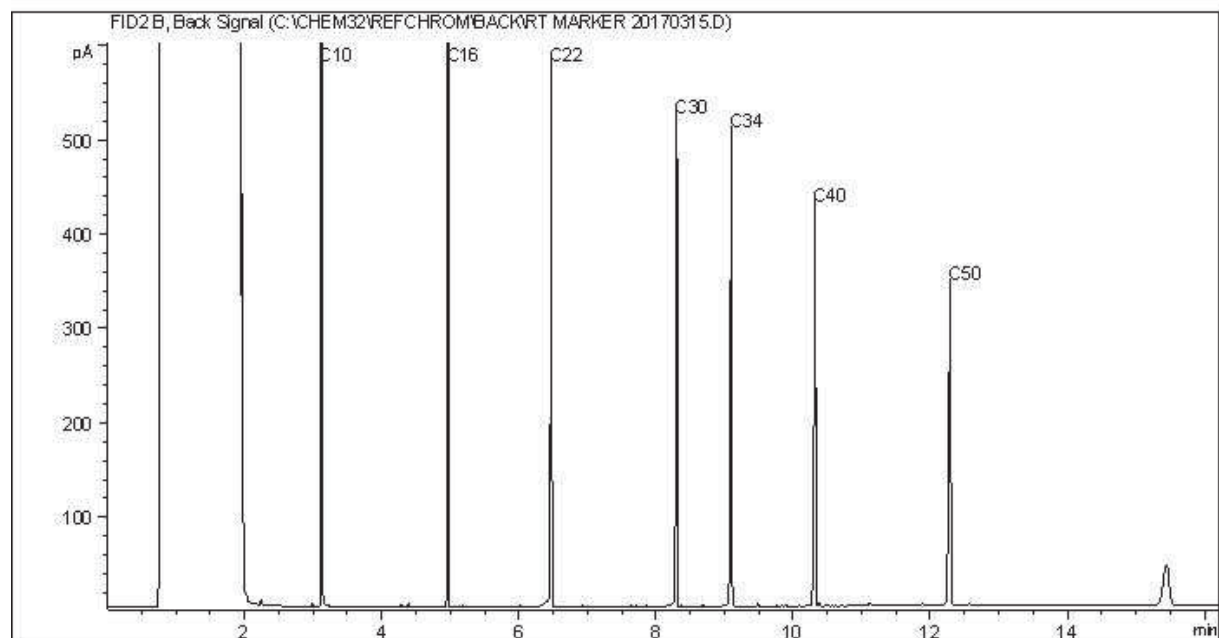
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



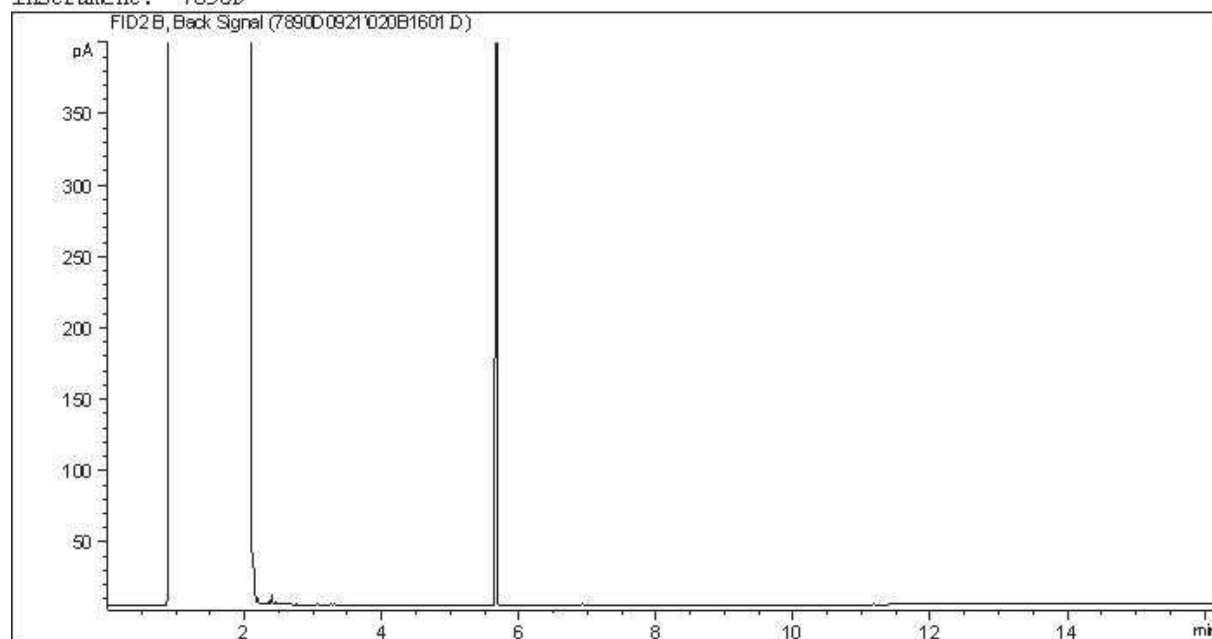
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

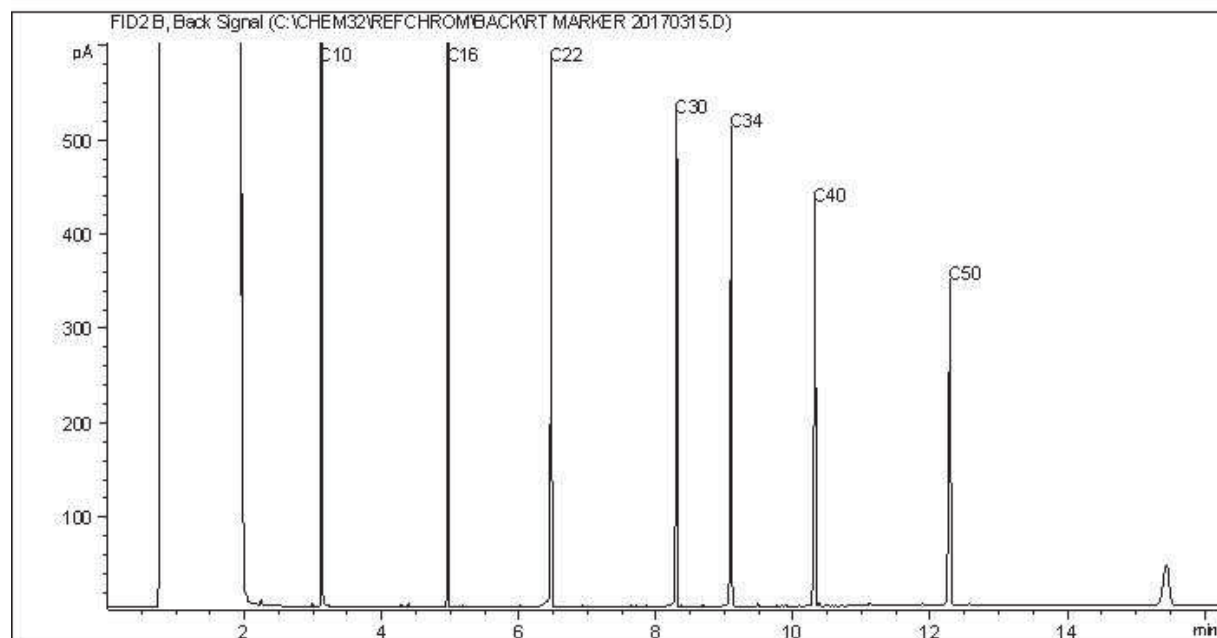
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



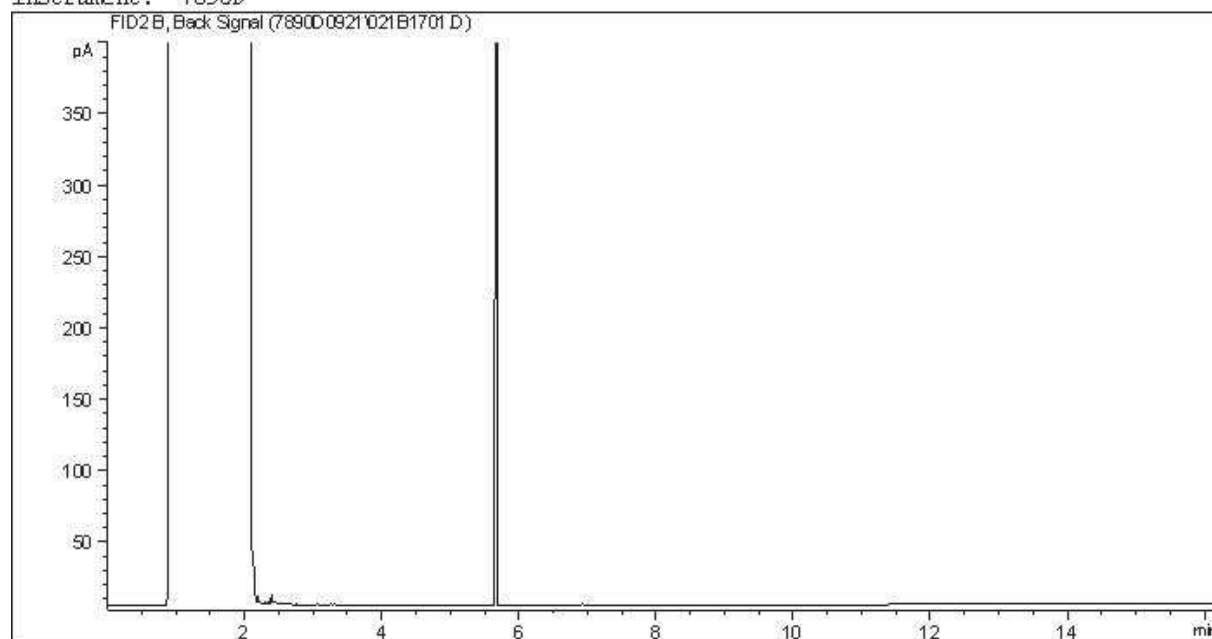
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

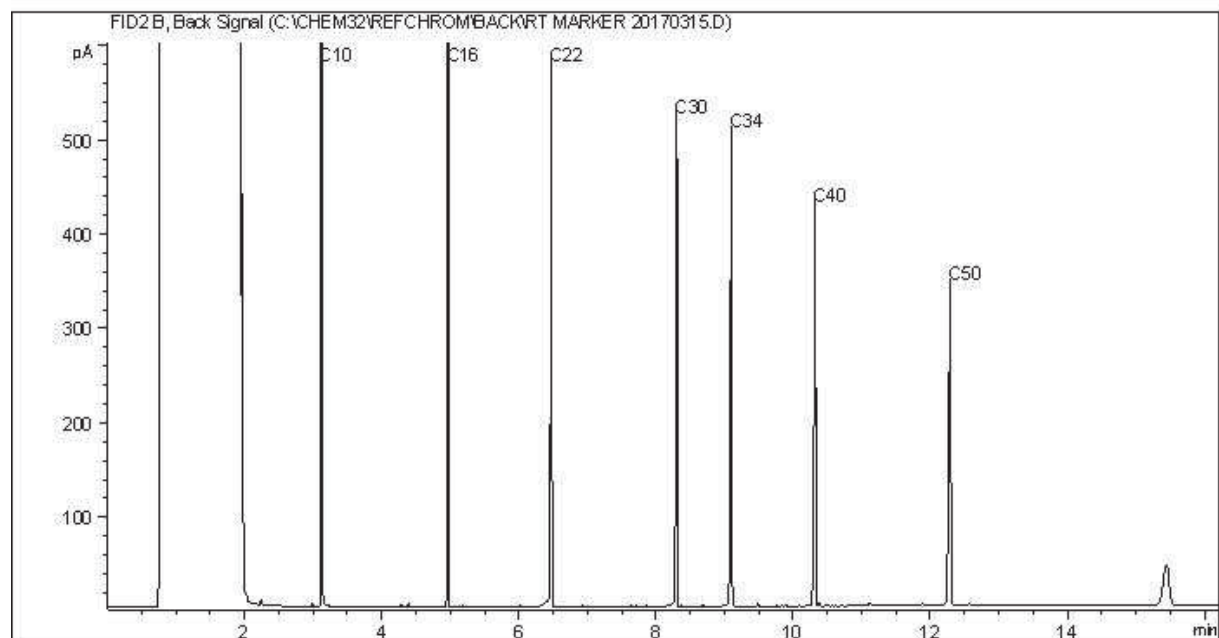
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

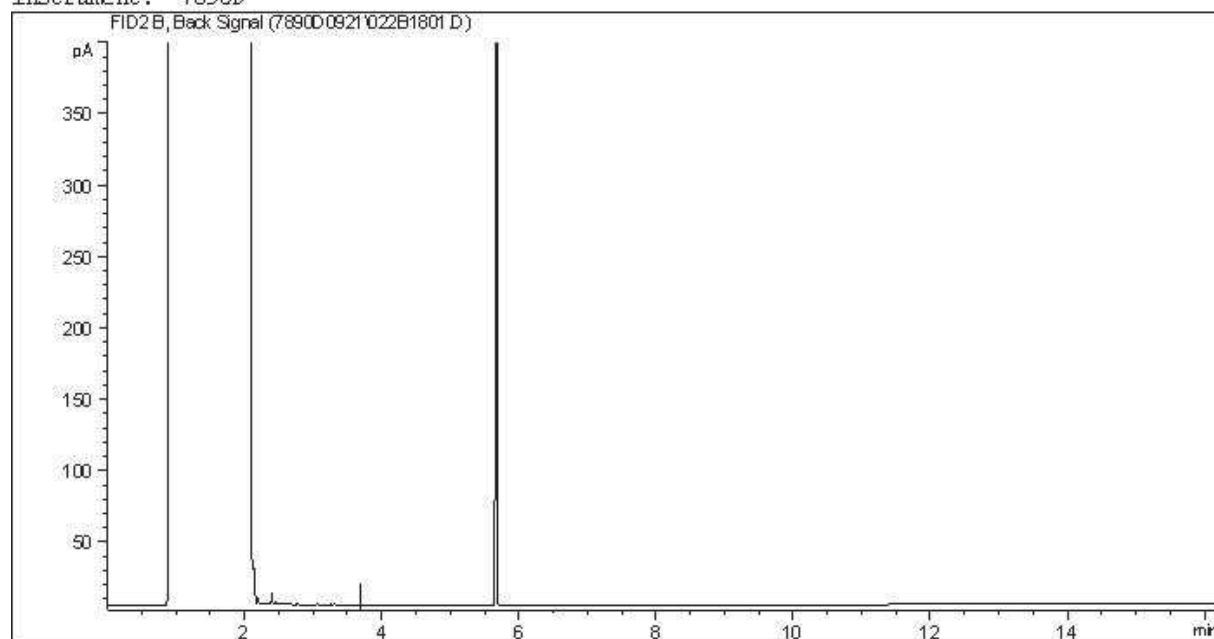
Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

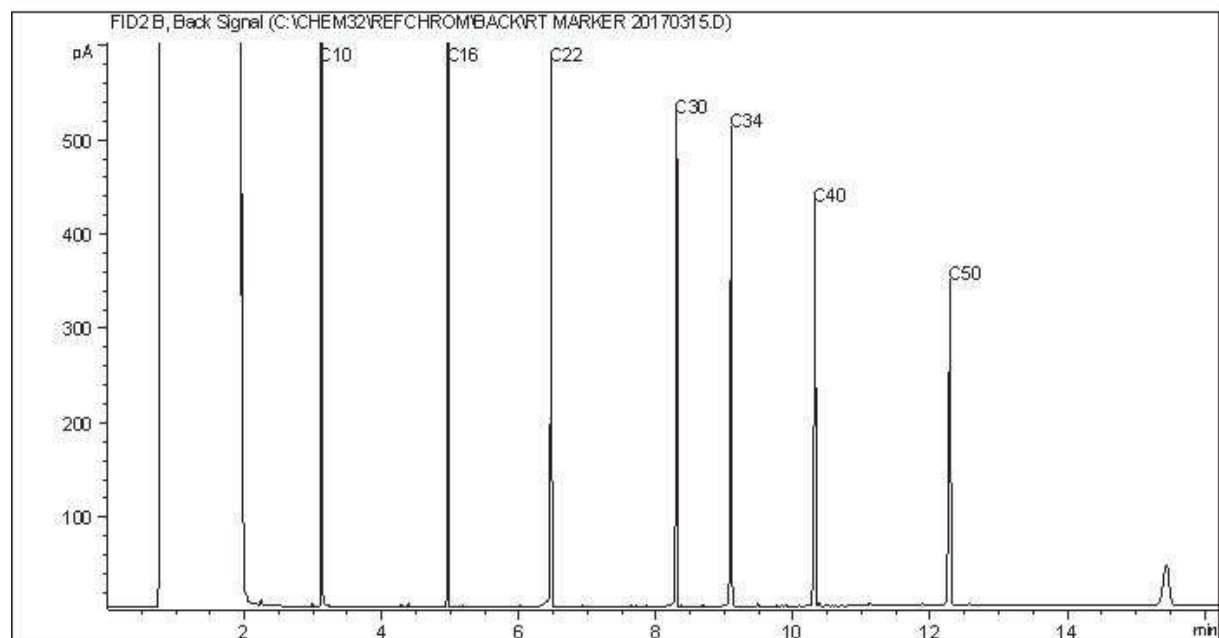
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



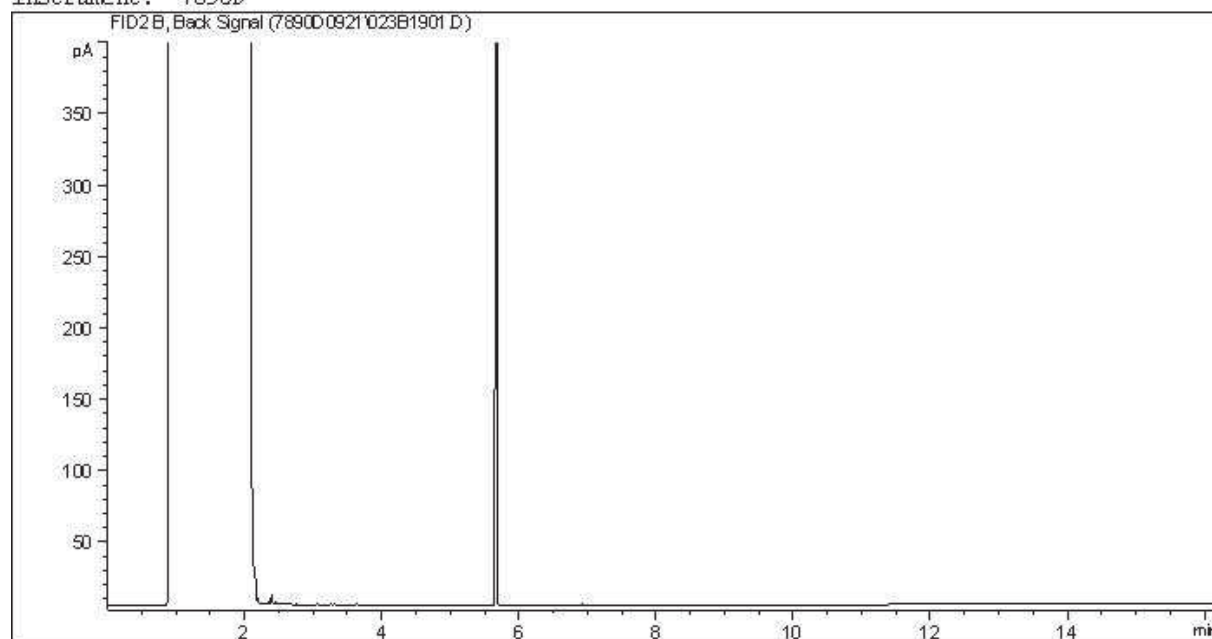
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

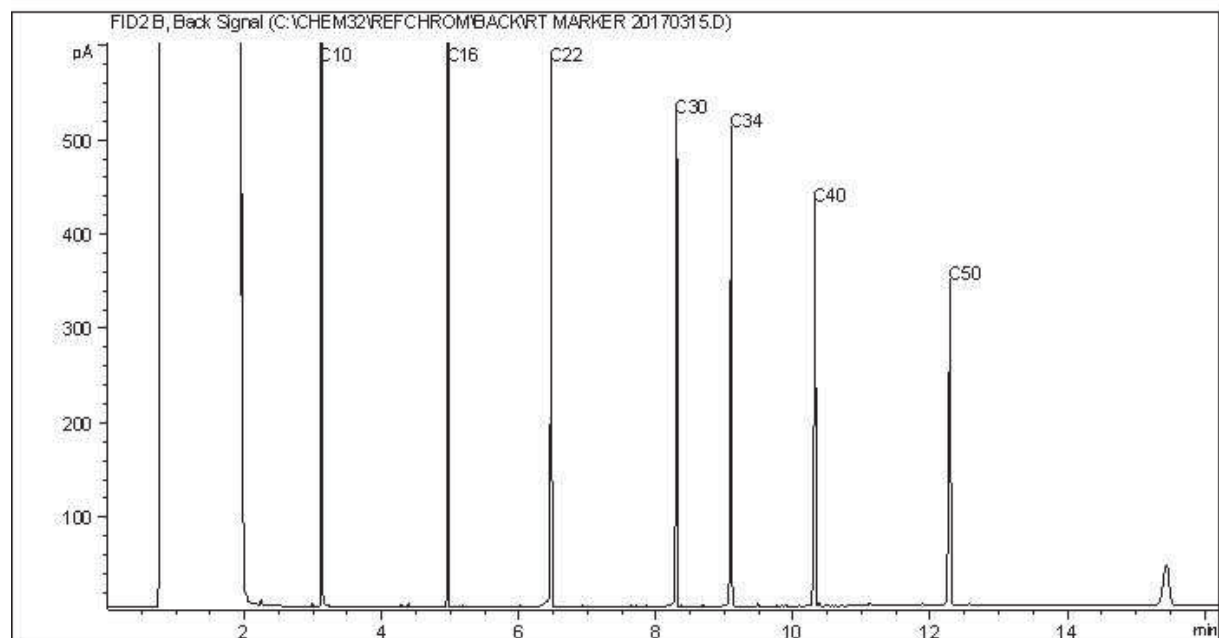
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



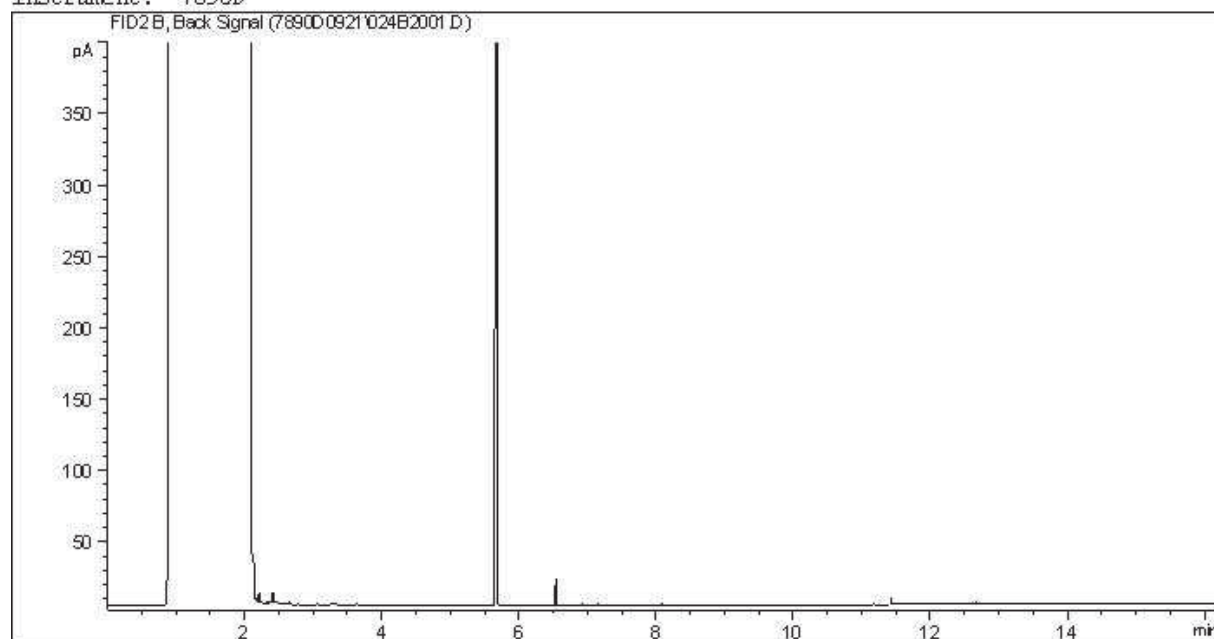
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

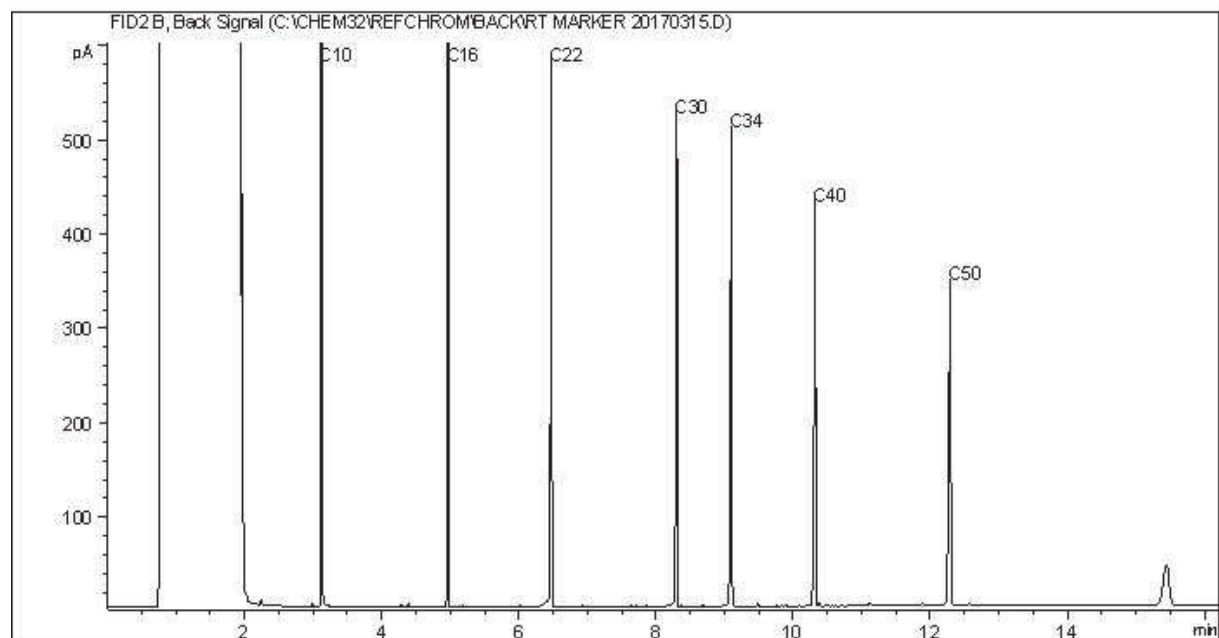
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 12-Sep-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B780015

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD	x			

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 16-Nov-17

Data Reviewed by (Signature): 

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 298418

Report Date: 2017/10/11
Report #: R2457659
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B780017

Received: 2017/09/16, 09:18

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	8	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	8	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	8	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	8	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	8	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	8	AB SOP-00037	CCME PHC-CWS m
Hardness	8	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	8	EENSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	8	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	8	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	8	AB WI-00065	Auto Calc
Nitrate and Nitrite	8	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	8	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	8	AB SOP-00023	SM 23 4110 B m
Phenols (4-AAP)	8	EENSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	8	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	8	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400
Your C.O.C. #: 298418

Report Date: 2017/10/11
Report #: R2457659
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B780017

Received: 2017/09/16, 09:18

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Jenna Chernuka
Project Manager
11 Oct 2017 11:10:24

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RZ2248	RZ2249	RZ2250	RZ2251	RZ2252	RZ2253		
Sampling Date		2017/09/14 09:20	2017/09/13 10:46	2017/09/13 10:46	2017/09/12 17:15	2017/09/12 15:00	2017/09/12 16:10		
COC Number		298418	298418	298418	298418	298418	298418		
	UNITS	MTF 97-1-5	TF 03-12-3	SNP-DUP3	C38 08-1-4	CPF 98-8-3	ARB-12-3-3	RDL	QC Batch
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8763774
Volatiles									
Benzene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Toluene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8763437
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8763437
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8763437
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8763437
F1 (C6-C10)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	8763437
Extraction Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	93	90	94	105	89	88		8763774
Instrument Surrogate Recovery (%)									
1,4-Difluorobenzene (sur.)	%	102	101	100	100	103	100		8763437
4-Bromofluorobenzene (sur.)	%	105	99	104	102	102	104		8763437
D4-1,2-Dichloroethane (sur.)	%	123	124	125	124	127	122		8763437
RDL = Reportable Detection Limit									

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RZ2265	RZ2265	RZ2266		
Sampling Date		2017/09/12 13:15	2017/09/12 13:15	2017/09/12 13:00		
COC Number		298418	298418	298418		
	UNITS	BISS2 09-DP-1	BISS2 09-DP-1 Lab-Dup	BISS2 09-DP-2	RDL	QC Batch
Ext. Pet. Hydrocarbon						
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10		<0.10	0.10	8763774
Volatiles						
Benzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8763452
Toluene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8763452
Ethylbenzene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8763452
m & p-Xylene	mg/L	<0.00080	<0.00080	<0.00080	0.00080	8763452
o-Xylene	mg/L	<0.00040	<0.00040	<0.00040	0.00040	8763452
Xylenes (Total)	mg/L	<0.00080	<0.00080	<0.00080	0.00080	8763452
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	<0.10	0.10	8763452
F1 (C6-C10)	mg/L	<0.10	<0.10	<0.10	0.10	8763452
Extraction Surrogate Recovery (%)						
O-TERPHENYL (sur.)	%	91		89		8763774
Instrument Surrogate Recovery (%)						
1,4-Difluorobenzene (sur.)	%	98	100	99		8763452
4-Bromofluorobenzene (sur.)	%	106	104	105		8763452
D4-1,2-Dichloroethane (sur.)	%	129	124	127		8763452
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate						

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2248	RZ2248	RZ2249	RZ2250	RZ2251		
Sampling Date		2017/09/14 09:20	2017/09/14 09:20	2017/09/13 10:46	2017/09/13 10:46	2017/09/12 17:15		
COC Number		298418	298418	298418	298418	298418		
	UNITS	MTF 97-1-5	MTF 97-1-5 Lab-Dup	TF 03-12-3	SNP-DUP3	C38 08-1-4	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	0.00017		0.000098	0.000098	<0.000020	0.000020	8760258
Elements								
Dissolved Aluminum (Al)	mg/L	0.019		0.014	0.018	0.11	0.0030	8763751
Dissolved Antimony (Sb)	mg/L	<0.00060		<0.00060	<0.00060	<0.00060	0.00060	8763751
Dissolved Arsenic (As)	mg/L	0.00021		0.0058	0.0058	0.015	0.00020	8763751
Dissolved Barium (Ba)	mg/L	0.027	0.027	0.065	0.068	0.48	0.010	8765646
Dissolved Beryllium (Be)	mg/L	<0.0010		<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Boron (B)	mg/L	0.030	0.029	0.042	0.039	0.047	0.020	8765646
Dissolved Calcium (Ca)	mg/L	270	270	190	200	190	0.30	8765646
Dissolved Chromium (Cr)	mg/L	<0.0010		<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Cobalt (Co)	mg/L	<0.00030		0.0036	0.0041	0.0053	0.00030	8763751
Dissolved Copper (Cu)	mg/L	0.0023		0.00082	0.00061	<0.00020	0.00020	8763751
Dissolved Iron (Fe)	mg/L	<0.060	<0.060	2.8	3.7	20	0.060	8765646
Dissolved Lead (Pb)	mg/L	<0.00020		<0.00020	<0.00020	<0.00020	0.00020	8763751
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	0.029	0.020	8765646
Dissolved Magnesium (Mg)	mg/L	75	75	79	81	64	0.20	8765646
Dissolved Manganese (Mn)	mg/L	<0.0040	<0.0040	0.31	0.38	2.0	0.0040	8765646
Dissolved Molybdenum (Mo)	mg/L	0.018		0.21	0.20	0.00031	0.00020	8763751
Dissolved Nickel (Ni)	mg/L	0.0065		0.024	0.025	0.0076	0.00050	8763751
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	<0.10	0.16	0.10	8765646
Dissolved Potassium (K)	mg/L	1.5	1.6	5.1	5.0	3.7	0.30	8765646
Dissolved Selenium (Se)	mg/L	0.15		0.0021	0.0021	0.00058	0.00020	8763751
Dissolved Silicon (Si)	mg/L	5.2	5.2	15	14	12	0.10	8765646
Dissolved Silver (Ag)	mg/L	<0.00010		<0.00010	<0.00010	<0.00010	0.00010	8763751
Dissolved Sodium (Na)	mg/L	3.8	3.8	54	56	53	0.50	8765646
Dissolved Strontium (Sr)	mg/L	0.45	0.45	0.66	0.71	0.62	0.020	8765646
Dissolved Sulphur (S)	mg/L	230	230	81	71	40	0.20	8765646
Dissolved Thallium (Tl)	mg/L	<0.00020		0.0015	0.0015	<0.00020	0.00020	8763751
Dissolved Tin (Sn)	mg/L	<0.0010		<0.0010	<0.0010	<0.0010	0.0010	8763751
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2248	RZ2248	RZ2249	RZ2250	RZ2251		
Sampling Date		2017/09/14 09:20	2017/09/14 09:20	2017/09/13 10:46	2017/09/13 10:46	2017/09/12 17:15		
COC Number		298418	298418	298418	298418	298418		
	UNITS	MTF 97-1-5	MTF 97-1-5 Lab-Dup	TF 03-12-3	SNP-DUP3	C38 08-1-4	RDL	QC Batch
Dissolved Titanium (Ti)	mg/L	<0.0010		<0.0010	<0.0010	0.0065	0.0010	8763751
Dissolved Uranium (U)	mg/L	0.029		0.015	0.015	0.0019	0.00010	8763751
Dissolved Vanadium (V)	mg/L	<0.0010		0.0047	0.0046	0.0018	0.0010	8763751
Dissolved Zinc (Zn)	mg/L	0.0094		0.0091	0.0087	<0.0030	0.0030	8763751
Low Level Elements								
Dissolved Mercury (Hg)	mg/L	<0.0000020		<0.0000020	<0.0000020	<0.0000020	0.0000020	8765842
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2252	RZ2253	RZ2265	RZ2266		
Sampling Date		2017/09/12 15:00	2017/09/12 16:10	2017/09/12 13:15	2017/09/12 13:00		
COC Number		298418	298418	298418	298418		
	UNITS	CPF 98-8-3	ARB-12-3-3	BISS2 09-DP-1	BISS2 09-DP-2	RDL	QC Batch
Low Level Elements							
Dissolved Cadmium (Cd)	mg/L	0.000032	0.000070	0.000085	<0.000020	0.000020	8760482
Elements							
Dissolved Aluminum (Al)	mg/L	0.049	0.013	0.0052	0.0066	0.0030	8763751
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	0.00060	8763751
Dissolved Arsenic (As)	mg/L	0.00063	0.00077	0.00098	0.0047	0.00020	8763751
Dissolved Barium (Ba)	mg/L	0.16	0.11	0.36	0.44	0.010	8765646
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Boron (B)	mg/L	0.021	0.039	<0.020	<0.020	0.020	8765646
Dissolved Calcium (Ca)	mg/L	160	160	190	99	0.30	8765646
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Cobalt (Co)	mg/L	0.00098	<0.00030	0.0053	0.0022	0.00030	8763751
Dissolved Copper (Cu)	mg/L	0.0016	0.0040	0.0019	0.0016	0.00020	8763751
Dissolved Iron (Fe)	mg/L	0.76	<0.060	0.87	6.9	0.060	8765646
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8763751
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	0.020	8765646
Dissolved Magnesium (Mg)	mg/L	34	46	30	15	0.20	8765646
Dissolved Manganese (Mn)	mg/L	0.63	0.025	4.0	0.78	0.0040	8765646
Dissolved Molybdenum (Mo)	mg/L	0.00081	0.0031	0.0014	0.0012	0.00020	8763751
Dissolved Nickel (Ni)	mg/L	0.0032	0.0033	0.011	0.0067	0.00050	8763751
Dissolved Phosphorus (P)	mg/L	<0.10	0.14	<0.10	<0.10	0.10	8765646
Dissolved Potassium (K)	mg/L	2.6	2.3	0.82	2.0	0.30	8765646
Dissolved Selenium (Se)	mg/L	0.00022	0.0030	<0.00020	<0.00020	0.00020	8763751
Dissolved Silicon (Si)	mg/L	4.6	5.7	4.7	2.9	0.10	8765646
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	8763751
Dissolved Sodium (Na)	mg/L	12	46	5.9	4.7	0.50	8765646
Dissolved Strontium (Sr)	mg/L	0.56	0.49	0.77	0.34	0.020	8765646
Dissolved Sulphur (S)	mg/L	69	78	19	4.3	0.20	8765646
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8763751
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763751
RDL = Reportable Detection Limit							

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		RZ2252	RZ2253	RZ2265	RZ2266		
Sampling Date		2017/09/12 15:00	2017/09/12 16:10	2017/09/12 13:15	2017/09/12 13:00		
COC Number		298418	298418	298418	298418		
	UNITS	CPF 98-8-3	ARB-12-3-3	BISS2 09-DP-1	BISS2 09-DP-2	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.00059	0.0081	0.0051	0.0011	0.00010	8763751
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8763751
Dissolved Zinc (Zn)	mg/L	0.015	0.0047	0.0070	0.023	0.0030	8763751
Low Level Elements							
Dissolved Mercury (Hg)	mg/L	<0.0000020	<0.0000020	<0.0000020	<0.0000020	0.0000020	8765842
RDL = Reportable Detection Limit							

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RZ2248	RZ2248			RZ2249	RZ2250		
Sampling Date		2017/09/14 09:20	2017/09/14 09:20			2017/09/13 10:46	2017/09/13 10:46		
COC Number		298418	298418			298418	298418		
	UNITS	MTF 97-1-5	MTF 97-1-5 Lab-Dup	RDL	QC Batch	TF 03-12-3	SNP-DUP3	RDL	QC Batch
Calculated Parameters									
Hardness (CaCO ₃)	mg/L	980		0.50	8760361	800	820	0.50	8760361
Ion Balance (% Difference)	%	3.6		N/A	8760362	7.0	0.28	N/A	8760362
Dissolved Nitrate (NO ₃)	mg/L	14		0.044	8760364	<0.044	<0.044	0.044	8760364
Nitrate plus Nitrite (N)	mg/L	3.3		0.014	8760365	<0.014	<0.014	0.014	8760365
Dissolved Nitrite (NO ₂)	mg/L	<0.033		0.033	8760364	<0.033	<0.033	0.033	8760364
Misc. Inorganics									
Conductivity	uS/cm	1500		1.0	8760642	1900	1700	1.0	8760642
Total Dissolved Solids	mg/L	1300		10	8761764	1100 (1)	990 (1)	25	8761764
Anions									
Alkalinity (PP as CaCO ₃)	mg/L	<0.50		0.50	8760638	<0.50	<0.50	0.50	8760638
Alkalinity (Total as CaCO ₃)	mg/L	290		0.50	8760638	670	570	0.50	8760638
Bicarbonate (HCO ₃)	mg/L	350		0.50	8760638	820	690	0.50	8760638
Carbonate (CO ₃)	mg/L	<0.50		0.50	8760638	<0.50	<0.50	0.50	8760638
Hydroxide (OH)	mg/L	<0.50		0.50	8760638	<0.50	<0.50	0.50	8760638
Dissolved Sulphate (SO ₄)	mg/L	600 (2)		5.0	8761012	110	150	1.0	8761027
Dissolved Chloride (Cl)	mg/L	1.0		1.0	8761011	190	160	1.0	8761024
Nutrients									
Dissolved Nitrite (N)	mg/L	<0.010	<0.010	0.010	8760899	<0.010	<0.010	0.010	8760606
Dissolved Nitrate (N)	mg/L	3.3	3.4	0.010	8760899	<0.010	<0.010	0.010	8760606
Misc. Organics									
Phenols	mg/L	<0.0020		0.0020	8766726	0.0066	0.0062	0.0020	8766726
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis. (2) Detection limits raised due to dilution to bring analyte within the calibrated range.									

Maxxam Job #: B780017
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WORLEY PARSONS
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Site Location: NORMAN WELLS, NT
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RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RZ2251		RZ2252			RZ2253		RZ2265		
Sampling Date		2017/09/12 17:15		2017/09/12 15:00			2017/09/12 16:10		2017/09/12 13:15		
COC Number		298418		298418			298418		298418		
	UNITS	C38 08-1-4	RDL	CPF 98-8-3	RDL	QC Batch	ARB-12-3-3	RDL	BISS2 09-DP-1	RDL	QC Batch
Calculated Parameters											
Hardness (CaCO ₃)	mg/L	730	0.50	530	0.50	8760361	590	0.50	590	0.50	8760361
Ion Balance (% Difference)	%	4.5	N/A	4.0	N/A	8760362	2.5	N/A	9.1	N/A	8760362
Dissolved Nitrate (NO ₃)	mg/L	<0.044	0.044	0.18	0.044	8760364	1.5	0.044	0.58	0.044	8760364
Nitrate plus Nitrite (N)	mg/L	<0.014	0.014	0.059	0.014	8760365	0.34	0.014	0.13	0.014	8760365
Dissolved Nitrite (NO ₂)	mg/L	<0.033	0.033	0.062	0.033	8760364	<0.033	0.033	<0.033	0.033	8760364
Misc. Inorganics											
Conductivity	uS/cm	1400	1.0	920	1.0	8760642	1100	1.0	890	1.0	8760642
Total Dissolved Solids	mg/L	960 (1)	50	660 (1)	50	8761474	810	10	610 (1)	25	8761474
Anions											
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	0.50	<0.50	0.50	8760638	<0.50	0.50	<0.50	0.50	8760638
Alkalinity (Total as CaCO ₃)	mg/L	740	0.50	330	0.50	8760638	460	0.50	450	0.50	8760638
Bicarbonate (HCO ₃)	mg/L	900	0.50	410	0.50	8760638	560	0.50	550	0.50	8760638
Carbonate (CO ₃)	mg/L	<0.50	0.50	<0.50	0.50	8760638	<0.50	0.50	<0.50	0.50	8760638
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	8760638	<0.50	0.50	<0.50	0.50	8760638
Dissolved Sulphate (SO ₄)	mg/L	51 (2)	2.0	170	1.0	8761027	160	1.0	48	1.0	8761012
Dissolved Chloride (Cl)	mg/L	14 (3)	2.0	9.1	1.0	8761024	22	1.0	6.9	1.0	8761011
Nutrients											
Dissolved Nitrite (N)	mg/L	<0.010	0.010	0.019	0.010	8760606	<0.010	0.010	<0.010	0.010	8760606
Dissolved Nitrate (N)	mg/L	<0.010	0.010	0.040	0.010	8760606	0.34	0.010	0.13	0.010	8760606
Misc. Organics											
Phenols	mg/L	0.022	0.0020	0.0069	0.0020	8766726	0.0034	0.0020	0.0064	0.0020	8766726

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Detection limit raised based on sample volume used for analysis.

(2) Detection limits raised due to dilution to bring analyte within the calibrated range.

(3) Detection limits raised due to sample matrix.

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RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RZ2265		RZ2266		
Sampling Date		2017/09/12 13:15		2017/09/12 13:00		
COC Number		298418		298418		
	UNITS	BISS2 09-DP-1 Lab-Dup	QC Batch	BISS2 09-DP-2	RDL	QC Batch
Calculated Parameters						
Hardness (CaCO ₃)	mg/L		8760361	310	0.50	8760361
Ion Balance (% Difference)	%		8760362	3.8	N/A	8760362
Dissolved Nitrate (NO ₃)	mg/L		8760364	<0.044	0.044	8760364
Nitrate plus Nitrite (N)	mg/L		8760365	<0.014	0.014	8760365
Dissolved Nitrite (NO ₂)	mg/L		8760364	<0.033	0.033	8760364
Misc. Inorganics						
Conductivity	uS/cm		8760642	570	1.0	8760642
Total Dissolved Solids	mg/L		8761474	300 (1)	25	8761474
Anions						
Alkalinity (PP as CaCO ₃)	mg/L		8760638	<0.50	0.50	8760638
Alkalinity (Total as CaCO ₃)	mg/L		8760638	290	0.50	8760638
Bicarbonate (HCO ₃)	mg/L		8760638	360	0.50	8760638
Carbonate (CO ₃)	mg/L		8760638	<0.50	0.50	8760638
Hydroxide (OH)	mg/L		8760638	<0.50	0.50	8760638
Dissolved Sulphate (SO ₄)	mg/L	46	8761012	14	1.0	8761027
Dissolved Chloride (Cl)	mg/L	6.9	8761011	4.8	1.0	8761024
Nutrients						
Dissolved Nitrite (N)	mg/L		8760606	<0.010	0.010	8760606
Dissolved Nitrate (N)	mg/L		8760606	<0.010	0.010	8760606
Misc. Organics						
Phenols	mg/L		8766726	0.0059	0.0020	8766726
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limit raised based on sample volume used for analysis.						

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2248
Sample ID: MTF 97-1-5
Matrix: Water

Collected: 2017/09/14
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/18	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/18	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760899	N/A	2017/09/17	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761764	2017/09/18	2017/09/19	Kruti Patel

Maxxam ID: RZ2248 Dup
Sample ID: MTF 97-1-5
Matrix: Water

Collected: 2017/09/14
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760899	N/A	2017/09/17	Krista Dawe

Maxxam ID: RZ2249
Sample ID: TF 03-12-3
Matrix: Water

Collected: 2017/09/13
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761024	N/A	2017/09/21	Ashley Fedoriuk
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk

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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2249
Sample ID: TF 03-12-3
Matrix: Water

Collected: 2017/09/13
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761027	N/A	2017/09/21	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8761764	2017/09/18	2017/09/19	Kruti Patel

Maxxam ID: RZ2250
Sample ID: SNP-DUP3
Matrix: Water

Collected: 2017/09/13
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761024	N/A	2017/09/21	Ashley Fedoriuk
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761027	N/A	2017/09/21	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8761764	2017/09/18	2017/09/19	Kruti Patel

Maxxam ID: RZ2251
Sample ID: C38 08-1-4
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760258	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761024	N/A	2017/09/21	Ashley Fedoriuk
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky

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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2251
Sample ID: C38 08-1-4
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761027	N/A	2017/09/21	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2252
Sample ID: CPF 98-8-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760482	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761024	N/A	2017/09/21	Ashley Fedoriuk
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761027	N/A	2017/09/21	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2253
Sample ID: ARB-12-3-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763437	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760482	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/19	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo

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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
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TEST SUMMARY

Maxxam ID: RZ2253
Sample ID: ARB-12-3-3
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/19	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2265
Sample ID: BISS2 09-DP-1
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763452	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760482	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/20	Chelsea Harmatys
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/20	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

Maxxam ID: RZ2265 Dup
Sample ID: BISS2 09-DP-1
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763452	N/A	2017/09/22	Ying (Emma) Zhu
Chloride by Automated Colourimetry	KONE	8761011	N/A	2017/09/20	Chelsea Harmatys
Sulphate by Automated Colourimetry	KONE	8761012	N/A	2017/09/20	Chelsea Harmatys

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

TEST SUMMARY

Maxxam ID: RZ2266
Sample ID: BISS2 09-DP-2
Matrix: Water

Collected: 2017/09/12
Relinquished: 2017/09/15
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8760638	N/A	2017/09/16	Chelsea Harmatys
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8763452	N/A	2017/09/22	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8760482	N/A	2017/09/22	Automated Statchk
Chloride by Automated Colourimetry	KONE	8761024	N/A	2017/09/21	Ashley Fedoriuk
Conductivity @25C	COND	8760642	N/A	2017/09/16	Chelsea Harmatys
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8763774	2017/09/20	2017/09/21	Grace Guo
Hardness	CALC	8760361	N/A	2017/09/21	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8765842	2017/09/21	2017/09/21	Nishant Prajapati
Elements by ICP - Dissolved	ICPA	8765646	N/A	2017/09/21	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8763751	N/A	2017/09/21	Julie Harrison
Ion Balance	CALC	8760362	N/A	2017/09/17	Automated Statchk
Nitrate and Nitrite	CALC	8760364	N/A	2017/09/17	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8760365	N/A	2017/09/17	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8760606	N/A	2017/09/17	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8766726	N/A	2017/09/21	Ying Yang
Sulphate by Automated Colourimetry	KONE	8761027	N/A	2017/09/21	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8761474	2017/09/18	2017/09/21	Kruti Patel

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.7°C

Report reissued to remove deficiency as per IOL.

Sample RZ2249 [TF 03-12-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2250 [SNP-DUP3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2251 [C38 08-1-4] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2252 [CPF 98-8-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2253 [ARB-12-3-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2265 [BISS2 09-DP-1] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RZ2266 [BISS2 09-DP-2] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8760606	MSD	Method Blank	Dissolved Nitrite (N)	2017/09/16	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/09/16	<0.010		mg/L	
8760638	CH7	Method Blank	Alkalinity (Total as CaCO ₃)	2017/09/16	<0.50		mg/L	
			Alkalinity (PP as CaCO ₃)	2017/09/16	<0.50		mg/L	
			Bicarbonate (HCO ₃)	2017/09/16	<0.50		mg/L	
			Carbonate (CO ₃)	2017/09/16	<0.50		mg/L	
			Hydroxide (OH)	2017/09/16	<0.50		mg/L	
8760642	CH7	Method Blank	Conductivity	2017/09/16	<1.0		uS/cm	
8760899	KD5	Method Blank	Dissolved Nitrite (N)	2017/09/17	<0.010		mg/L	
			Dissolved Nitrate (N)	2017/09/17	<0.010		mg/L	
8761011	CH7	Method Blank	Dissolved Chloride (Cl)	2017/09/19	<1.0		mg/L	
8761012	CH7	Method Blank	Dissolved Sulphate (SO ₄)	2017/09/19	<1.0		mg/L	
8761024	AF6	Method Blank	Dissolved Chloride (Cl)	2017/09/21	<1.0		mg/L	
8761027	AF6	Method Blank	Dissolved Sulphate (SO ₄)	2017/09/21	<1.0		mg/L	
8761474	KPG	Method Blank	Total Dissolved Solids	2017/09/21	<10		mg/L	
8761764	KPG	Method Blank	Total Dissolved Solids	2017/09/19	<10		mg/L	
8763437	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/09/21		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/21		106	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/21		117	%	70 - 130
			Benzene	2017/09/21	<0.00040		mg/L	
			Toluene	2017/09/21	<0.00040		mg/L	
			Ethylbenzene	2017/09/21	<0.00040		mg/L	
			m & p-Xylene	2017/09/21	<0.00080		mg/L	
			o-Xylene	2017/09/21	<0.00040		mg/L	
			Xylenes (Total)	2017/09/21	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/09/21	<0.10		mg/L	
			F1 (C6-C10)	2017/09/21	<0.10		mg/L	
8763452	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/09/22		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/22		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/22		121	%	70 - 130
			Benzene	2017/09/22	<0.00040		mg/L	
			Toluene	2017/09/22	<0.00040		mg/L	
			Ethylbenzene	2017/09/22	<0.00040		mg/L	
			m & p-Xylene	2017/09/22	<0.00080		mg/L	
			o-Xylene	2017/09/22	<0.00040		mg/L	
			Xylenes (Total)	2017/09/22	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/09/22	<0.10		mg/L	
			F1 (C6-C10)	2017/09/22	<0.10		mg/L	
8763751	JHS	Method Blank	Dissolved Aluminum (Al)	2017/09/21	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/09/21	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/09/21	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/09/21	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/09/21	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/09/21	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/09/21	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/09/21	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/09/21	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/09/21	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/09/21	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/09/21	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/09/21	<0.0010		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8763774	GG3	Method Blank	Dissolved Titanium (Ti)	2017/09/21	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/09/21	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/09/21	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/09/21	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/09/21	<0.0010		mg/L	
			O-TERPHENYL (sur.)	2017/09/21		107	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/09/21	<0.10		mg/L	
8765646	JK9	Method Blank	Dissolved Iron (Fe)	2017/09/21	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/09/21	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/09/21	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/09/21	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/09/21	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/09/21	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/09/21	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/09/21	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/09/21	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/09/21	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/09/21	<0.10		mg/L	
			Dissolved Boron (B)	2017/09/21	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/09/21	<0.30		mg/L	
8765842	NP4	Method Blank	Dissolved Mercury (Hg)	2017/09/21	<0.0000020		mg/L	
8766726	YY	Method Blank	Phenols	2017/09/21	<0.0020		mg/L	
8760899	KD5	RPD [RZ2248-03]	Dissolved Nitrite (N)	2017/09/17	NC		%	20
			Dissolved Nitrate (N)	2017/09/17	2.9		%	20
8765646	JK9	RPD [RZ2248-05]	Dissolved Iron (Fe)	2017/09/21	NC		%	20
			Dissolved Lithium (Li)	2017/09/21	NC		%	20
			Dissolved Magnesium (Mg)	2017/09/21	0.17		%	20
			Dissolved Manganese (Mn)	2017/09/21	NC		%	20
			Dissolved Potassium (K)	2017/09/21	0.63		%	20
			Dissolved Sodium (Na)	2017/09/21	0.55		%	20
			Dissolved Strontium (Sr)	2017/09/21	0.29		%	20
			Dissolved Sulphur (S)	2017/09/21	0.27		%	20
			Dissolved Phosphorus (P)	2017/09/21	NC		%	20
			Dissolved Barium (Ba)	2017/09/21	0.67		%	20
			Dissolved Silicon (Si)	2017/09/21	0.27		%	20
			Dissolved Boron (B)	2017/09/21	2.9		%	20
			Dissolved Calcium (Ca)	2017/09/21	0.043		%	20
8761011	CH7	RPD [RZ2265-03]	Dissolved Chloride (Cl)	2017/09/20	0.068		%	20
8761012	CH7	RPD [RZ2265-03]	Dissolved Sulphate (SO4)	2017/09/20	4.7		%	20
8763452	YZ3	RPD [RZ2265-02]	Benzene	2017/09/22	NC		%	30
			Toluene	2017/09/22	NC		%	30
			Ethylbenzene	2017/09/22	NC		%	30
			m & p-Xylene	2017/09/22	NC		%	30
			o-Xylene	2017/09/22	NC		%	30
			Xylenes (Total)	2017/09/22	NC		%	30
			F1 (C6-C10) - BTEX	2017/09/22	NC		%	30
			F1 (C6-C10)	2017/09/22	NC		%	30
			Dissolved Nitrite (N)	2017/09/17		101	%	80 - 120
			Dissolved Nitrate (N)	2017/09/17		100	%	80 - 120
8761011	CH7	Matrix Spike [RZ2265-03]	Dissolved Chloride (Cl)	2017/09/20		108	%	80 - 120
8761012	CH7	Matrix Spike [RZ2265-03]	Dissolved Sulphate (SO4)	2017/09/20		NC	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8763452	YZ3	Matrix Spike [RZ2266-02]	1,4-Difluorobenzene (sur.)	2017/09/22		99	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/22		101	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/22		126	%	70 - 130
			Benzene	2017/09/22		98	%	70 - 130
			Toluene	2017/09/22		92	%	70 - 130
			Ethylbenzene	2017/09/22		95	%	70 - 130
			m & p-Xylene	2017/09/22		90	%	70 - 130
			o-Xylene	2017/09/22		97	%	70 - 130
			F1 (C6-C10)	2017/09/22		76	%	70 - 130
8765646	JK9	Matrix Spike [RZ2248-05]	Dissolved Iron (Fe)	2017/09/21		100	%	80 - 120
			Dissolved Lithium (Li)	2017/09/21		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/09/21		99	%	80 - 120
			Dissolved Manganese (Mn)	2017/09/21		100	%	80 - 120
			Dissolved Potassium (K)	2017/09/21		101	%	80 - 120
			Dissolved Sodium (Na)	2017/09/21		102	%	80 - 120
			Dissolved Strontium (Sr)	2017/09/21		96	%	80 - 120
			Dissolved Phosphorus (P)	2017/09/21		108	%	80 - 120
			Dissolved Barium (Ba)	2017/09/21		100	%	80 - 120
			Dissolved Silicon (Si)	2017/09/21		108	%	80 - 120
			Dissolved Boron (B)	2017/09/21		110	%	80 - 120
			Dissolved Calcium (Ca)	2017/09/21		NC	%	80 - 120
			Dissolved Nitrite (N)	2017/09/16		100	%	80 - 120
8760606	MSD	LCS	Dissolved Nitrate (N)	2017/09/16		100	%	80 - 120
			Alkalinity (Total as CaCO3)	2017/09/16		103	%	80 - 120
8760638	CH7	LCS	Conductivity	2017/09/16		100	%	90 - 110
8760899	KD5	LCS	Dissolved Nitrite (N)	2017/09/17		101	%	80 - 120
			Dissolved Nitrate (N)	2017/09/17		101	%	80 - 120
8761011	CH7	LCS	Dissolved Chloride (Cl)	2017/09/19		103	%	80 - 120
8761012	CH7	LCS	Dissolved Sulphate (SO4)	2017/09/19		104	%	80 - 120
8761024	AF6	LCS	Dissolved Chloride (Cl)	2017/09/21		104	%	80 - 120
8761027	AF6	LCS	Dissolved Sulphate (SO4)	2017/09/21		102	%	80 - 120
8761474	KPG	LCS	Total Dissolved Solids	2017/09/21		102	%	80 - 120
8761764	KPG	LCS	Total Dissolved Solids	2017/09/19		102	%	80 - 120
8763437	YZ3	LCS	1,4-Difluorobenzene (sur.)	2017/09/21		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/09/21		104	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/21		117	%	70 - 130
			Benzene	2017/09/21		98	%	70 - 130
			Toluene	2017/09/21		94	%	70 - 130
			Ethylbenzene	2017/09/21		100	%	70 - 130
			m & p-Xylene	2017/09/21		95	%	70 - 130
			o-Xylene	2017/09/21		102	%	70 - 130
			F1 (C6-C10)	2017/09/21		101	%	70 - 130
			1,4-Difluorobenzene (sur.)	2017/09/22		99	%	70 - 130
8763452	YZ3	LCS	4-Bromofluorobenzene (sur.)	2017/09/22		104	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/09/22		125	%	70 - 130
			Benzene	2017/09/22		99	%	70 - 130
			Toluene	2017/09/22		92	%	70 - 130
			Ethylbenzene	2017/09/22		96	%	70 - 130
			m & p-Xylene	2017/09/22		92	%	70 - 130
			o-Xylene	2017/09/22		99	%	70 - 130
			F1 (C6-C10)	2017/09/22		90	%	70 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8763751	JHS	LCS	Dissolved Aluminum (Al)	2017/09/21		106	%	80 - 120
			Dissolved Chromium (Cr)	2017/09/21		103	%	80 - 120
			Dissolved Cobalt (Co)	2017/09/21		102	%	80 - 120
			Dissolved Copper (Cu)	2017/09/21		101	%	80 - 120
			Dissolved Lead (Pb)	2017/09/21		101	%	80 - 120
			Dissolved Antimony (Sb)	2017/09/21		99	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/09/21		102	%	80 - 120
			Dissolved Nickel (Ni)	2017/09/21		101	%	80 - 120
			Dissolved Selenium (Se)	2017/09/21		103	%	80 - 120
			Dissolved Silver (Ag)	2017/09/21		102	%	80 - 120
			Dissolved Arsenic (As)	2017/09/21		102	%	80 - 120
			Dissolved Thallium (Tl)	2017/09/21		98	%	80 - 120
			Dissolved Tin (Sn)	2017/09/21		98	%	80 - 120
			Dissolved Titanium (Ti)	2017/09/21		102	%	80 - 120
			Dissolved Uranium (U)	2017/09/21		100	%	80 - 120
			Dissolved Vanadium (V)	2017/09/21		105	%	80 - 120
			Dissolved Zinc (Zn)	2017/09/21		103	%	80 - 120
			Dissolved Beryllium (Be)	2017/09/21		104	%	80 - 120
8763774	GG3	LCS	O-TERPHENYL (sur.)	2017/09/21		95	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/09/21		100	%	70 - 130
8765646	JK9	LCS	Dissolved Iron (Fe)	2017/09/21		98	%	80 - 120
			Dissolved Lithium (Li)	2017/09/21		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/09/21		103	%	80 - 120
			Dissolved Manganese (Mn)	2017/09/21		99	%	80 - 120
			Dissolved Potassium (K)	2017/09/21		101	%	80 - 120
			Dissolved Sodium (Na)	2017/09/21		103	%	80 - 120
			Dissolved Strontium (Sr)	2017/09/21		98	%	80 - 120
			Dissolved Phosphorus (P)	2017/09/21		103	%	80 - 120
			Dissolved Barium (Ba)	2017/09/21		99	%	80 - 120
			Dissolved Silicon (Si)	2017/09/21		109	%	80 - 120
			Dissolved Boron (B)	2017/09/21		105	%	80 - 120
			Dissolved Calcium (Ca)	2017/09/21		97	%	80 - 120
8765842	NP4	LCS	Dissolved Mercury (Hg)	2017/09/21		98	%	80 - 120
8766726	YY	LCS	Phenols	2017/09/21		99	%	80 - 120
8765842	NP4	SRM	Dissolved Mercury (Hg)	2017/09/21		102	%	80 - 120

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.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

LCS: 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).

Maxxam Job #: B780017
Report Date: 2017/10/11

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#: 70458415
Site Location: NORMAN WELLS, NT
Project #: 407074-00828.400

VALIDATION SIGNATURE PAGE

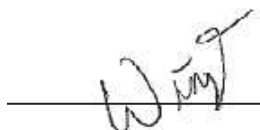
The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

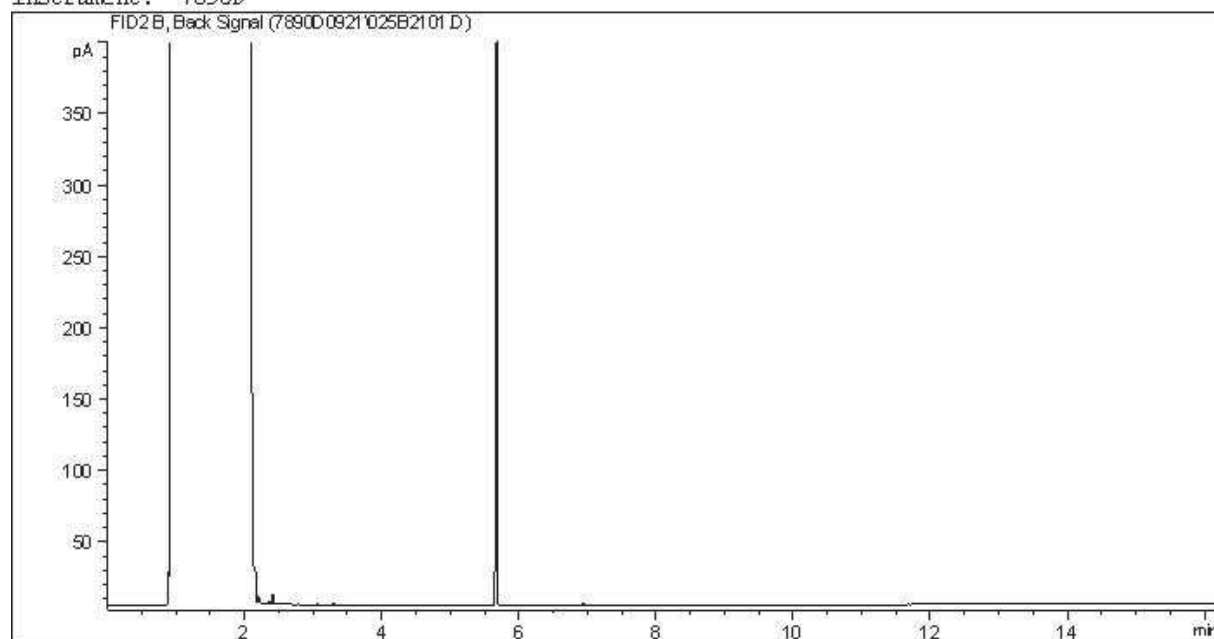


Winnie Au, B.Sc., QP, Scientific Specialist

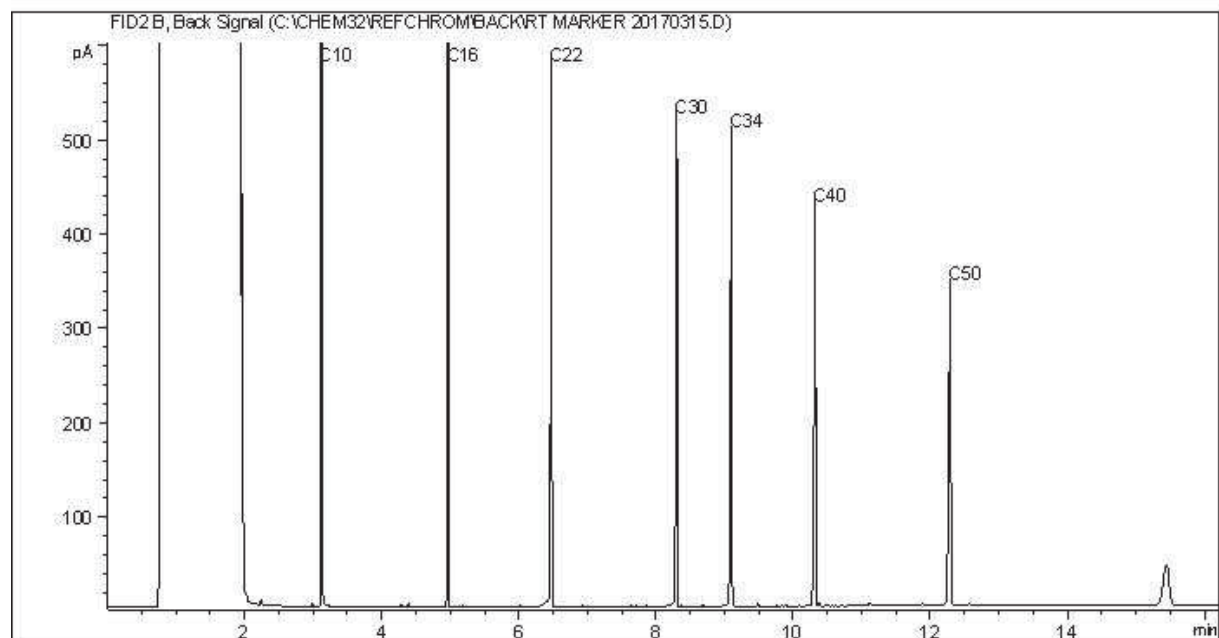
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



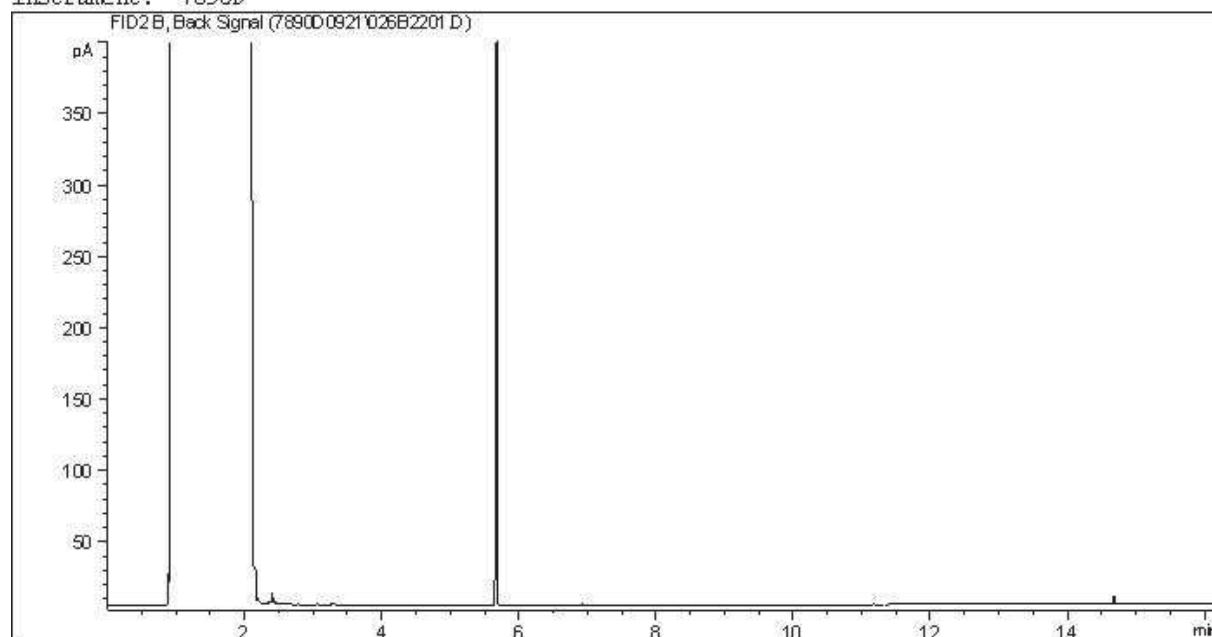
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

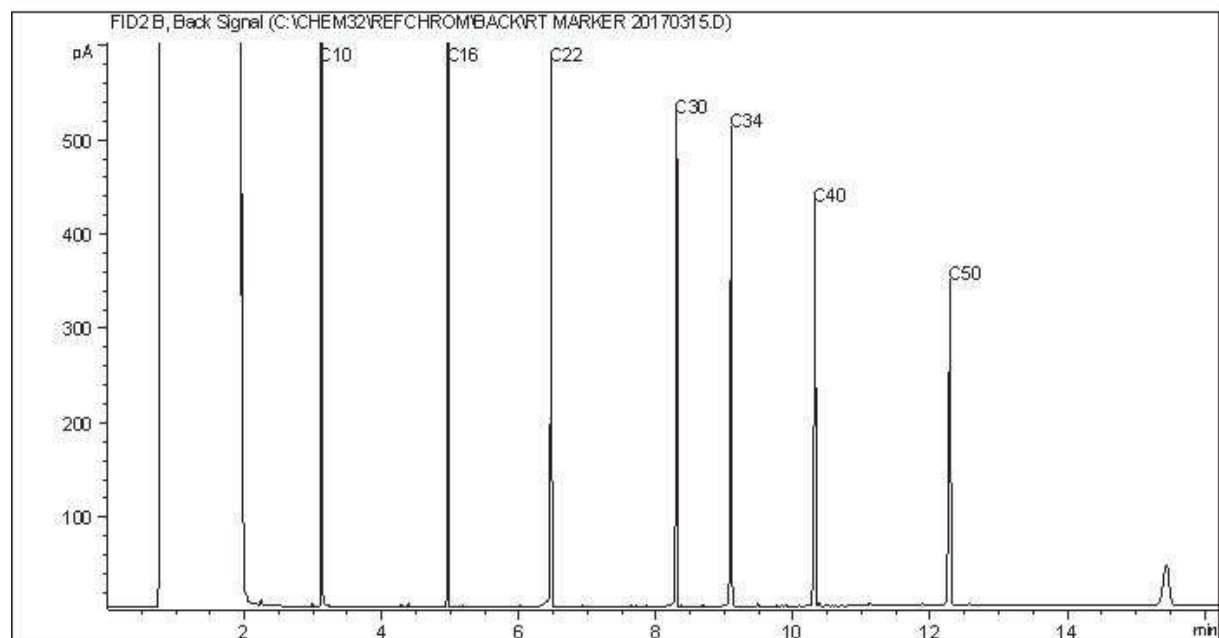
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



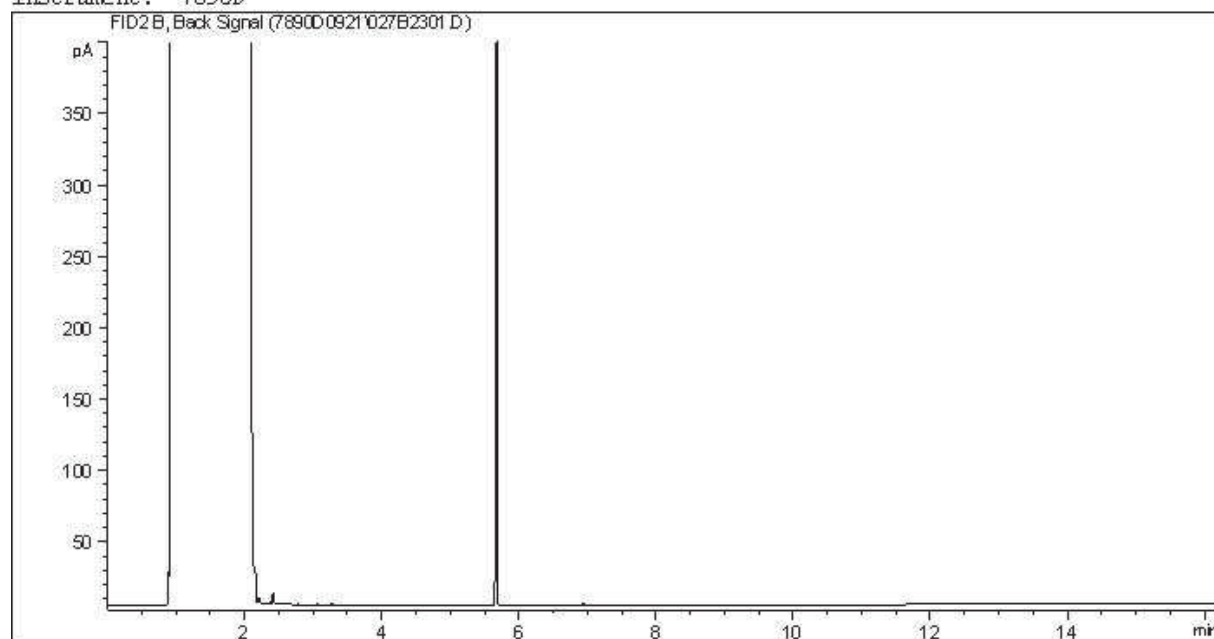
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

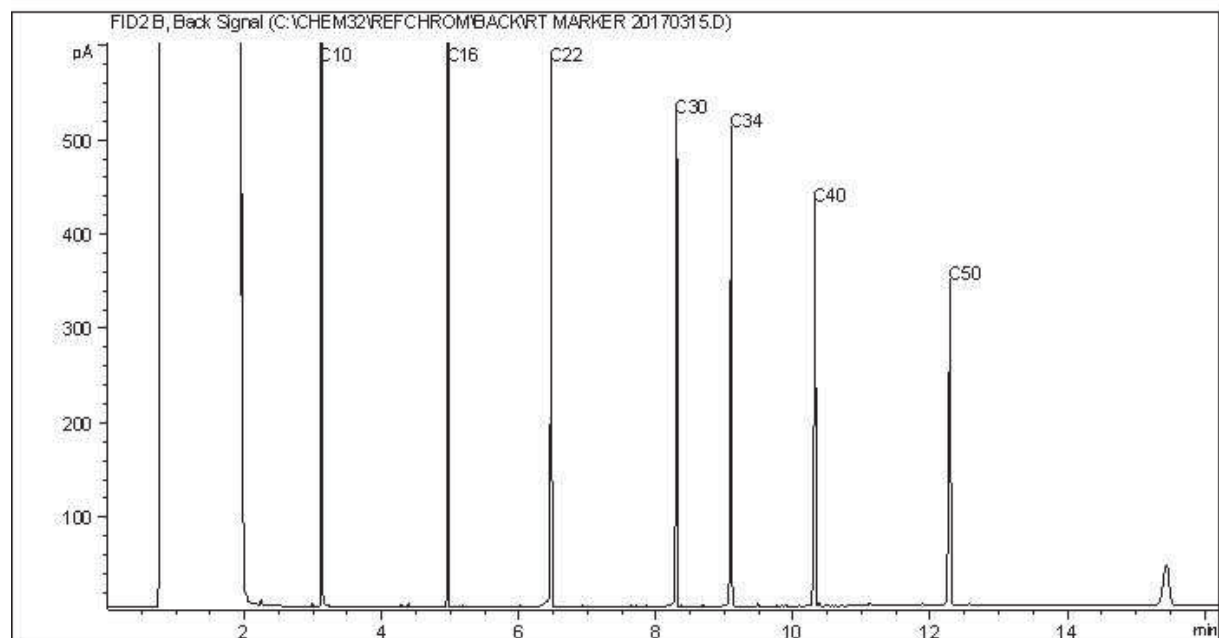
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



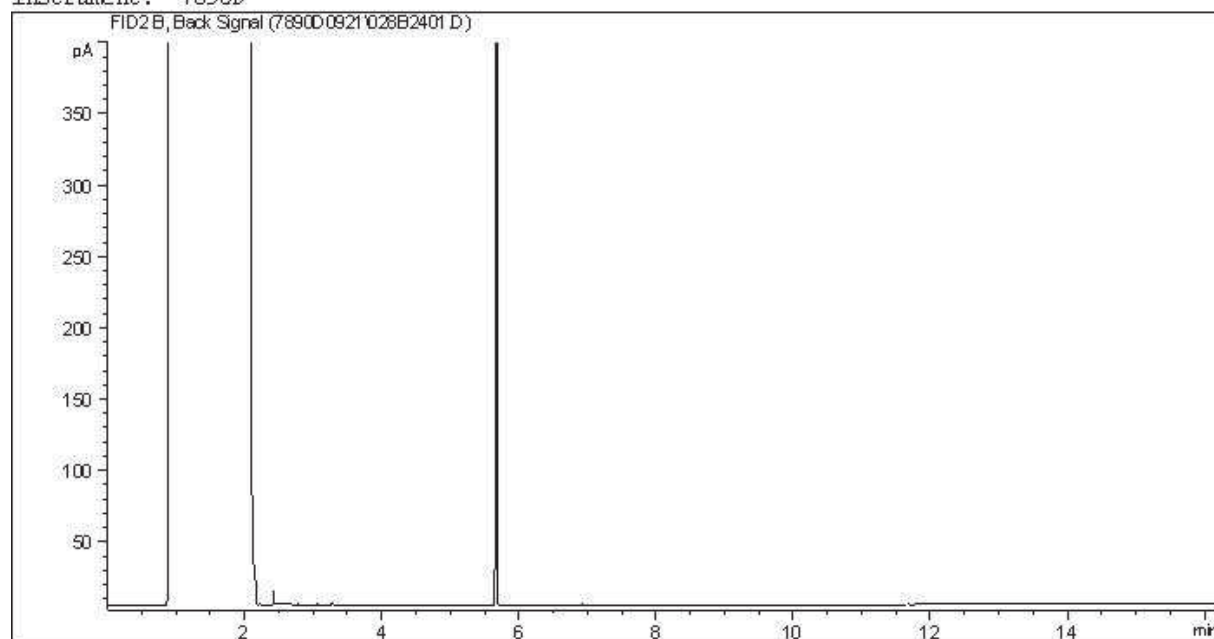
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

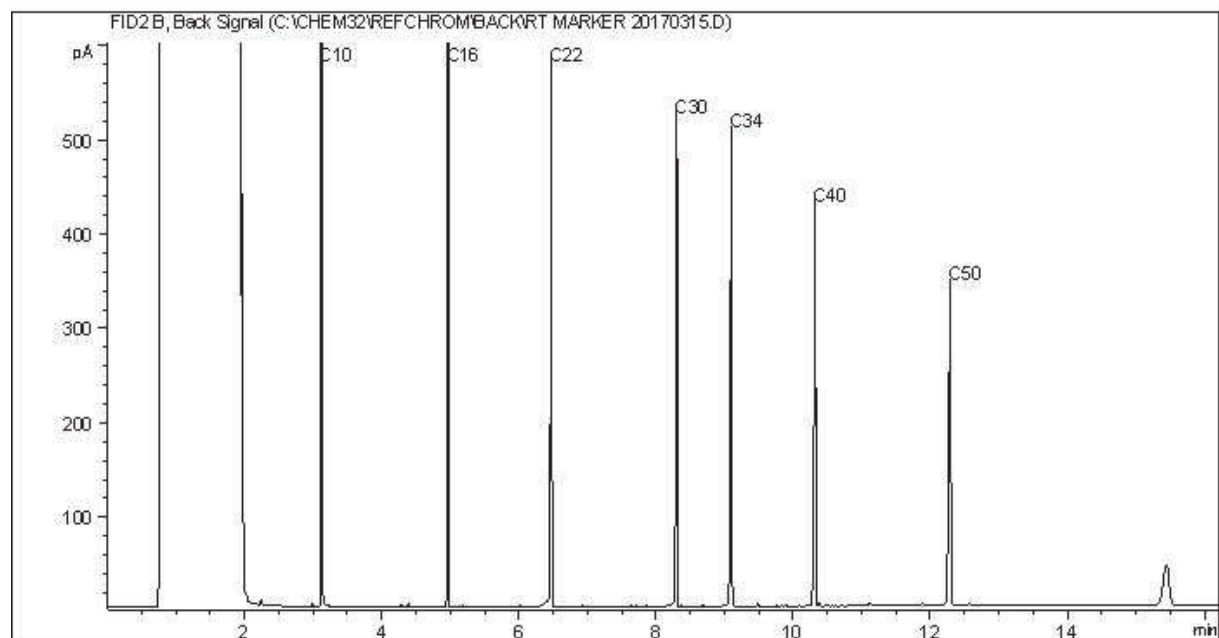
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



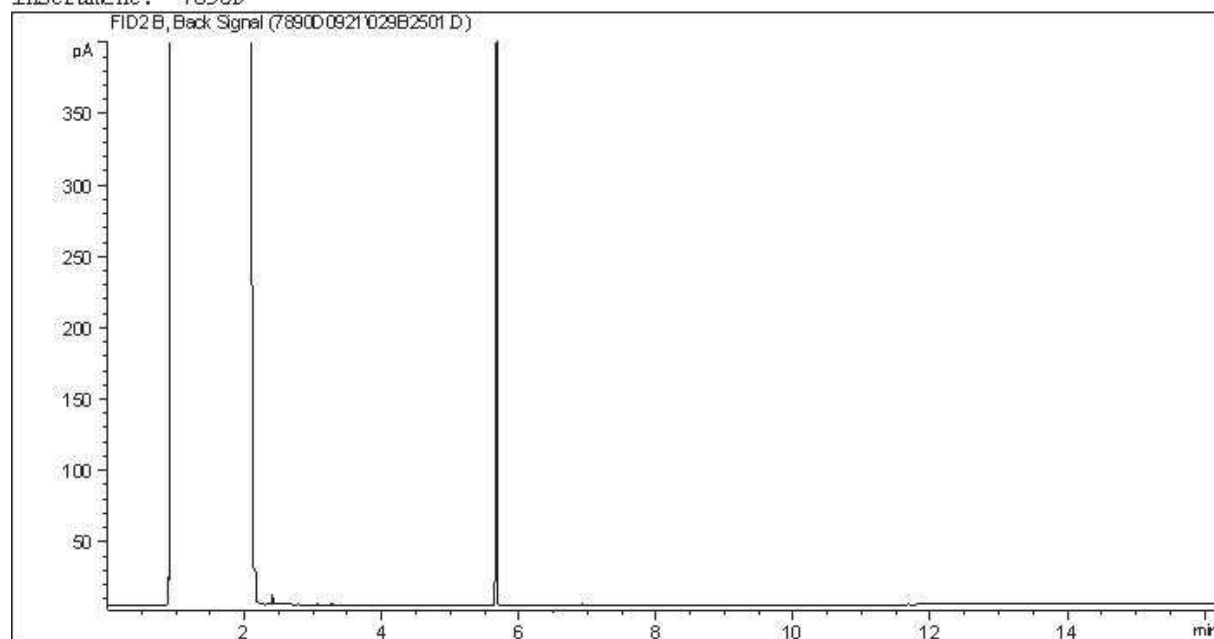
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

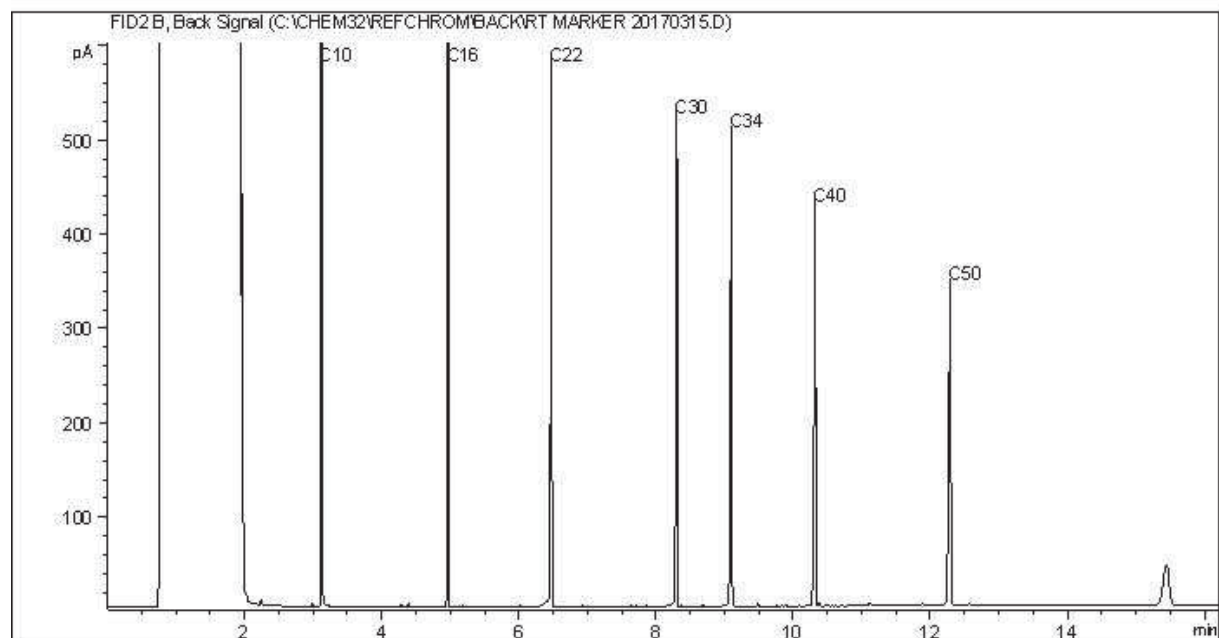
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



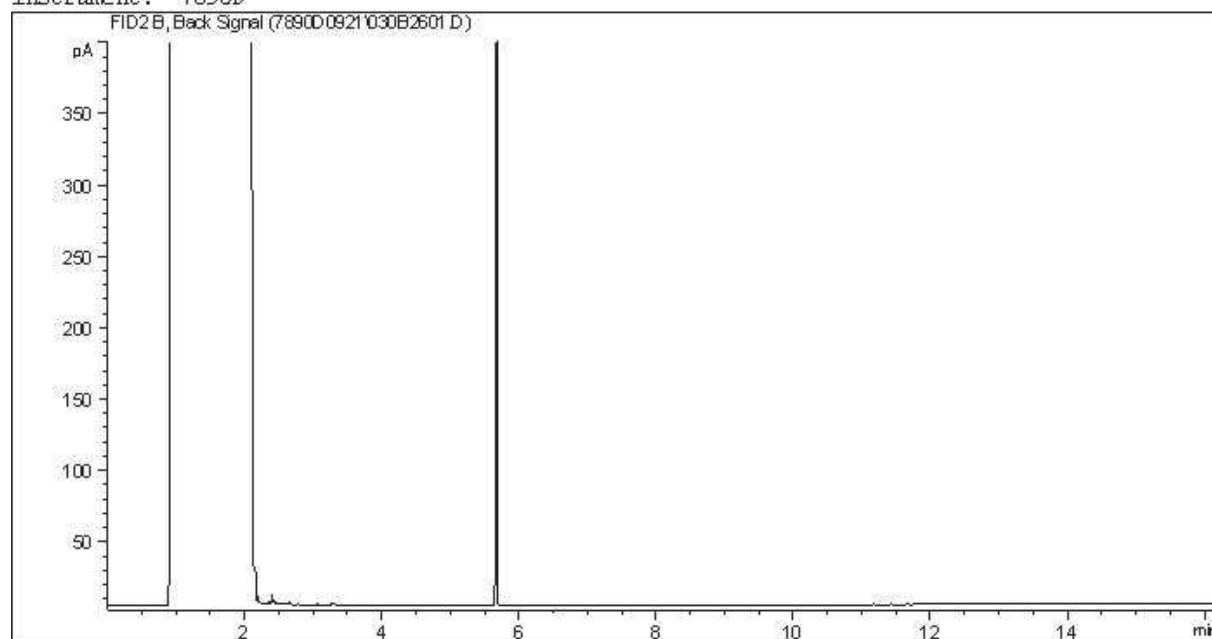
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

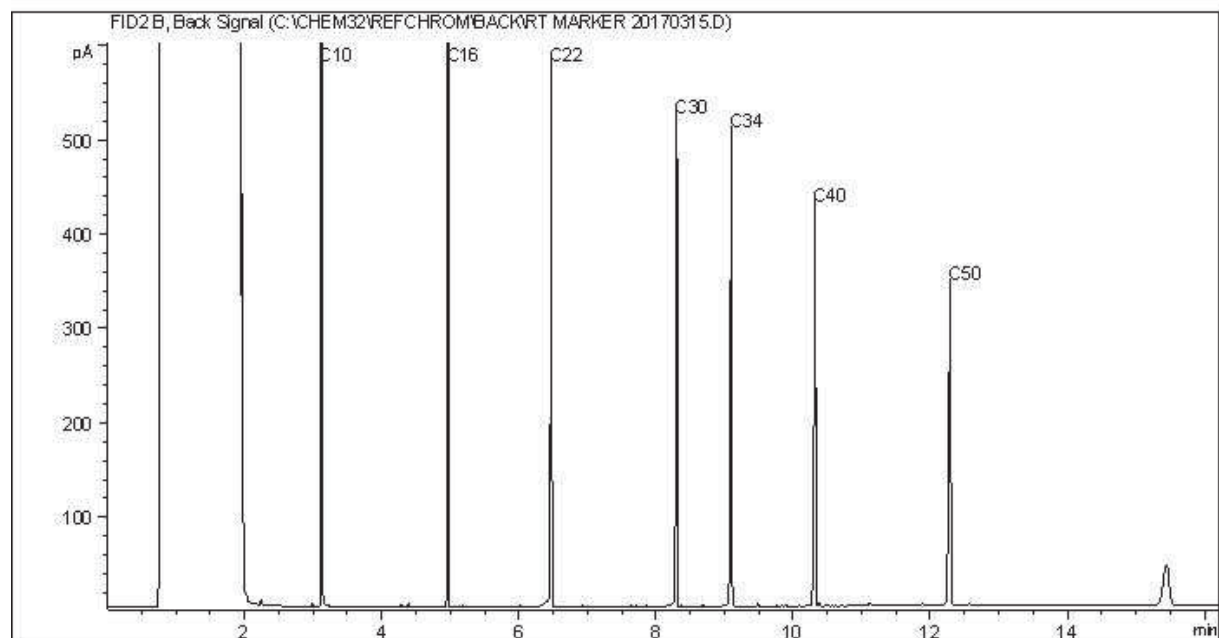
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



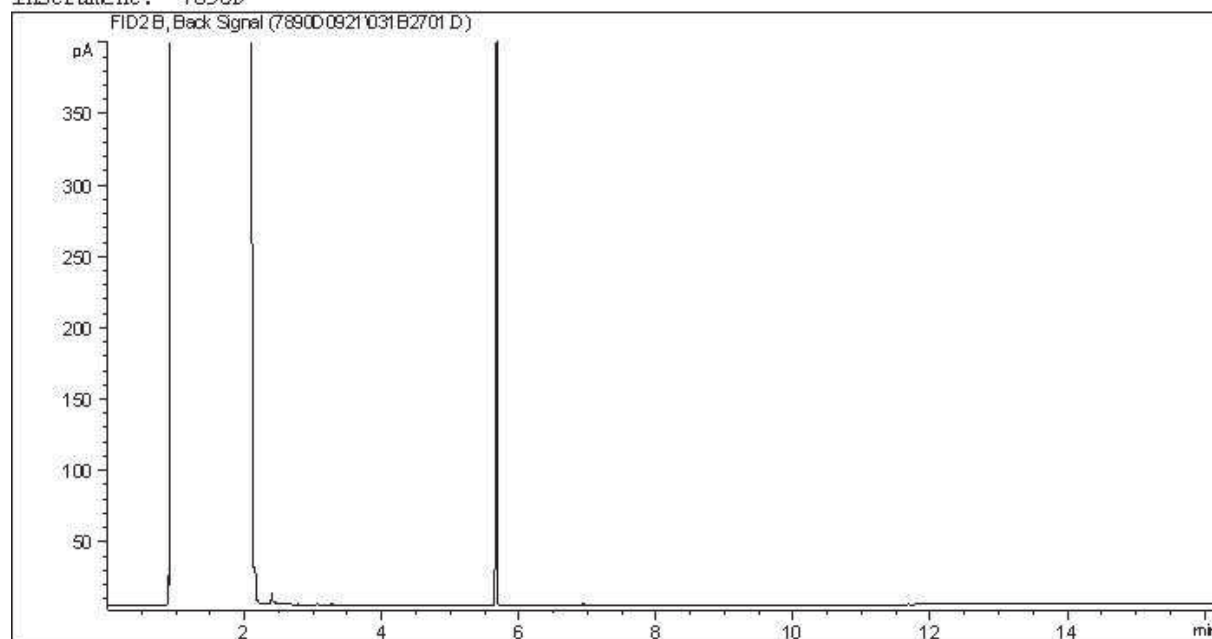
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

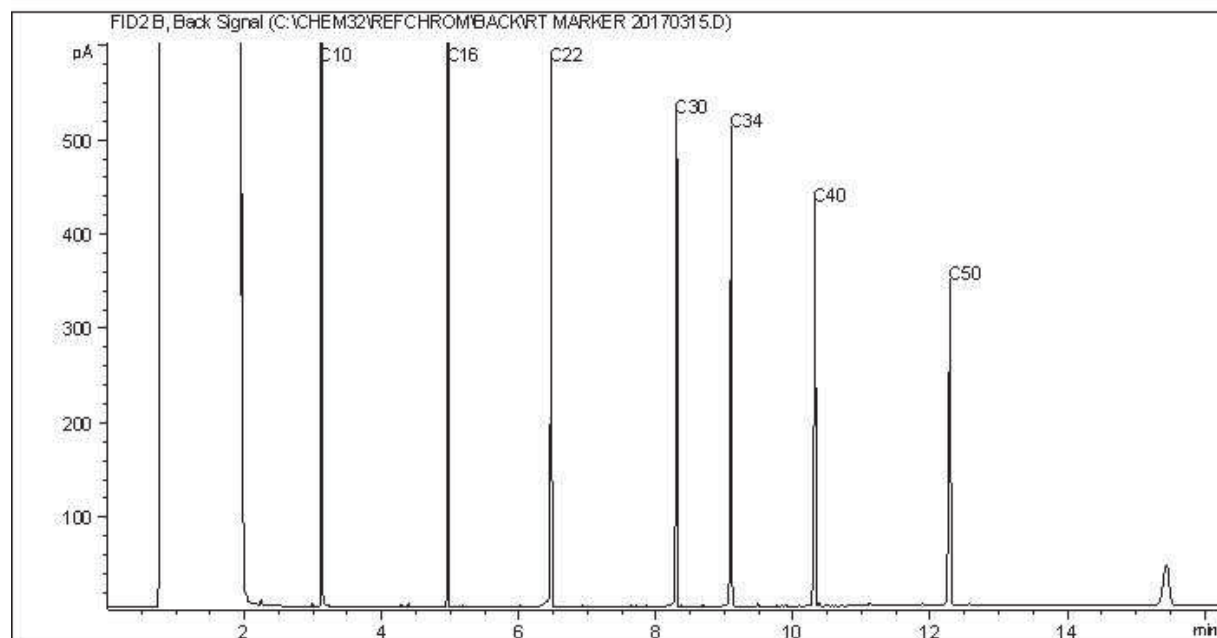
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



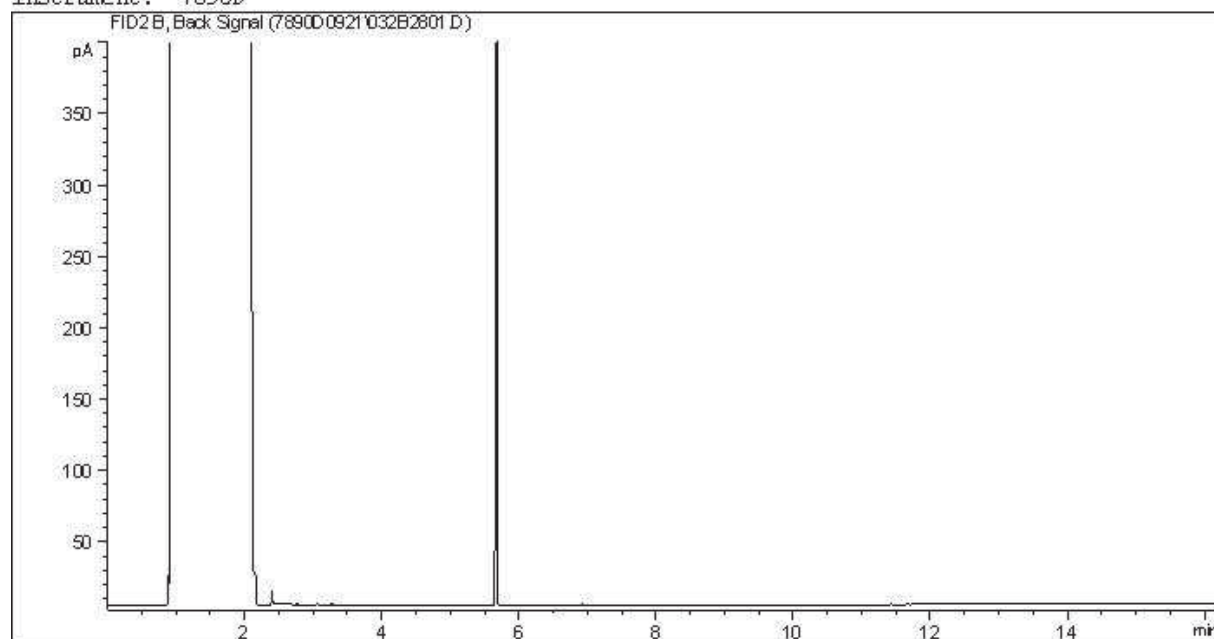
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

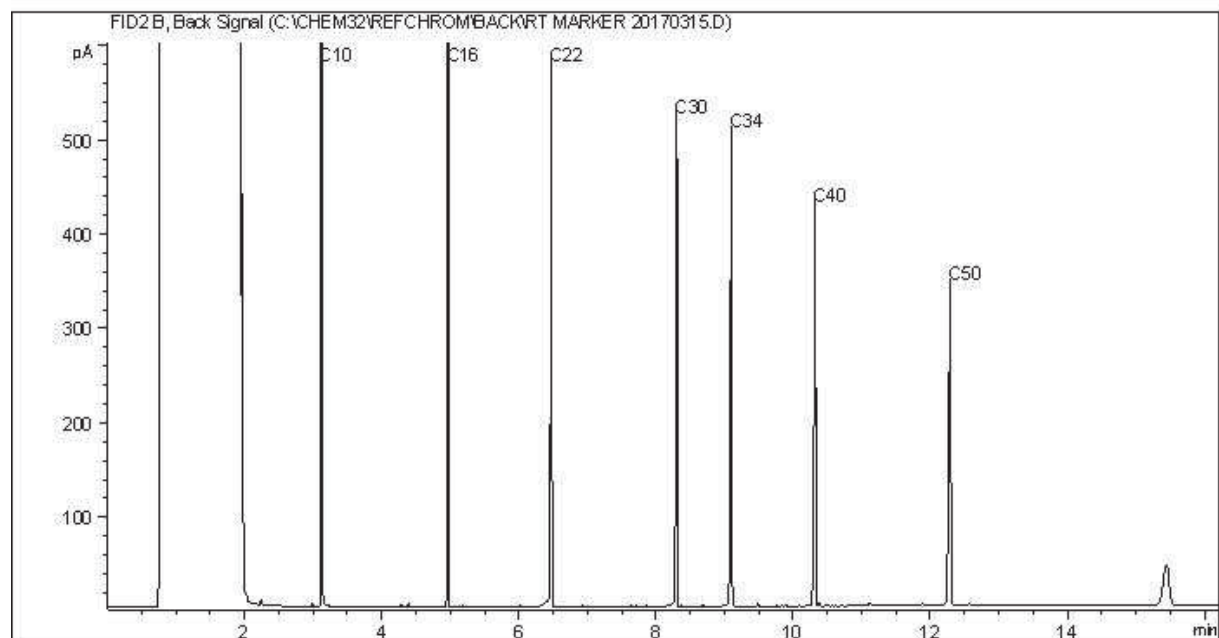
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 14-Sep-17, 13-Sep-17, 12-Sep-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407074-00828.400

Sample Submission Number: B780017

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	All field QC samples met alert limits.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD	x			

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 16-Nov-17

Data Reviewed by (Signature):



Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526
Your C.O.C. #: 294841

Report Date: 2017/08/24

Report #: R2433669

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769793

Received: 2017/08/17, 09:35

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	3	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	5	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	4	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	4	AB SOP-00020	SM 22 4500-Cl-E m
Chloride (Cl) and Sulphate (SO ₄) by IC	1	AB SOP-00026	SM 22 4110 B m
Conductivity @25C	4	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	5	AB SOP-00037	CCME PHC-CWS m
Hardness	3	AB WI-00065	Auto Calc
Elements by ICP - Dissolved (2)	4	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	4	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	3	AB WI-00065	Auto Calc
Nitrate and Nitrite	4	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	4	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	4	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (3)	1	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	1	AB SOP-00037 / AB SOP-00003	EPA 3510C/8270D m
Phenols (4-AAP)	3	EENSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	4	AB SOP-00018	SM 22 4500-SO ₄ E m
Total Dissolved Solids (Filt. Residue)	3	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526
Your C.O.C. #: 294841

Report Date: 2017/08/24

Report #: R2433669

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769793

Received: 2017/08/17, 09:35

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

(3) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key



Jenna Chernuka
Project Manager
24 Aug 2017 16:04:43

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT4254	RT4254	RT4255	RT4256	RT4257	RT4257		
Sampling Date		2017/08/15 17:30	2017/08/15 17:30	2017/08/15 12:25	2017/08/15 11:25	2017/08/15 11:15	2017/08/15 11:15		
COC Number		294841	294841	294841	294841	294841	294841		
	UNITS	NWD 17-06	NWD 17-06 Lab-Dup	BI-13-2-4.5	BIWS-16-1-4	BI-13-3-4.5	BI-13-3-4.5 Lab-Dup	RDL	QC Batch
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10		0.10	8730508
Volatiles									
Benzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8730681
Toluene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8730681
Ethylbenzene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8730681
m & p-Xylene	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8730681
o-Xylene	mg/L	<0.00040		<0.00040	<0.00040	<0.00040	<0.00040	0.00040	8730681
Xylenes (Total)	mg/L	<0.00080		<0.00080	<0.00080	<0.00080	<0.00080	0.00080	8730681
F1 (C6-C10) - BTEX	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8730681
F1 (C6-C10)	mg/L	<0.10		<0.10	<0.10	<0.10	<0.10	0.10	8730681
Extraction Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	99	102	111	105	109			8730508
Instrument Surrogate Recovery (%)									
1,4-Difluorobenzene (sur.)	%	102		102	106	100	100		8730681
4-Bromofluorobenzene (sur.)	%	102		101	102	103	102		8730681
D4-1,2-Dichloroethane (sur.)	%	106		109	105	107	106		8730681
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate									

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT4258		
Sampling Date		2017/08/15 16:30		
COC Number		294841		
	UNITS	NWR 09-4-5	RDL	QC Batch
Ext. Pet. Hydrocarbon				
F2 (C10-C16 Hydrocarbons)	mg/L	1.2	0.10	8730089
Volatiles				
Benzene	mg/L	0.54	0.00040	8730681
Toluene	mg/L	0.0015	0.00040	8730681
Ethylbenzene	mg/L	0.0029	0.00040	8730681
m & p-Xylene	mg/L	0.058	0.00080	8730681
o-Xylene	mg/L	0.0050	0.00040	8730681
Xylenes (Total)	mg/L	0.063	0.00080	8730681
F1 (C6-C10) - BTEX	mg/L	0.70	0.10	8730681
F1 (C6-C10)	mg/L	1.3	0.10	8730681
Extraction Surrogate Recovery (%)				
O-TERPHENYL (sur.)	%	103		8730089
Instrument Surrogate Recovery (%)				
1,4-Difluorobenzene (sur.)	%	95		8730681
4-Bromofluorobenzene (sur.)	%	115		8730681
D4-1,2-Dichloroethane (sur.)	%	109		8730681
RDL = Reportable Detection Limit				

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4255	RT4255	RT4256	RT4257	RT4258		
Sampling Date		2017/08/15 12:25	2017/08/15 12:25	2017/08/15 11:25	2017/08/15 11:15	2017/08/15 16:30		
COC Number		294841	294841	294841	294841	294841		
	UNITS	BI-13-2-4.5	BI-13-2-4.5 Lab-Dup	BIWS-16-1-4	BI-13-3-4.5	NWR 09-4-5	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	<0.000020		<0.000020	0.00017	<0.000020	0.000020	8729385
Elements								
Dissolved Aluminum (Al)	mg/L	0.018	0.018	0.0056	0.0090	0.072	0.0030	8734663
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	0.00073	0.00060	8734663
Dissolved Arsenic (As)	mg/L	0.0082	0.0084	0.0022	0.0012	0.12	0.00020	8734663
Dissolved Barium (Ba)	mg/L	0.19		0.019	0.069	0.80	0.010	8735440
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8734663
Dissolved Boron (B)	mg/L	<0.020		<0.020	<0.020	0.067	0.020	8735440
Dissolved Calcium (Ca)	mg/L	240		470	280	180	0.30	8735440
Dissolved Chromium (Cr)	mg/L	0.0011	0.0011	<0.0010	<0.0010	0.0015	0.0010	8734663
Dissolved Cobalt (Co)	mg/L	0.0069	0.0071	0.032	0.0033	0.0036	0.00030	8734663
Dissolved Copper (Cu)	mg/L	0.00061	0.00063	0.0014	0.0025	0.00048	0.00020	8734663
Dissolved Iron (Fe)	mg/L	43		69	1.0	88	0.060	8735440
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.0022	0.00020	8734663
Dissolved Lithium (Li)	mg/L	<0.020		0.021	<0.020	<0.020	0.020	8735440
Dissolved Magnesium (Mg)	mg/L	76		130	150	46	0.20	8735440
Dissolved Manganese (Mn)	mg/L	0.94		1.7	0.64	7.0	0.0040	8735440
Dissolved Molybdenum (Mo)	mg/L	0.0048	0.0050	0.00068	0.019	0.00067	0.00020	8734663
Dissolved Nickel (Ni)	mg/L	0.016	0.016	0.035	0.022	0.0061	0.00050	8734663
Dissolved Phosphorus (P)	mg/L	<0.10		<0.10	<0.10	<0.10	0.10	8735440
Dissolved Potassium (K)	mg/L	2.0		4.0	3.6	2.0	0.30	8735440
Dissolved Selenium (Se)	mg/L	0.0012	0.0014	0.00056	0.0018	0.0010	0.00020	8734663
Dissolved Silicon (Si)	mg/L	6.6		7.2	6.0	5.0	0.10	8735440
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010	8734663
Dissolved Sodium (Na)	mg/L	20		28	15	35	0.50	8735440
Dissolved Strontium (Sr)	mg/L	1.6		1.7	0.90	0.88	0.020	8735440
Dissolved Sulphur (S)	mg/L	87		330	300	2.9	0.20	8735440
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020	8734663
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	8734663
Dissolved Titanium (Ti)	mg/L	0.0013	0.0014	<0.0010	<0.0010	0.0013	0.0010	8734663
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B769793
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REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4255	RT4255	RT4256	RT4257	RT4258		
Sampling Date		2017/08/15 12:25	2017/08/15 12:25	2017/08/15 11:25	2017/08/15 11:15	2017/08/15 16:30		
COC Number		294841	294841	294841	294841	294841		
	UNITS	BI-13-2-4.5	BI-13-2-4.5 Lab-Dup	BIWS-16-1-4	BI-13-3-4.5	NWR 09-4-5	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0018	0.0018	0.0093	0.010	0.00019	0.00010	8734663
Dissolved Vanadium (V)	mg/L	0.0020	0.0019	<0.0010	0.0011	0.0043	0.0010	8734663
Dissolved Zinc (Zn)	mg/L	0.0047	0.0049	0.020	0.015	0.0091	0.0030	8734663
RDL = Reportable Detection Limit								
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B769793
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WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT4255	RT4255			RT4256		RT4257		
Sampling Date		2017/08/15 12:25	2017/08/15 12:25			2017/08/15 11:25		2017/08/15 11:15		
COC Number		294841	294841			294841		294841		
	UNITS	BI-13-2-4.5	BI-13-2-4.5 Lab-Dup	RDL	QC Batch	BIWS-16-1-4	RDL	BI-13-3-4.5	RDL	QC Batch
Calculated Parameters										
Hardness (CaCO ₃)	mg/L	910		0.50	8730136	1700	0.50	1300	0.50	8730136
Ion Balance (% Difference)	%	5.7		N/A	8729972	2.8	N/A	2.2	N/A	8729972
Dissolved Nitrate (NO ₃)	mg/L	<0.044		0.044	8729911	<0.22	0.22	0.38	0.044	8730304
Nitrate plus Nitrite (N)	mg/L	<0.014		0.014	8729973	<0.071	0.071	0.085	0.014	8729973
Dissolved Nitrite (NO ₂)	mg/L	<0.033		0.033	8729911	<0.16	0.16	<0.033	0.033	8730304
Misc. Inorganics										
Conductivity	uS/cm	1500	1500	1.0	8731246	2800	1.0	2000	1.0	8731246
Total Dissolved Solids	mg/L	1200		10	8730538	2300	10	1700	10	8730538
Anions										
Alkalinity (PP as CaCO ₃)	mg/L	<0.50	<0.50	0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Alkalinity (Total as CaCO ₃)	mg/L	640	640	0.50	8731243	530	0.50	410	0.50	8731243
Bicarbonate (HCO ₃)	mg/L	780	780	0.50	8731243	640	0.50	500	0.50	8731243
Carbonate (CO ₃)	mg/L	<0.50	<0.50	0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Hydroxide (OH)	mg/L	<0.50	<0.50	0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Dissolved Sulphate (SO ₄)	mg/L	250 (1)		5.0	8733346	980 (1)	5.0	850 (1)	5.0	8733346
Dissolved Chloride (Cl)	mg/L	16		1.0	8733338	180 (2)	2.0	8.7	1.0	8733338
Nutrients										
Dissolved Nitrite (N)	mg/L	<0.010		0.010	8732073	<0.050 (3)	0.050	<0.010	0.010	8732073
Dissolved Nitrate (N)	mg/L	<0.010		0.010	8732073	<0.050 (3)	0.050	0.085	0.010	8732073
Misc. Organics										
Phenols	mg/L	0.020		0.0020	8735489	0.014	0.0020	0.0093	0.0020	8735489
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range. (2) Detection limits raised due to matrix interference. (3) Detection limits raised due to sample matrix.										

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RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT4258	RT4258		
Sampling Date		2017/08/15 16:30	2017/08/15 16:30		
COC Number		294841	294841		
	UNITS	NWR 09-4-5	NWR 09-4-5 Lab-Dup	RDL	QC Batch
Calculated Parameters					
Dissolved Nitrate (NO3)	mg/L	<0.22		0.22	8730304
Nitrate plus Nitrite (N)	mg/L	<0.071		0.071	8729973
Dissolved Nitrite (NO2)	mg/L	<0.16		0.16	8730304
Misc. Inorganics					
Conductivity	uS/cm	1400		1.0	8731061
Anions					
Dissolved Sulphate (SO4)	mg/L	2.2	2.0	0.50	8734641
Dissolved Chloride (Cl)	mg/L	15		1.0	8733338
Nutrients					
Dissolved Nitrite (N)	mg/L	<0.050 (1)		0.050	8732073
Dissolved Nitrate (N)	mg/L	<0.050 (1)		0.050	8732073
RDL = Reportable Detection Limit					
Lab-Dup = Laboratory Initiated Duplicate					
(1) Detection limits raised due to sample matrix.					

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		RT4258		
Sampling Date		2017/08/15 16:30		
COC Number		294841		
	UNITS	NWR 09-4-5	RDL	QC Batch
Polycyclic Aromatics				
Benzo[a]pyrene equivalency	mg/L	<0.000010	0.000010	8729776
Acenaphthene	mg/L	<0.00010	0.00010	8730088
Acenaphthylene	mg/L	<0.00010	0.00010	8730088
Acridine	mg/L	<0.000050	0.000050	8730088
Anthracene	mg/L	<0.000010	0.000010	8730088
Benzo(a)anthracene	mg/L	<0.0000085	0.0000085	8730088
Benzo(b&j)fluoranthene	mg/L	<0.0000085	0.0000085	8730088
Benzo(k)fluoranthene	mg/L	<0.0000085	0.0000085	8730088
Benzo(g,h,i)perylene	mg/L	<0.0000085	0.0000085	8730088
Benzo(c)phenanthrene	mg/L	<0.000050	0.000050	8730088
Benzo(a)pyrene	mg/L	<0.0000075	0.0000075	8730088
Benzo[e]pyrene	mg/L	<0.000050	0.000050	8730088
Chrysene	mg/L	<0.0000085	0.0000085	8730088
Dibenz(a,h)anthracene	mg/L	<0.0000075	0.0000075	8730088
Fluoranthene	mg/L	<0.000010	0.000010	8730088
Fluorene	mg/L	0.000061	0.000050	8730088
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	0.0000085	8730088
1-Methylnaphthalene	mg/L	0.00097	0.00010	8730088
2-Methylnaphthalene	mg/L	0.00076	0.00010	8730088
Naphthalene	mg/L	0.00074	0.00010	8730088
Phenanthrene	mg/L	<0.000050	0.000050	8730088
Perylene	mg/L	<0.000050	0.000050	8730088
Pyrene	mg/L	0.000024	0.000020	8730088
Quinoline	mg/L	<0.00020	0.00020	8730088
Extraction Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	89		8730088
D8-ACENAPHTHYLENE (sur.)	%	71		8730088
D8-NAPHTHALENE (sur.)	%	41 (1)		8730088
RDL = Reportable Detection Limit				
(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.				

Maxxam Job #: B769793
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WORLEY PARSONS
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SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		RT4258		
Sampling Date		2017/08/15 16:30		
COC Number		294841		
	UNITS	NWR 09-4-5	RDL	QC Batch
TERPHENYL-D14 (sur.)	%	83		8730088
RDL = Reportable Detection Limit				

Maxxam Job #: B769793
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WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT4254
Sample ID: NWD 17-06
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova

Maxxam ID: RT4254 Dup
Sample ID: NWD 17-06
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova

Maxxam ID: RT4255
Sample ID: BI-13-2-4.5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733338	N/A	2017/08/22	Ashley Fedoriuk
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735440	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8729972	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8729911	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733346	N/A	2017/08/22	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8730538	2017/08/18	2017/08/22	Kruti Patel

Maxxam ID: RT4255 Dup
Sample ID: BI-13-2-4.5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
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TEST SUMMARY

Maxxam ID: RT4256
Sample ID: BIWS-16-1-4
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733338	N/A	2017/08/22	Ashley Fedoriuk
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735440	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8729972	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733346	N/A	2017/08/22	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8730538	2017/08/18	2017/08/22	Kruti Patel

Maxxam ID: RT4257
Sample ID: BI-13-3-4.5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733338	N/A	2017/08/22	Ashley Fedoriuk
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735440	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8729972	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733346	N/A	2017/08/22	Ashley Fedoriuk
Total Dissolved Solids (Filt. Residue)	BAL	8730538	2017/08/18	2017/08/22	Kruti Patel

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
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Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT4257 Dup
Sample ID: BI-13-3-4.5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu

Maxxam ID: RT4258
Sample ID: NWR 09-4-5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730681	N/A	2017/08/18	Ying (Emma) Zhu
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733338	N/A	2017/08/22	Ashley Fedoriuk
Chloride (Cl) and Sulphate (SO4) by IC	IC/EC	8734641	N/A	2017/08/22	Mahesh Ranjan
Conductivity @25C	COND	8731061	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730089	2017/08/18	2017/08/19	Kelsey Holt
Elements by ICP - Dissolved	ICPA	8735440	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8729776	N/A	2017/08/22	Automated Statchk
PAH in Water by GC/MS	GC/MS	8730088	2017/08/18	2017/08/21	Bert Chi

Maxxam ID: RT4258 Dup
Sample ID: NWR 09-4-5
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (Cl) and Sulphate (SO4) by IC	IC/EC	8734641	N/A	2017/08/22	Mahesh Ranjan

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WORLEY PARSONS
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.3°C

Sample RT4255 [BI-13-2-4.5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4256 [BIWS-16-1-4] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4257 [BI-13-3-4.5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4258 [NWR 09-4-5] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

Maxxam Job #: B769793
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
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Project #: 407011-00526

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8730088	BC5	Method Blank	D10-ANTHRACENE (sur.)	2017/08/20		97	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/20		118	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/20		81	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/20		60	%	50 - 130
			Acenaphthene	2017/08/20	<0.00010		mg/L	
			Acenaphthylene	2017/08/20	<0.00010		mg/L	
			Acridine	2017/08/20	<0.000050		mg/L	
			Anthracene	2017/08/20	<0.000010		mg/L	
			Benzo(a)anthracene	2017/08/20	<0.0000085		mg/L	
			Benzo(b&j)fluoranthene	2017/08/20	<0.0000085		mg/L	
			Benzo(k)fluoranthene	2017/08/20	<0.0000085		mg/L	
			Benzo(g,h,i)perylene	2017/08/20	<0.0000085		mg/L	
			Benzo(c)phenanthrene	2017/08/20	<0.000050		mg/L	
			Benzo(a)pyrene	2017/08/20	<0.0000075		mg/L	
			Benzo[e]pyrene	2017/08/20	<0.000050		mg/L	
			Chrysene	2017/08/20	<0.0000085		mg/L	
			Dibenz(a,h)anthracene	2017/08/20	<0.0000075		mg/L	
			Fluoranthene	2017/08/20	<0.000010		mg/L	
			Fluorene	2017/08/20	<0.000050		mg/L	
			Indeno(1,2,3-cd)pyrene	2017/08/20	<0.0000085		mg/L	
			1-Methylnaphthalene	2017/08/20	<0.00010		mg/L	
			2-Methylnaphthalene	2017/08/20	<0.00010		mg/L	
			Naphthalene	2017/08/20	<0.00010		mg/L	
			Phenanthrene	2017/08/20	<0.000050		mg/L	
			Perylene	2017/08/20	<0.000050		mg/L	
			Pyrene	2017/08/20	<0.000020		mg/L	
			Quinoline	2017/08/20	<0.00020		mg/L	
8730089	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/19		104	%	60 - 130
8730508	JR1	Method Blank	F2 (C10-C16 Hydrocarbons)	2017/08/19	<0.10		mg/L	
			F2 (C10-C16 Hydrocarbons)	2017/08/18	<0.10	103	%	60 - 130
8730538	KPG	Method Blank	Total Dissolved Solids	2017/08/22	<10		mg/L	
8730681	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/18		102	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/18		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/18		102	%	70 - 130
			Benzene	2017/08/18	<0.00040		mg/L	
			Toluene	2017/08/18	<0.00040		mg/L	
			Ethylbenzene	2017/08/18	<0.00040		mg/L	
			m & p-Xylene	2017/08/18	<0.00080		mg/L	
			o-Xylene	2017/08/18	<0.00040		mg/L	
			Xylenes (Total)	2017/08/18	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/18	<0.10		mg/L	
			F1 (C6-C10)	2017/08/18	<0.10		mg/L	
8731061	AF6	Method Blank	Conductivity	2017/08/18	<1.0		uS/cm	
8731243	AF6	Method Blank	Alkalinity (Total as CaCO3)	2017/08/18	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/18	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/18	<0.50		mg/L	
			Carbonate (CO3)	2017/08/18	<0.50		mg/L	
			Hydroxide (OH)	2017/08/18	<0.50		mg/L	
8731246	AF6	Method Blank	Conductivity	2017/08/18	<1.0		uS/cm	
8732073	MSD	Method Blank	Dissolved Nitrite (N)	2017/08/19	<0.010		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8733338	AF6	Method Blank	Dissolved Nitrate (N)	2017/08/19	<0.010		mg/L	
8733346	AF6	Method Blank	Dissolved Chloride (Cl)	2017/08/22	<1.0		mg/L	
8734641	MSD	Method Blank	Dissolved Sulphate (SO4)	2017/08/22	<1.0		mg/L	
8734663	APY	Method Blank	Dissolved Sulphate (SO4)	2017/08/22	<0.50		mg/L	
			Dissolved Aluminum (Al)	2017/08/24	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/24	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/24	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/24	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/24	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/24	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/24	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/24	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/24	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/24	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/24	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/24	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/24	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/24	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/24	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/24	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/24	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/24	<0.0010		mg/L	
8735440	JK9	Method Blank	Dissolved Iron (Fe)	2017/08/23	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/23	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/23	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/23	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/23	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/23	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/23	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/23	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/23	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/23	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/23	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/23	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/23	<0.30		mg/L	
8735489	YY	Method Blank	Phenols	2017/08/23	<0.0020		mg/L	
8730508	JR1	RPD [RT4254-01]	F2 (C10-C16 Hydrocarbons)	2017/08/18	NC		%	30
8731243	AF6	RPD [RT4255-01]	Alkalinity (Total as CaCO3)	2017/08/18	0.018		%	20
			Alkalinity (PP as CaCO3)	2017/08/18	NC		%	20
			Bicarbonate (HCO3)	2017/08/18	0.018		%	20
			Carbonate (CO3)	2017/08/18	NC		%	20
			Hydroxide (OH)	2017/08/18	NC		%	20
8731246	AF6	RPD [RT4255-01]	Conductivity	2017/08/18	0.20		%	10
8734663	APY	RPD [RT4255-03]	Dissolved Aluminum (Al)	2017/08/22	0.84		%	20
			Dissolved Chromium (Cr)	2017/08/22	4.9		%	20
			Dissolved Cobalt (Co)	2017/08/22	2.8		%	20
			Dissolved Copper (Cu)	2017/08/22	2.7		%	20
			Dissolved Lead (Pb)	2017/08/22	NC		%	20
			Dissolved Antimony (Sb)	2017/08/22	NC		%	20
			Dissolved Molybdenum (Mo)	2017/08/22	5.2		%	20
			Dissolved Nickel (Ni)	2017/08/22	1.8		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8730681	YZ3	RPD [RT4257-06]	Dissolved Selenium (Se)	2017/08/22	14		%	20
			Dissolved Silver (Ag)	2017/08/22	NC		%	20
			Dissolved Arsenic (As)	2017/08/22	2.0		%	20
			Dissolved Thallium (Tl)	2017/08/22	NC		%	20
			Dissolved Tin (Sn)	2017/08/22	NC		%	20
			Dissolved Titanium (Ti)	2017/08/22	9.3		%	20
			Dissolved Uranium (U)	2017/08/22	0.28		%	20
			Dissolved Vanadium (V)	2017/08/22	3.4		%	20
			Dissolved Zinc (Zn)	2017/08/22	2.7		%	20
			Dissolved Beryllium (Be)	2017/08/22	NC		%	20
			Benzene	2017/08/18	NC		%	30
			Toluene	2017/08/18	NC		%	30
			Ethylbenzene	2017/08/18	NC		%	30
			m & p-Xylene	2017/08/18	NC		%	30
			o-Xylene	2017/08/18	NC		%	30
			Xylenes (Total)	2017/08/18	NC		%	30
8734641	MSD	RPD [RT4258-01]	F1 (C6-C10) - BTEX	2017/08/18	NC		%	30
			F1 (C6-C10)	2017/08/18	NC		%	30
8730508	JR1	Matrix Spike [RT4256-05]	Dissolved Sulphate (SO4)	2017/08/22	11		%	20
8730681	YZ3	Matrix Spike [RT4258-04]	O-TERPHENYL (sur.)	2017/08/18		115	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/18		106	%	60 - 130
			1,4-Difluorobenzene (sur.)	2017/08/18		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/18		117	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/18		108	%	70 - 130
			Benzene	2017/08/18		NC	%	70 - 130
			Toluene	2017/08/18		99	%	70 - 130
			Ethylbenzene	2017/08/18		105	%	70 - 130
			m & p-Xylene	2017/08/18		104	%	70 - 130
			o-Xylene	2017/08/18		102	%	70 - 130
8734641	MSD	Matrix Spike [RT4258-01]	F1 (C6-C10)	2017/08/18		74	%	70 - 130
			Dissolved Sulphate (SO4)	2017/08/22		103	%	75 - 125
8734663	APY	Matrix Spike [RT4255-03]	Dissolved Aluminum (Al)	2017/08/22		101	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/22		95	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/22		94	%	80 - 120
			Dissolved Copper (Cu)	2017/08/22		92	%	80 - 120
			Dissolved Lead (Pb)	2017/08/22		94	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/22		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/22		101	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/22		93	%	80 - 120
			Dissolved Selenium (Se)	2017/08/22		101	%	80 - 120
			Dissolved Silver (Ag)	2017/08/22		80	%	80 - 120
			Dissolved Arsenic (As)	2017/08/22		97	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/22		98	%	80 - 120
			Dissolved Tin (Sn)	2017/08/22		95	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/22		99	%	80 - 120
			Dissolved Uranium (U)	2017/08/22		100	%	80 - 120
			Dissolved Vanadium (V)	2017/08/22		99	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/22		92	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/22		95	%	80 - 120
8730088	BC5	LCS	D10-ANTHRACENE (sur.)	2017/08/20		112	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/20		140 (1)	%	50 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			D8-ACENAPHTHYLENE (sur.)	2017/08/20		96	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/20		87	%	50 - 130
			Acenaphthene	2017/08/20		91	%	50 - 130
			Acenaphthylene	2017/08/20		94	%	50 - 130
			Acridine	2017/08/20		100	%	50 - 130
			Anthracene	2017/08/20		106	%	50 - 130
			Benzo(a)anthracene	2017/08/20		132 (1)	%	50 - 130
			Benzo(b&j)fluoranthene	2017/08/20		128	%	50 - 130
			Benzo(k)fluoranthene	2017/08/20		128	%	50 - 130
			Benzo(g,h,i)perylene	2017/08/20		123	%	50 - 130
			Benzo(c)phenanthrene	2017/08/20		129	%	50 - 130
			Benzo(a)pyrene	2017/08/20		121	%	50 - 130
			Benzo[e]pyrene	2017/08/20		135 (1)	%	50 - 130
			Chrysene	2017/08/20		123	%	50 - 130
			Dibenz(a,h)anthracene	2017/08/20		127	%	50 - 130
			Fluoranthene	2017/08/20		106	%	50 - 130
			Fluorene	2017/08/20		93	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2017/08/20		111	%	50 - 130
			2-Methylnaphthalene	2017/08/20		88	%	50 - 130
			Naphthalene	2017/08/20		79	%	50 - 130
			Phenanthrene	2017/08/20		101	%	50 - 130
			Perylene	2017/08/20		128	%	50 - 130
			Pyrene	2017/08/20		99	%	50 - 130
			Quinoline	2017/08/20		96	%	50 - 130
8730089	KHO	LCS	O-TERPHENYL (sur.)	2017/08/19		97	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19		107	%	70 - 130
8730508	JR1	LCS	O-TERPHENYL (sur.)	2017/08/18		103	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/18		104	%	70 - 130
8730538	KPG	LCS	Total Dissolved Solids	2017/08/22		102	%	80 - 120
8730681	YZ3	LCS	1,4-Difluorobenzene (sur.)	2017/08/18		100	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/18		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/18		102	%	70 - 130
			Benzene	2017/08/18		108	%	70 - 130
			Toluene	2017/08/18		100	%	70 - 130
			Ethylbenzene	2017/08/18		108	%	70 - 130
			m & p-Xylene	2017/08/18		109	%	70 - 130
			o-Xylene	2017/08/18		102	%	70 - 130
			F1 (C6-C10)	2017/08/18		104	%	70 - 130
8731061	AF6	LCS	Conductivity	2017/08/18		100	%	90 - 110
8731243	AF6	LCS	Alkalinity (Total as CaCO3)	2017/08/18		98	%	80 - 120
8731246	AF6	LCS	Conductivity	2017/08/18		98	%	90 - 110
8732073	MSD	LCS	Dissolved Nitrite (N)	2017/08/19		101	%	80 - 120
			Dissolved Nitrate (N)	2017/08/19		101	%	80 - 120
8733338	AF6	LCS	Dissolved Chloride (Cl)	2017/08/22		106	%	80 - 120
8733346	AF6	LCS	Dissolved Sulphate (SO4)	2017/08/22		109	%	80 - 120
8734641	MSD	LCS	Dissolved Sulphate (SO4)	2017/08/22		105	%	75 - 125
8734663	APY	LCS	Dissolved Aluminum (Al)	2017/08/23		98	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/23		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/23		99	%	80 - 120
			Dissolved Copper (Cu)	2017/08/23		98	%	80 - 120
			Dissolved Lead (Pb)	2017/08/23		98	%	80 - 120

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8735440	JK9	LCS	Dissolved Antimony (Sb)	2017/08/23		100	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/23		99	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/23		98	%	80 - 120
			Dissolved Selenium (Se)	2017/08/23		99	%	80 - 120
			Dissolved Silver (Ag)	2017/08/23		99	%	80 - 120
			Dissolved Arsenic (As)	2017/08/23		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/23		98	%	80 - 120
			Dissolved Tin (Sn)	2017/08/23		99	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/23		101	%	80 - 120
			Dissolved Uranium (U)	2017/08/23		96	%	80 - 120
			Dissolved Vanadium (V)	2017/08/23		100	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/23		102	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/23		98	%	80 - 120
			Dissolved Iron (Fe)	2017/08/23		94	%	80 - 120
			Dissolved Lithium (Li)	2017/08/23		91	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/23		101	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/23		94	%	80 - 120
			Dissolved Potassium (K)	2017/08/23		98	%	80 - 120
			Dissolved Sodium (Na)	2017/08/23		98	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/23		93	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/23		98	%	80 - 120
			Dissolved Barium (Ba)	2017/08/23		92	%	80 - 120
			Dissolved Silicon (Si)	2017/08/23		103	%	80 - 120
			Dissolved Boron (B)	2017/08/23		96	%	80 - 120
8735489	YY	LCS	Dissolved Calcium (Ca)	2017/08/23		97	%	80 - 120
			Phenols	2017/08/23		85	%	80 - 120

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.

LCS: 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 $\leq 2 \times \text{RDL}$).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



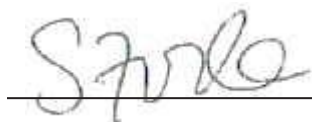
Daniel Reslan, cCT, QP, Organics Supervisor



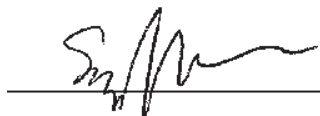
Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor



Suwan Fock, B.Sc., QP, Inorganics Senior Analyst



Sandy Yuan, M.Sc., Scientific Specialist

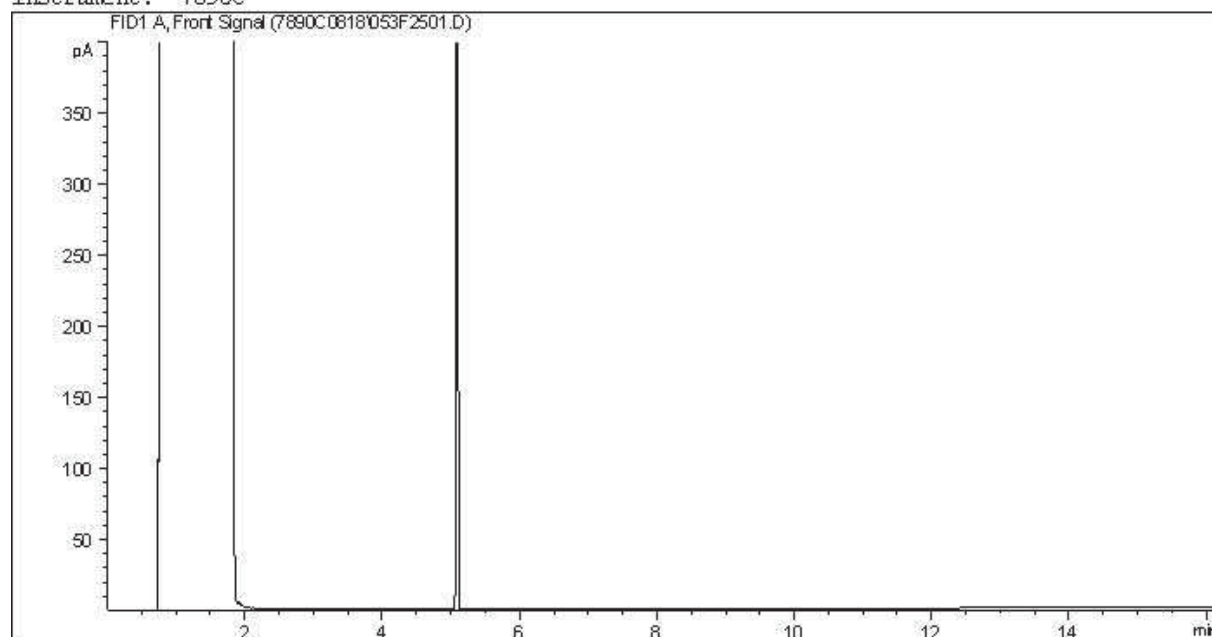
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Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4254

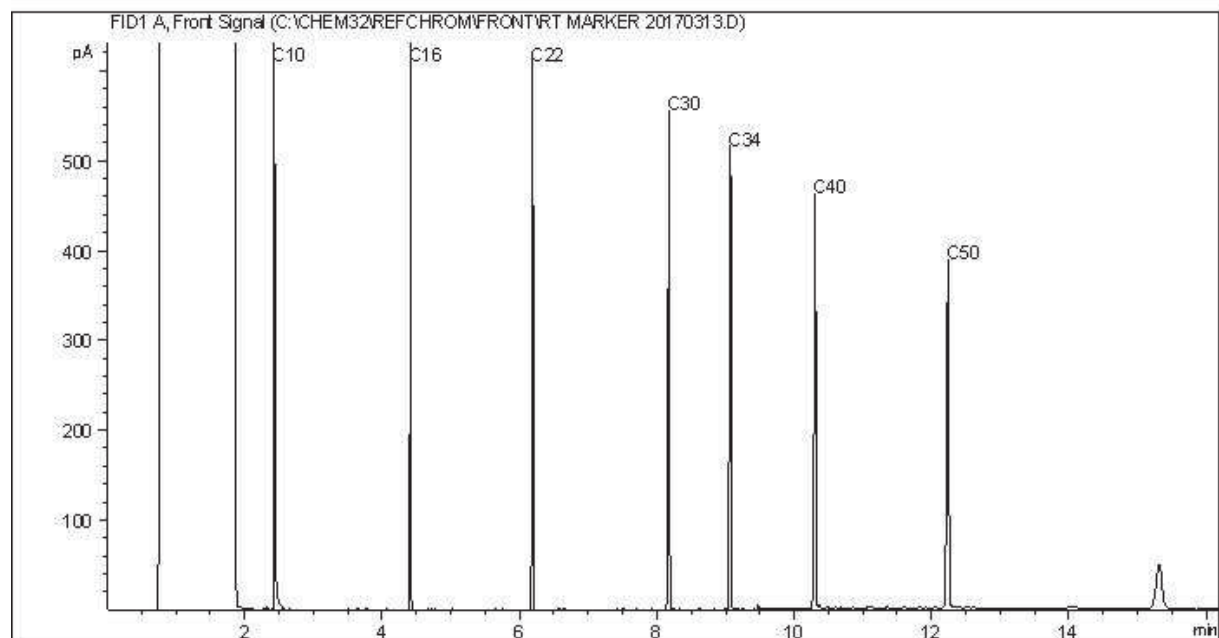
WORLEY PARSONS
Task Order#: 450249059310 Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: NWD 17-06

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

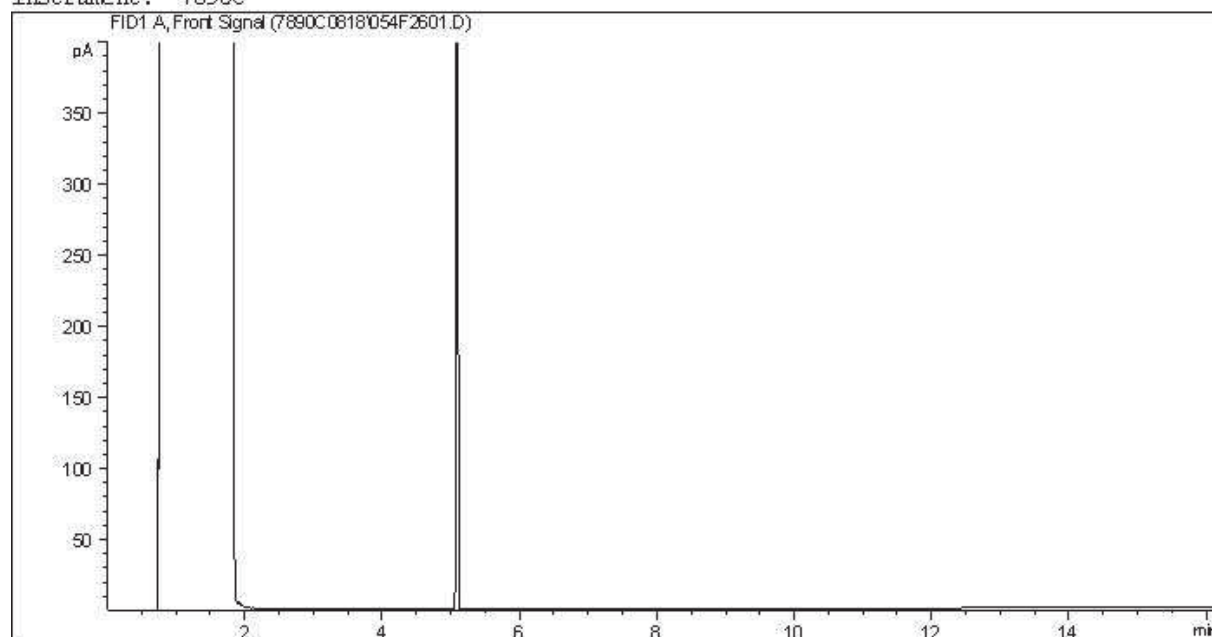
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4254 Lab-Dup

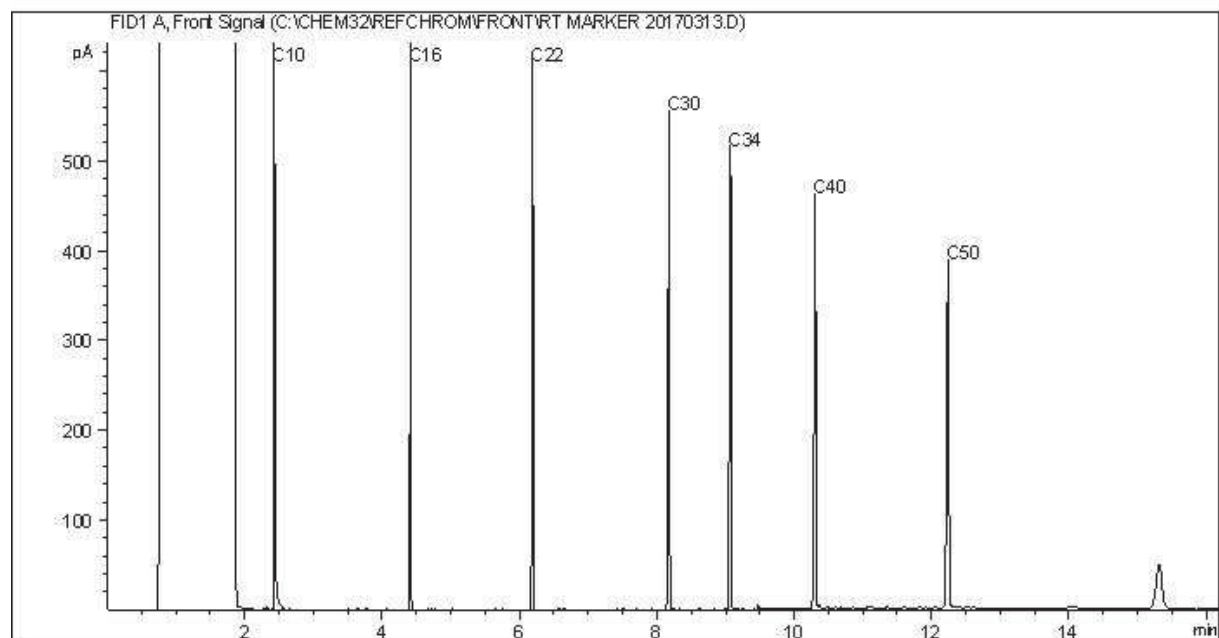
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: NWD 17-06

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

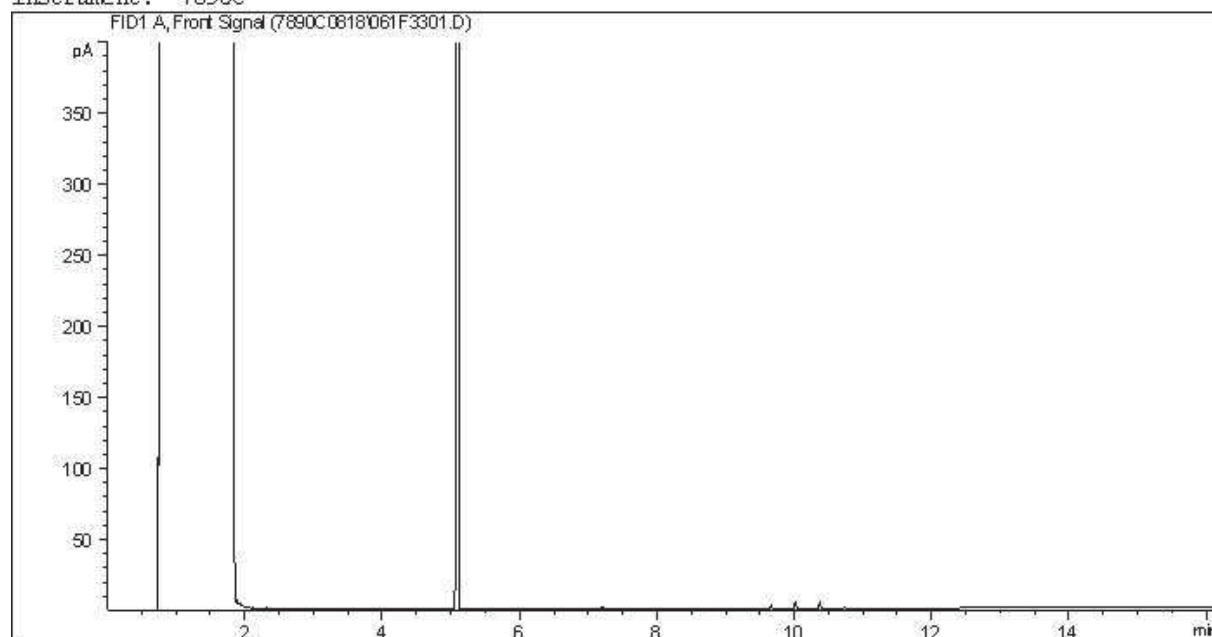
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4255

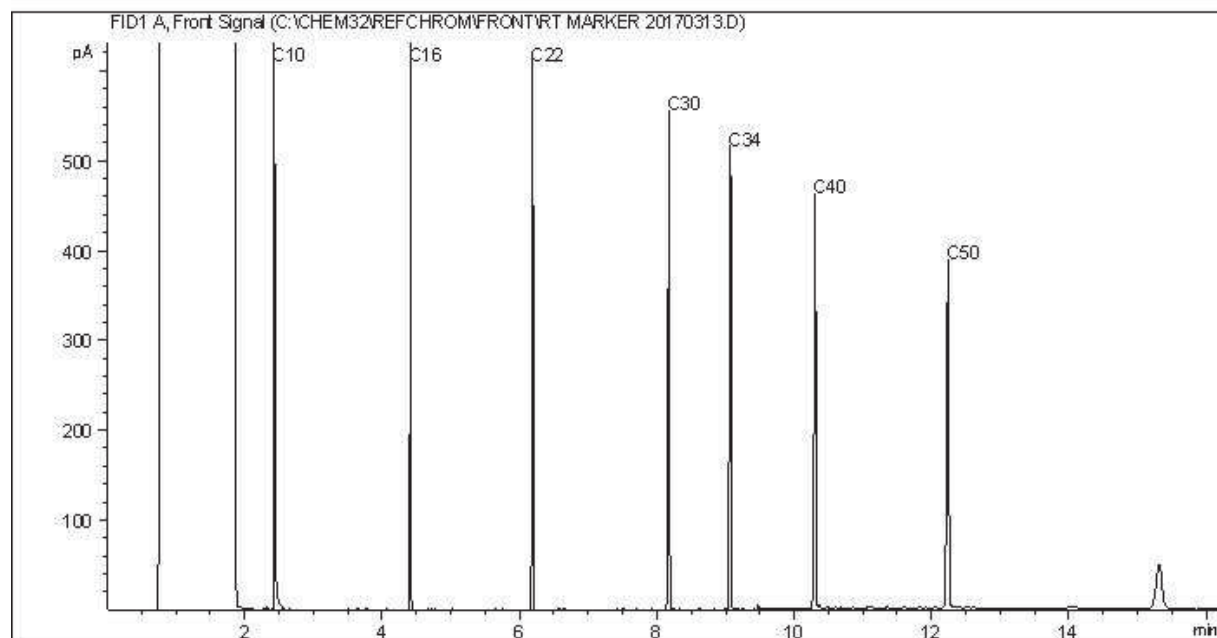
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: BI-13-2-4.5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

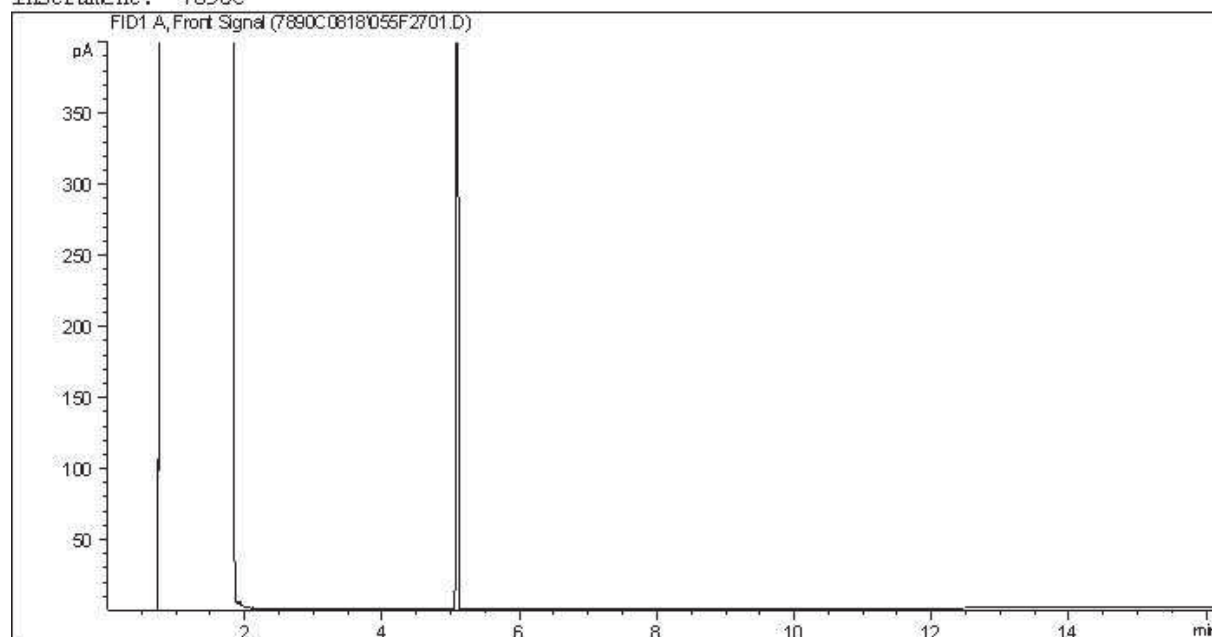
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4256

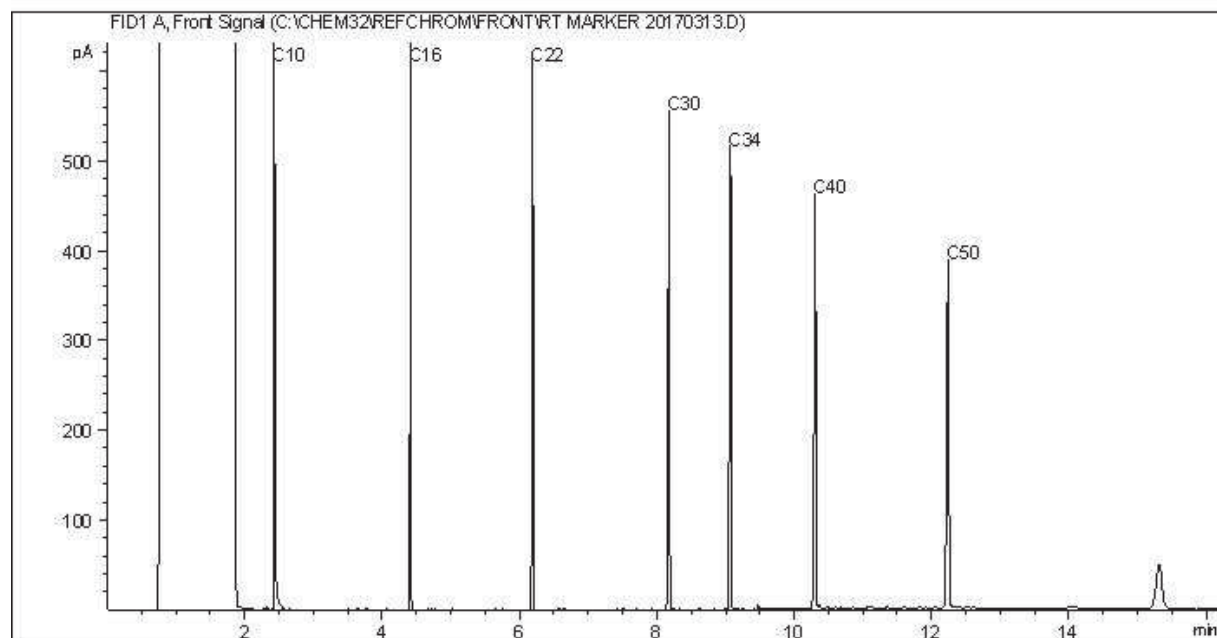
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: BIWS-16-1-4

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

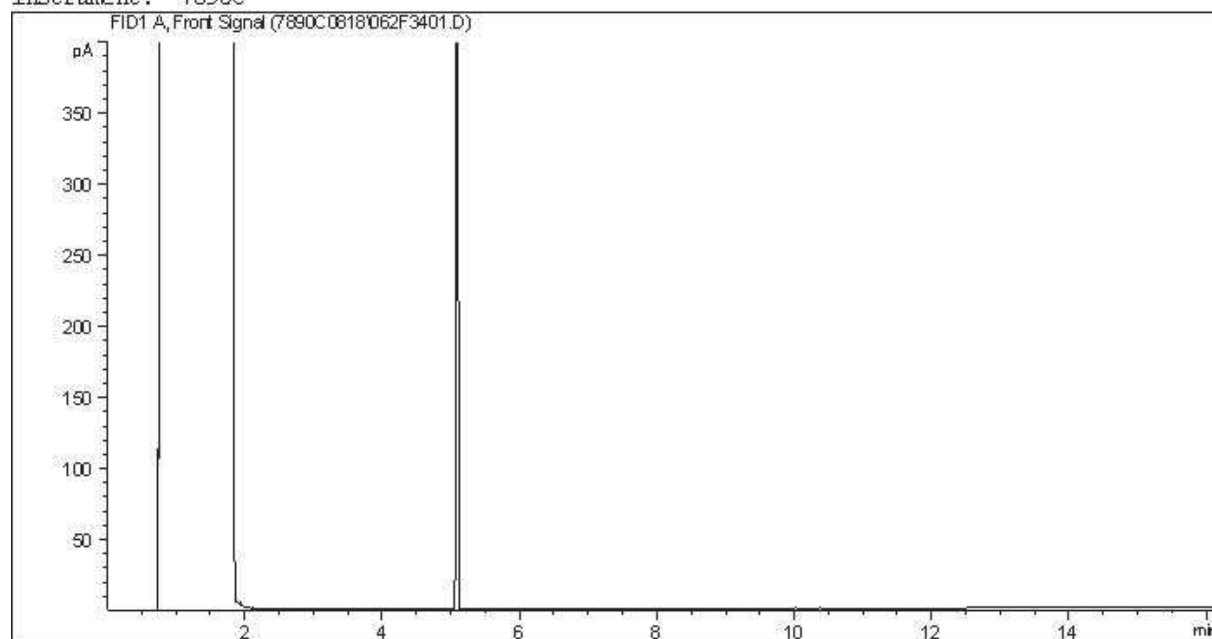
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4257

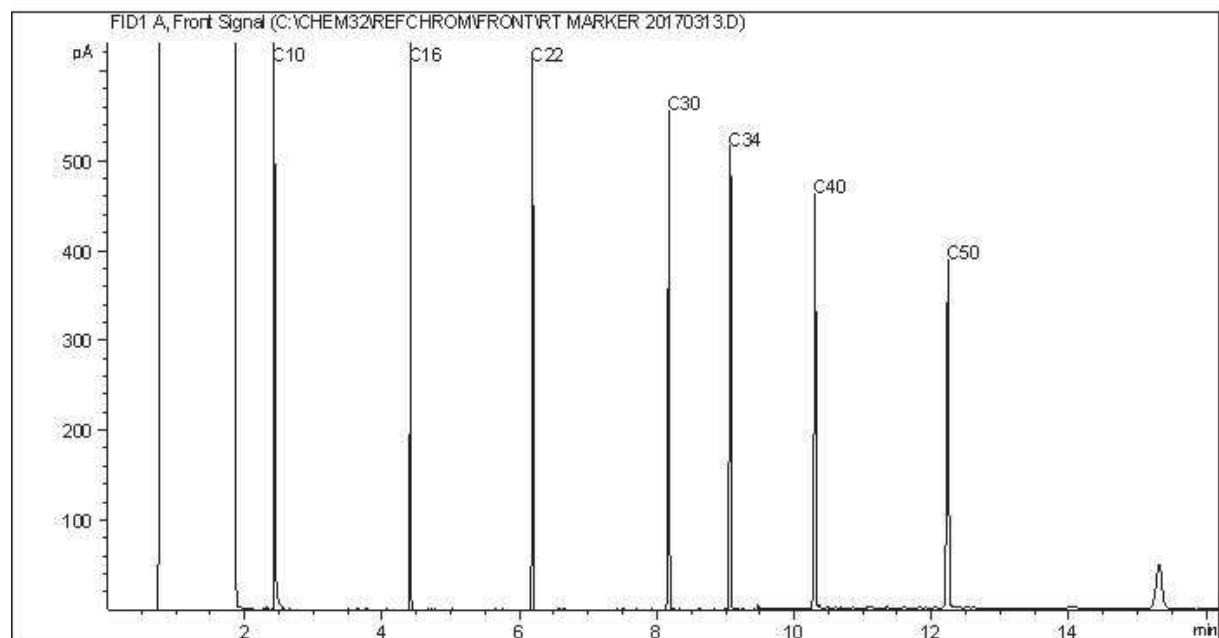
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: BI-13-3-4.5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

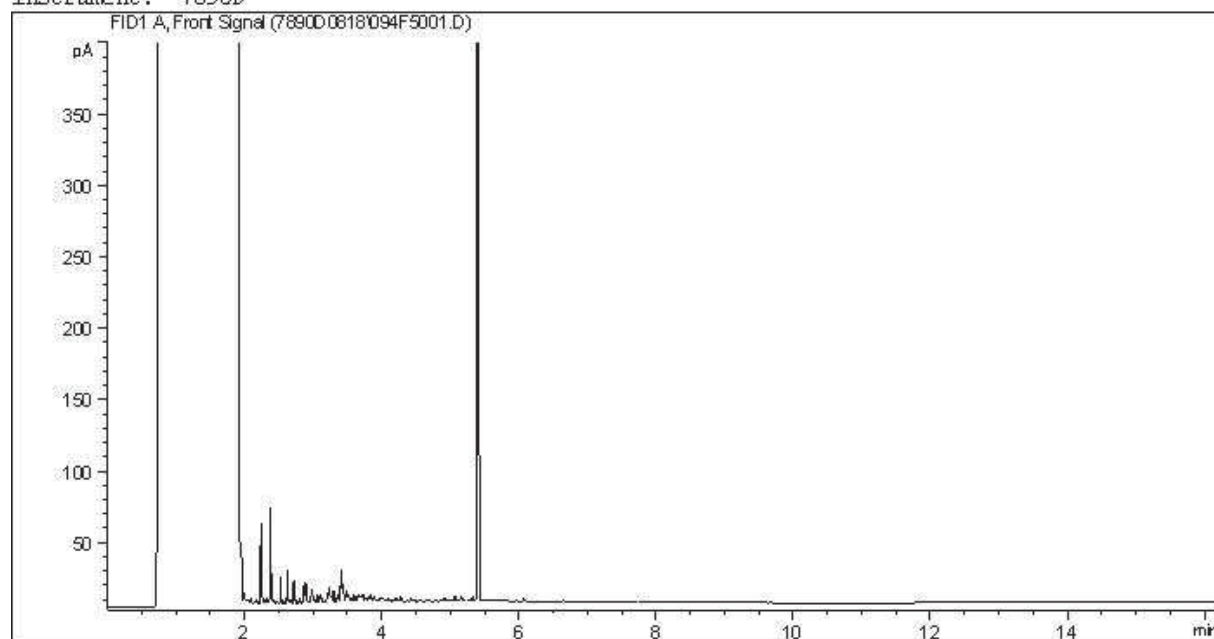
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769793
Report Date: 2017/08/24
Maxxam Sample: RT4258

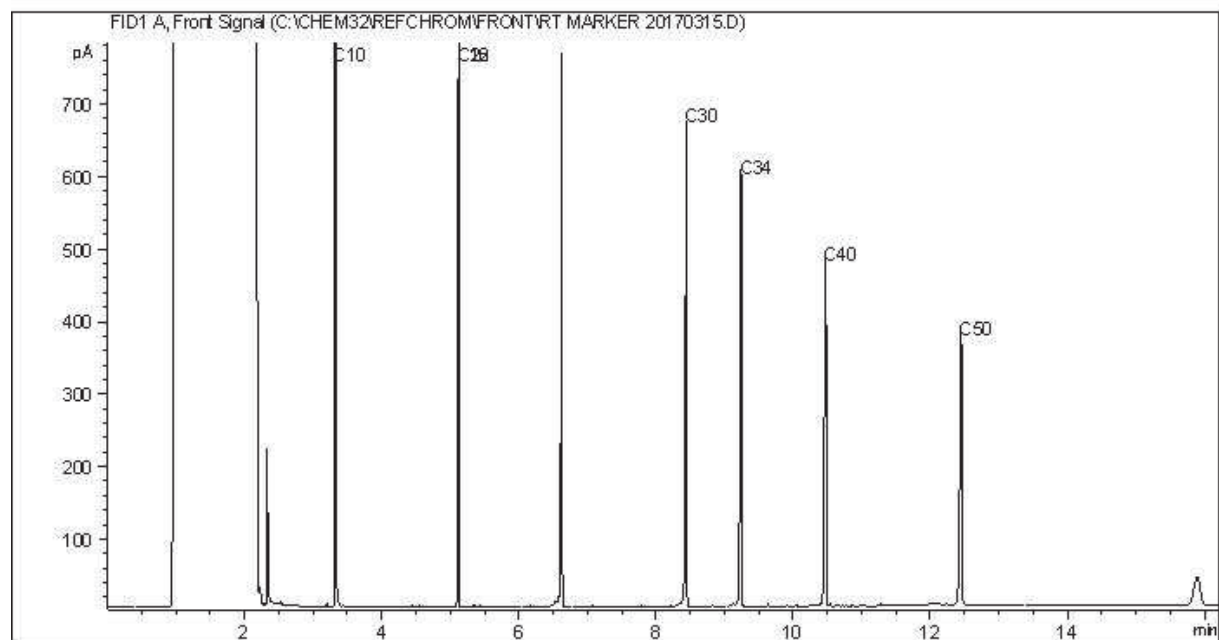
WORLEY PARSONS
Task Order#: 450249059310 Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS
Client ID: NWR 09-4-5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED												TURNAROUND TIME			
Company Name: ☒ Imperial Oil ☐ ExxonMobil Contact Name: <u>Shalini Jasra</u> Address: <u>505 Quarry Park Blvd SE</u> <u>Calgary, AB T2C 5N1</u> Email: <u>shalini.s.jasra@esso.ca</u> Ph: <u>587-476-2461</u> Sampler Name (Print): <u>Melissa Lord, Douglas Haney</u>				Company Name: <u>WorleyParsons</u> Contact Name: <u>Stacy Gibb</u> Address: <u>Suite 500</u> <u>151 Canada Olympic Rd SW</u> <u>Calgary, AB T3B 6B7</u> Email: <u>stacy.gibb@advisian.com</u> Ph: <u>403-247-0200</u> Consultant Project #: <u>407011-00526</u>				ANALYSIS REQUESTED BASIC CLASS II LANDFILL PKG PH ☐ EC ☐ ALKALINITY ☐ ROUTINE POTABILITY NUTRIENTS SOIL FERTILIZER WATER FERTILIZER SOIL SALINITY SOIL MERCURY TOTAL ☐ DISSOLVED ☐ REGULATED METALS TOT ☐ DIS ☒ PARTICLE SIZE DISTRIBUTION WITH GRAPH TEXTURE (% SAND, SILT, CLAY) GRAIN SIZE (75 MICRON) PHCs (FRACTION 1 PLUS BTEX) PHCs (FRACTIONS 2-4) PHCs (FRACTIONS 1-4 PLUS BTEX) PHCs (FRACTIONS 1-2 PLUS BTEX) PAH VOC LAB FILTRATION & PRESERVED TIME (24 HR)												TURNAROUND TIME Standard (5 days) ☒ Rush (3 days) ☐ (2 days) ☐ (1 day) ☐ (same day) ☐			
1 NWD 17-06				X				X												X			
2 BI-13-2-4.5				X				X												X			
3 BWS-16-1-4				X				X												X			
4 BI-13-3-4.5				X				X												X			
5 NWR 09-4-5				X				X												X			
6																							
7																							
8																							
9																							
10																							
IOL SITE LOCATION <u>Norman Wells, NT</u> IOL PROJECT # (if applicable) <u>N/A</u> MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM <u>4502 490 593 + 00010</u>				REGULATORY CRITERIA / DETECTION LIMITS: ☐ Alberta Tier 1 ☐ SEQG (SK) ☒ CCME <u>FAL</u> (incl. level)				SPECIAL INSTRUCTIONS also email: - Standard Norman Wells email list - melissa.lord@advisian.com * Only 1 dissolved metals bottle provided for samples with routine potability dissolved metals requested *				# JARS USED & NOT SUBMITTED Enter N/A for Water N/A				Date Required LAB USE ONLY MAXXAM JOB # <u>B769793</u>							
SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				YES NO COOLER ID # TEMP °C SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT				YES NO COOLER ID # TEMP °C SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT				DATE: <u>2017/08/16</u> RECEIVED BY: <u>Melissa Lord</u> TIME (24 HR) <u>08:00</u>				DATE: <u>2017/08/17</u> TIME (24 HR) <u>0935</u>							
RELINQUISHED BY: <u>Melissa Lord</u>				1. <u>Melissa Lord</u>				2.				3.				LABELED BY: <u>SSB</u> VERIFIED BY: <u>DRO</u>							

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 15-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407011-00526

Sample Submission Number: B769793

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			Extraction surrogate recovery of D8-NAPHTHALENE (sur.) (41%) did not meet acceptance criteria (50-130%) for sample NWR 09-4-5. Laboratory control sample recovery of Benzo[e]pyrene (135%), Benzo(a)anthracene (132%) and TERPHENYL-D14 (sur.) (140%) did not meet acceptance criteria (50-130%). All other laboratory QC met acceptance criteria.
Extraction Surrogate Recovery		x		
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery		x		

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 07-Sep-17

Data Reviewed by (Signature): 

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526
Your C.O.C. #: 294866

Report Date: 2017/08/24

Report #: R2433654

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769817

Received: 2017/08/17, 09:35

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	4	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	6	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	7	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	7	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	7	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	6	AB SOP-00037	CCME PHC-CWS m
Hardness	4	AB WI-00065	Auto Calc
Elements by ICP - Dissolved (2)	7	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	7	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	4	AB WI-00065	Auto Calc
Nitrate and Nitrite	7	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	7	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	7	AB SOP-00023	SM 22 4110 B m
Benzo[a]pyrene Equivalency (3)	3	AB SOP-00003	Auto Calc
PAH in Water by GC/MS	3	AB SOP-00037 / AB SOP-00003	EPA 3510C/8270D m
Phenols (4-AAP)	4	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	7	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	4	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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.

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526
Your C.O.C. #: 294866

Report Date: 2017/08/24

Report #: R2433654

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769817

Received: 2017/08/17, 09:35

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) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved >Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

(3) B[a]P TPE is calculated using 1/2 of the RDL for non detect results as per Alberta Environment instructions. This protocol may not apply in other jurisdictions.

Encryption Key



Jenna Chernuka
Project Manager
24 Aug 2017 16:02:39

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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.

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT4333		RT4334		RT4335		
Sampling Date		2017/08/15 16:10		2017/08/15 16:15		2017/08/15 13:30		
COC Number		294866		294866		294866		
	UNITS	C27-16-2-3	QC Batch	NWD 17-24	QC Batch	BIBG-12-2-4	RDL	QC Batch
Ext. Pet. Hydrocarbon								
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	8730508	<0.10	8730508	<0.10	0.10	8730089
Volatiles								
Benzene	mg/L	<0.00040	8731611	<0.00040	8732259	<0.00040	0.00040	8732259
Toluene	mg/L	<0.00040	8731611	<0.00040	8732259	<0.00040	0.00040	8732259
Ethylbenzene	mg/L	<0.00040	8731611	<0.00040	8732259	<0.00040	0.00040	8732259
m & p-Xylene	mg/L	<0.00080	8731611	<0.00080	8732259	<0.00080	0.00080	8732259
o-Xylene	mg/L	<0.00040	8731611	<0.00040	8732259	<0.00040	0.00040	8732259
Xylenes (Total)	mg/L	<0.00080	8731611	<0.00080	8732259	<0.00080	0.00080	8732259
F1 (C6-C10) - BTEX	mg/L	<0.10	8731611	<0.10	8732259	<0.10	0.10	8732259
F1 (C6-C10)	mg/L	<0.10 (1)	8731611	<0.10	8732259	<0.10	0.10	8732259
Extraction								
Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	101	8730508	101	8730508	100		8730089
Instrument								
Surrogate Recovery (%)								
1,4-Difluorobenzene (sur.)	%	102	8731611	103	8732259	102		8732259
4-Bromofluorobenzene (sur.)	%	103	8731611	102	8732259	101		8732259
D4-1,2-Dichloroethane (sur.)	%	107	8731611	105	8732259	106		8732259
RDL = Reportable Detection Limit								
(1) Matrix Spike below acceptance limits due to matrix interference. Reanalysis yields similar results.								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT4337		RT4339		RT4340		
Sampling Date		2017/08/15 17:15		2017/08/15 16:00		2017/08/15 12:05		
COC Number		294866		294866		294866		
	UNITS	NWD 17-16	QC Batch	NWR 98-13-21	QC Batch	BI-13-1-4	RDL	QC Batch
Ext. Pet. Hydrocarbon								
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	8730508	0.18	8730089	<0.10	0.10	8730508
Volatiles								
Benzene	mg/L	<0.00040	8732259	0.024	8732259	<0.00040	0.00040	8732259
Toluene	mg/L	<0.00040	8732259	<0.00040	8732259	<0.00040	0.00040	8732259
Ethylbenzene	mg/L	<0.00040	8732259	<0.00040	8732259	<0.00040	0.00040	8732259
m & p-Xylene	mg/L	<0.00080	8732259	<0.00080	8732259	<0.00080	0.00080	8732259
o-Xylene	mg/L	<0.00040	8732259	<0.00040	8732259	<0.00040	0.00040	8732259
Xylenes (Total)	mg/L	<0.00080	8732259	<0.00080	8732259	<0.00080	0.00080	8732259
F1 (C6-C10) - BTEX	mg/L	<0.10	8732259	0.23	8732259	<0.10	0.10	8732259
F1 (C6-C10)	mg/L	<0.10	8732259	0.25	8732259	<0.10	0.10	8732259
Extraction Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	100	8730508	100	8730089	100		8730508
Instrument Surrogate Recovery (%)								
1,4-Difluorobenzene (sur.)	%	103	8732259	103	8732259	102		8732259
4-Bromofluorobenzene (sur.)	%	101	8732259	103	8732259	101		8732259
D4-1,2-Dichloroethane (sur.)	%	105	8732259	104	8732259	104		8732259
RDL = Reportable Detection Limit								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4333	RT4334	RT4335		RT4336		
Sampling Date		2017/08/15 16:10	2017/08/15 16:15	2017/08/15 13:30		2017/08/15 13:50		
COC Number		294866	294866	294866		294866		
	UNITS	C27-16-2-3	NWD 17-24	BIBG-12-2-4	RDL	BI-08-2-3	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	0.00023	0.00024	0.00039	0.000020	0.00035	0.000020	8729385
Elements								
Dissolved Aluminum (Al)	mg/L	0.012	0.012	0.017	0.0030	0.026	0.0030	8734663
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	0.00060	<0.00060	0.00060	8734663
Dissolved Arsenic (As)	mg/L	0.00094	0.00098	0.00054	0.00020	0.00099	0.00020	8734663
Dissolved Barium (Ba)	mg/L	0.12	0.12	0.10	0.010	0.033	0.010	8735840
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Boron (B)	mg/L	0.12	0.11	<0.020	0.020	<0.020	0.020	8735840
Dissolved Calcium (Ca)	mg/L	150	150	180	0.30	610 (1)	3.0	8735840
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Cobalt (Co)	mg/L	0.0017	0.0017	0.00058	0.00030	0.022	0.00030	8734663
Dissolved Copper (Cu)	mg/L	0.0058	0.0057	0.0053	0.00020	0.0014	0.00020	8734663
Dissolved Iron (Fe)	mg/L	<0.060	<0.060	<0.060	0.060	120	0.060	8735840
Dissolved Lead (Pb)	mg/L	0.00030	0.00028	<0.00020	0.00020	<0.00020	0.00020	8734663
Dissolved Lithium (Li)	mg/L	0.12	0.12	0.021	0.020	0.035	0.020	8735840
Dissolved Magnesium (Mg)	mg/L	65	64	48	0.20	190	0.20	8735840
Dissolved Manganese (Mn)	mg/L	0.87	0.87	0.31	0.0040	3.5	0.0040	8735840
Dissolved Molybdenum (Mo)	mg/L	0.00081	0.00084	0.0010	0.00020	0.00071	0.00020	8734663
Dissolved Nickel (Ni)	mg/L	0.011	0.011	0.0085	0.00050	0.043	0.00050	8734663
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	<0.10	0.10	<0.10	0.10	8735840
Dissolved Potassium (K)	mg/L	4.6	4.5	2.7	0.30	3.7	0.30	8735840
Dissolved Selenium (Se)	mg/L	0.00048	0.00048	0.00031	0.00020	0.00099	0.00020	8734663
Dissolved Silicon (Si)	mg/L	7.3	7.1	3.4	0.10	7.5	0.10	8735840
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	0.00010	<0.00010	0.00010	8734663
Dissolved Sodium (Na)	mg/L	240	240	14	0.50	200	0.50	8735840
Dissolved Strontium (Sr)	mg/L	0.60	0.60	0.64	0.020	2.3	0.020	8735840
Dissolved Sulphur (S)	mg/L	120	110	30	0.20	340	0.20	8735840
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	0.00020	<0.00020	0.00020	8734663
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	0.0011	0.0010	8734663
RDL = Reportable Detection Limit								
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4333	RT4334	RT4335		RT4336		
Sampling Date		2017/08/15 16:10	2017/08/15 16:15	2017/08/15 13:30		2017/08/15 13:50		
COC Number		294866	294866	294866		294866		
	UNITS	C27-16-2-3	NWD 17-24	BIBG-12-2-4	RDL	BI-08-2-3	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.024	0.025	0.0051	0.00010	0.0087	0.00010	8734663
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	<0.0010	0.0010	0.0018	0.0010	8734663
Dissolved Zinc (Zn)	mg/L	0.014	0.013	0.0087	0.0030	0.020	0.0030	8734663
RDL = Reportable Detection Limit								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4338		RT4339		RT4340		
Sampling Date		2017/08/15 15:30		2017/08/15 16:00		2017/08/15 12:05		
COC Number		294866		294866		294866		
	UNITS	NWR 09-3-20	RDL	NWR 98-13-21	RDL	BI-13-1-4	RDL	QC Batch
Low Level Elements								
Dissolved Cadmium (Cd)	mg/L	<0.000020	0.000020	<0.000020	0.000020	0.00010	0.000020	8729385
Elements								
Dissolved Aluminum (Al)	mg/L	0.0040	0.0030	0.0051	0.0030	0.0069	0.0030	8734663
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	<0.00060	0.00060	<0.00060	0.00060	8734663
Dissolved Arsenic (As)	mg/L	0.0050	0.00020	0.0013	0.00020	0.0014	0.00020	8734663
Dissolved Barium (Ba)	mg/L	2.7	0.010	6.5 (1)	0.10	0.037	0.010	8735840
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Boron (B)	mg/L	0.84	0.020	0.50	0.020	0.021	0.020	8735840
Dissolved Calcium (Ca)	mg/L	48	0.30	94	0.30	210	0.30	8735840
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Cobalt (Co)	mg/L	0.00030	0.00030	<0.00030	0.00030	0.0093	0.00030	8734663
Dissolved Copper (Cu)	mg/L	0.0013	0.00020	0.00057	0.00020	0.0015	0.00020	8734663
Dissolved Iron (Fe)	mg/L	2.4	0.060	0.15	0.060	9.1	0.060	8735840
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	<0.00020	0.00020	<0.00020	0.00020	8734663
Dissolved Lithium (Li)	mg/L	0.070	0.020	0.043	0.020	0.024	0.020	8735840
Dissolved Magnesium (Mg)	mg/L	16	0.20	39	0.20	73	0.20	8735840
Dissolved Manganese (Mn)	mg/L	0.30	0.0040	0.20	0.0040	2.4	0.0040	8735840
Dissolved Molybdenum (Mo)	mg/L	0.00088	0.00020	<0.00020	0.00020	0.0031	0.00020	8734663
Dissolved Nickel (Ni)	mg/L	0.0013	0.00050	0.00052	0.00050	0.015	0.00050	8734663
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	<0.10	0.10	<0.10	0.10	8735840
Dissolved Potassium (K)	mg/L	3.5	0.30	4.4	0.30	1.6	0.30	8735840
Dissolved Selenium (Se)	mg/L	0.00029	0.00020	0.0072	0.00020	0.00080	0.00020	8734663
Dissolved Silicon (Si)	mg/L	6.5	0.10	3.7	0.10	4.1	0.10	8735840
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	<0.00010	0.00010	<0.00010	0.00010	8734663
Dissolved Sodium (Na)	mg/L	400	0.50	260	0.50	15	0.50	8735840
Dissolved Strontium (Sr)	mg/L	1.1	0.020	1.9	0.020	1.1	0.020	8735840
Dissolved Sulphur (S)	mg/L	1.3	0.20	110	0.20	79	0.20	8735840
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	<0.00020	0.00020	<0.00020	0.00020	8734663
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Titanium (Ti)	mg/L	0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
RDL = Reportable Detection Limit								
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

REGULATED METALS (CCME/AT1) - DISSOLVED

Maxxam ID		RT4338		RT4339		RT4340		
Sampling Date		2017/08/15 15:30		2017/08/15 16:00		2017/08/15 12:05		
COC Number		294866		294866		294866		
	UNITS	NWR 09-3-20	RDL	NWR 98-13-21	RDL	BI-13-1-4	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.00027	0.00010	<0.00010	0.00010	0.011	0.00010	8734663
Dissolved Vanadium (V)	mg/L	<0.0010	0.0010	<0.0010	0.0010	<0.0010	0.0010	8734663
Dissolved Zinc (Zn)	mg/L	0.0053	0.0030	<0.0030	0.0030	0.021	0.0030	8734663
RDL = Reportable Detection Limit								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT4333	RT4333			RT4334		RT4335		
Sampling Date		2017/08/15 16:10	2017/08/15 16:10			2017/08/15 16:15		2017/08/15 13:30		
COC Number		294866	294866			294866		294866		
	UNITS	C27-16-2-3	C27-16-2-3 Lab-Dup	RDL	QC Batch	NWD 17-24	RDL	BIBG-12-2-4	RDL	QC Batch
Calculated Parameters										
Hardness (CaCO ₃)	mg/L	650		0.50	8730136	640	0.50	660	0.50	8730136
Ion Balance (% Difference)	%	0.31		N/A	8729972	0.20	N/A	0.044	N/A	8730302
Dissolved Nitrate (NO ₃)	mg/L	0.20		0.044	8730304	0.23	0.044	0.14	0.044	8730304
Nitrate plus Nitrite (N)	mg/L	0.045		0.014	8729973	0.053	0.014	0.031	0.014	8729973
Dissolved Nitrite (NO ₂)	mg/L	<0.033		0.033	8730304	<0.033	0.033	<0.033	0.033	8730304
Misc. Inorganics										
Conductivity	uS/cm	2000		1.0	8731246	2000	1.0	1200	1.0	8731246
Total Dissolved Solids	mg/L	1300		10	8730538	1300 (1)	25	770	10	8732982
Anions										
Alkalinity (PP as CaCO ₃)	mg/L	<0.50		0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Alkalinity (Total as CaCO ₃)	mg/L	830		0.50	8731243	830	0.50	590	0.50	8731243
Bicarbonate (HCO ₃)	mg/L	1000		0.50	8731243	1000	0.50	720	0.50	8731243
Carbonate (CO ₃)	mg/L	<0.50		0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Hydroxide (OH)	mg/L	<0.50		0.50	8731243	<0.50	0.50	<0.50	0.50	8731243
Dissolved Sulphate (SO ₄)	mg/L	330 (2)	330	5.0	8733272	330 (2)	5.0	89	1.0	8733272
Dissolved Chloride (Cl)	mg/L	3.7	3.7	1.0	8733237	3.8	1.0	8.8	1.0	8733237
Nutrients										
Dissolved Nitrite (N)	mg/L	<0.010	<0.010	0.010	8732073	<0.010	0.010	<0.010	0.010	8732073
Dissolved Nitrate (N)	mg/L	0.045	0.046	0.010	8732073	0.053	0.010	0.031	0.010	8732073
Misc. Organics										
Phenols	mg/L	0.011		0.0020	8735489	0.010	0.0020	0.0080	0.0020	8735602

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Detection limit raised based on sample volume used for analysis.

(2) Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		RT4336		RT4338	RT4339			RT4340		
Sampling Date		2017/08/15 13:50		2017/08/15 15:30	2017/08/15 16:00			2017/08/15 12:05		
COC Number		294866		294866	294866			294866		
	UNITS	BI-08-2-3	RDL	NWR 09-3-20	NWR 98-13-21	RDL	QC Batch	BI-13-1-4	RDL	QC Batch
Calculated Parameters										
Hardness (CaCO ₃)	mg/L		0.50			0.50	8730136	820	0.50	8730136
Ion Balance (% Difference)	%		N/A			N/A	8730302	6.4	N/A	8730302
Dissolved Nitrate (NO ₃)	mg/L	0.36	0.22	<0.044	<0.044	0.044	8730304	0.070	0.044	8730304
Nitrate plus Nitrite (N)	mg/L	0.13	0.071	<0.014	<0.014	0.014	8729973	0.016	0.014	8729973
Dissolved Nitrite (NO ₂)	mg/L	0.17	0.16	<0.033	<0.033	0.033	8730304	<0.033	0.033	8730304
Misc. Inorganics										
Conductivity	uS/cm	4500	1.0	1900	1800	1.0	8731061	1300	1.0	8731246
Total Dissolved Solids	mg/L					10		1000	10	8732982
Anions										
Alkalinity (PP as CaCO ₃)	mg/L					0.50		<0.50	0.50	8731243
Alkalinity (Total as CaCO ₃)	mg/L					0.50		530	0.50	8731243
Bicarbonate (HCO ₃)	mg/L					0.50		650	0.50	8731243
Carbonate (CO ₃)	mg/L					0.50		<0.50	0.50	8731243
Hydroxide (OH)	mg/L					0.50		<0.50	0.50	8731243
Dissolved Sulphate (SO ₄)	mg/L	1100 (1)	10	<1.0	5.9	1.0	8733272	220 (1)	5.0	8733272
Dissolved Chloride (Cl)	mg/L	500 (1)	5.0	110	140	1.0	8733237	6.2	1.0	8733237
Nutrients										
Dissolved Nitrite (N)	mg/L	0.053 (2)	0.050	<0.010	<0.010	0.010	8732073	<0.010	0.010	8732073
Dissolved Nitrate (N)	mg/L	0.082 (2)	0.050	<0.010	<0.010	0.010	8732073	0.016	0.010	8732073
Misc. Organics										
Phenols	mg/L							0.0083	0.0020	8735602
RDL = Reportable Detection Limit N/A = Not Applicable (1) Detection limits raised due to dilution to bring analyte within the calibrated range. (2) Detection limits raised due to matrix interference.										

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Maxxam ID		RT4335	RT4338	RT4339		
Sampling Date		2017/08/15 13:30	2017/08/15 15:30	2017/08/15 16:00		
COC Number		294866	294866	294866		
	UNITS	BIBG-12-2-4	NWR 09-3-20	NWR 98-13-21	RDL	QC Batch
Polycyclic Aromatics						
Benzo[a]pyrene equivalency	mg/L	<0.000010	<0.000010	<0.000010	0.000010	8729776
Acenaphthene	mg/L	<0.00010	<0.00010	<0.00010	0.00010	8730088
Acenaphthylene	mg/L	<0.00010	<0.00010	<0.00010	0.00010	8730088
Acridine	mg/L	<0.000050	<0.000050	<0.000050	0.000050	8730088
Anthracene	mg/L	<0.000010	0.000012	<0.000010	0.000010	8730088
Benzo(a)anthracene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
Benzo(b&j)fluoranthene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
Benzo(k)fluoranthene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
Benzo(g,h,i)perylene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
Benzo(c)phenanthrene	mg/L	<0.000050	<0.000050	<0.000050	0.000050	8730088
Benzo(a)pyrene	mg/L	<0.0000075	<0.0000075	<0.0000075	0.0000075	8730088
Benzo[e]pyrene	mg/L	<0.000050	<0.000050	<0.000050	0.000050	8730088
Chrysene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
Dibenz(a,h)anthracene	mg/L	<0.0000075	<0.0000075	<0.0000075	0.0000075	8730088
Fluoranthene	mg/L	<0.000010	0.000047	0.000021	0.000010	8730088
Fluorene	mg/L	<0.000050	0.000064	0.000057	0.000050	8730088
Indeno(1,2,3-cd)pyrene	mg/L	<0.0000085	<0.0000085	<0.0000085	0.0000085	8730088
1-Methylnaphthalene	mg/L	<0.00010	0.0012	0.00073	0.00010	8730088
2-Methylnaphthalene	mg/L	<0.00010	0.00056	0.00023	0.00010	8730088
Naphthalene	mg/L	<0.00010	0.00038	0.00028	0.00010	8730088
Phenanthrene	mg/L	<0.000050	0.00015	0.00021	0.000050	8730088
Perylene	mg/L	<0.000050	<0.000050	<0.000050	0.000050	8730088
Pyrene	mg/L	<0.000020	0.000038	<0.000020	0.000020	8730088
Quinoline	mg/L	<0.00020	<0.00020	<0.00020	0.00020	8730088
Extraction						
Surrogate Recovery (%)						
D10-ANTHRACENE (sur.)	%	90	95	94		8730088
D8-ACENAPHTHYLENE (sur.)	%	72	77	77		8730088
D8-NAPHTHALENE (sur.)	%	54	54	58		8730088
TERPHENYL-D14 (sur.)	%	85	98	89		8730088
RDL = Reportable Detection Limit						

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT4333
Sample ID: C27-16-2-3
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8731611	N/A	2017/08/19	Harneet Gill
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/18	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8729972	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735489	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8730538	2017/08/18	2017/08/22	Kruti Patel

Maxxam ID: RT4333 Dup
Sample ID: C27-16-2-3
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys

Maxxam ID: RT4334
Sample ID: NWD 17-24
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8732259	N/A	2017/08/20	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/19	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8730302	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT4334
Sample ID: NWD 17-24
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735602	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8732982	2017/08/21	2017/08/22	Kruti Patel

Maxxam ID: RT4335
Sample ID: BIBG-12-2-4
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8732259	N/A	2017/08/20	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730089	2017/08/18	2017/08/19	Kelsey Holt
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8730302	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8729776	N/A	2017/08/22	Automated Statchk
PAH in Water by GC/MS	GC/MS	8730088	2017/08/18	2017/08/21	Bert Chi
Phenols (4-AAP)	TECH/4AAP	8735602	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8732982	2017/08/21	2017/08/22	Kruti Patel

Maxxam ID: RT4336
Sample ID: BI-08-2-3
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731061	N/A	2017/08/18	Ashley Fedoriuk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT4337
Sample ID: NWD 17-16
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8732259	N/A	2017/08/20	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/19	Jana Rychlikova

Maxxam ID: RT4338
Sample ID: NWR 09-3-20
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731061	N/A	2017/08/18	Ashley Fedoriuk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8729776	N/A	2017/08/22	Automated Statchk
PAH in Water by GC/MS	GC/MS	8730088	2017/08/18	2017/08/21	Bert Chi
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys

Maxxam ID: RT4339
Sample ID: NWR 98-13-21
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8732259	N/A	2017/08/20	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731061	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730089	2017/08/18	2017/08/19	Kelsey Holt
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Benzo[a]pyrene Equivalency	GC/MSD	8729776	N/A	2017/08/22	Automated Statchk
PAH in Water by GC/MS	GC/MS	8730088	2017/08/18	2017/08/21	Bert Chi
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys

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TEST SUMMARY

Maxxam ID: RT4340
Sample ID: BI-13-1-4
Matrix: Water

Collected: 2017/08/15
Relinquished: 2017/08/16
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8731243	N/A	2017/08/18	Ashley Fedoriuk
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8732259	N/A	2017/08/20	Seema Singh
Cadmium - low level CCME - Dissolved	ICPM/MS	8729385	N/A	2017/08/24	Automated Statchk
Chloride by Automated Colourimetry	KONE	8733237	N/A	2017/08/23	Chelsea Harmatys
Conductivity @25C	COND	8731246	N/A	2017/08/18	Ashley Fedoriuk
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730508	2017/08/18	2017/08/19	Jana Rychlikova
Hardness	CALC	8730136	N/A	2017/08/23	Automated Statchk
Elements by ICP - Dissolved	ICPA	8735840	N/A	2017/08/23	Jonathan Kuprowsky
Elements by ICPMS - Dissolved	ICPM	8734663	N/A	2017/08/22	Andrew Payne
Ion Balance	CALC	8730302	N/A	2017/08/19	Automated Statchk
Nitrate and Nitrite	CALC	8730304	N/A	2017/08/20	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8729973	N/A	2017/08/20	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8732073	N/A	2017/08/19	Mahesh Ranjan
Phenols (4-AAP)	TECH/4AAP	8735602	N/A	2017/08/23	Ying Yang
Sulphate by Automated Colourimetry	KONE	8733272	N/A	2017/08/23	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8732982	2017/08/21	2017/08/22	Kruti Patel

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.3°C

Sample RT4333 [C27-16-2-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4334 [NWD 17-24] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4335 [BIBG-12-2-4] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4336 [BI-08-2-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4338 [NWR 09-3-20] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4339 [NWR 98-13-21] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Sample RT4340 [BI-13-1-4] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

DATA QUALITY OVERVIEW

Lab ID	Client Sample ID	Matrix	Test Code	Analysis Type	Parameters	Deviation	Root Cause	Potential Impact
RT4333	C27-16-2-3	Water	BTEXHSAB-W	VOL	F1 (C6-C10)	#1 Matrix Spike Recovery Below Control Limit	#1 Matrix Interference	This may represent a low bias for this parameter(s) in this sample.

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QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8730088	BC5	Method Blank	D10-ANTHRACENE (sur.)	2017/08/20		97	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/20		118	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/20		81	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/20		60	%	50 - 130
			Acenaphthene	2017/08/20	<0.00010		mg/L	
			Acenaphthylene	2017/08/20	<0.00010		mg/L	
			Acridine	2017/08/20	<0.000050		mg/L	
			Anthracene	2017/08/20	<0.000010		mg/L	
			Benzo(a)anthracene	2017/08/20	<0.0000085		mg/L	
			Benzo(b&j)fluoranthene	2017/08/20	<0.0000085		mg/L	
			Benzo(k)fluoranthene	2017/08/20	<0.0000085		mg/L	
			Benzo(g,h,i)perylene	2017/08/20	<0.0000085		mg/L	
			Benzo(c)phenanthrene	2017/08/20	<0.000050		mg/L	
			Benzo(a)pyrene	2017/08/20	<0.0000075		mg/L	
			Benzo[e]pyrene	2017/08/20	<0.000050		mg/L	
			Chrysene	2017/08/20	<0.0000085		mg/L	
			Dibenz(a,h)anthracene	2017/08/20	<0.0000075		mg/L	
			Fluoranthene	2017/08/20	<0.000010		mg/L	
			Fluorene	2017/08/20	<0.000050		mg/L	
			Indeno(1,2,3-cd)pyrene	2017/08/20	<0.0000085		mg/L	
			1-Methylnaphthalene	2017/08/20	<0.00010		mg/L	
			2-Methylnaphthalene	2017/08/20	<0.00010		mg/L	
			Naphthalene	2017/08/20	<0.00010		mg/L	
			Phenanthrene	2017/08/20	<0.000050		mg/L	
			Perylene	2017/08/20	<0.000050		mg/L	
			Pyrene	2017/08/20	<0.000020		mg/L	
			Quinoline	2017/08/20	<0.00020		mg/L	
8730089	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/19		104	%	60 - 130
8730508	JR1	Method Blank	F2 (C10-C16 Hydrocarbons)	2017/08/19	<0.10		mg/L	
			F2 (C10-C16 Hydrocarbons)	2017/08/18	<0.10	103	%	60 - 130
8730538	KPG	Method Blank	Total Dissolved Solids	2017/08/22	<10		mg/L	
8731061	AF6	Method Blank	Conductivity	2017/08/18	<1.0		uS/cm	
8731243	AF6	Method Blank	Alkalinity (Total as CaCO3)	2017/08/18	<0.50		mg/L	
			Alkalinity (PP as CaCO3)	2017/08/18	<0.50		mg/L	
			Bicarbonate (HCO3)	2017/08/18	<0.50		mg/L	
			Carbonate (CO3)	2017/08/18	<0.50		mg/L	
			Hydroxide (OH)	2017/08/18	<0.50		mg/L	
			Conductivity	2017/08/18	<1.0		uS/cm	
8731246	AF6	Method Blank	Conductivity	2017/08/18	<1.0		uS/cm	
8731611	HG3	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/19		101	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/19		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/19		106	%	70 - 130
			Benzene	2017/08/19	<0.00040		mg/L	
			Toluene	2017/08/19	<0.00040		mg/L	
			Ethylbenzene	2017/08/19	<0.00040		mg/L	
			m & p-Xylene	2017/08/19	<0.00080		mg/L	
			o-Xylene	2017/08/19	<0.00040		mg/L	
			Xylenes (Total)	2017/08/19	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/19	<0.10		mg/L	
			F1 (C6-C10)	2017/08/19	<0.10		mg/L	
8732073	MSD	Method Blank	Dissolved Nitrite (N)	2017/08/19	<0.010		mg/L	

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8732259	SES	Method Blank	Dissolved Nitrate (N)	2017/08/19	<0.010		mg/L	
			1,4-Difluorobenzene (sur.)	2017/08/22		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/22		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/22		101	%	70 - 130
			Benzene	2017/08/22	<0.00040		mg/L	
			Toluene	2017/08/22	<0.00040		mg/L	
			Ethylbenzene	2017/08/22	<0.00040		mg/L	
			m & p-Xylene	2017/08/22	<0.00080		mg/L	
			o-Xylene	2017/08/22	<0.00040		mg/L	
			Xylenes (Total)	2017/08/22	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/22	<0.10		mg/L	
			F1 (C6-C10)	2017/08/22	<0.10		mg/L	
8732982	KPG	Method Blank	Total Dissolved Solids	2017/08/22	<10		mg/L	
8733237	CH7	Method Blank	Dissolved Chloride (Cl)	2017/08/23	<1.0		mg/L	
8733272	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/08/23	<1.0		mg/L	
8734663	APY	Method Blank	Dissolved Aluminum (Al)	2017/08/24	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/08/24	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/08/24	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/08/24	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/08/24	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/08/24	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/08/24	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/08/24	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/08/24	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/08/24	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/08/24	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/08/24	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/08/24	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/08/24	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/08/24	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/08/24	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/08/24	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/08/24	<0.0010		mg/L	
8735489	YY	Method Blank	Phenols	2017/08/23	<0.0020		mg/L	
8735602	YY	Method Blank	Phenols	2017/08/23	<0.0020		mg/L	
8735840	JK9	Method Blank	Dissolved Iron (Fe)	2017/08/23	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/08/23	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/08/23	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/08/23	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/08/23	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/08/23	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/08/23	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/08/23	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/08/23	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/08/23	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/08/23	<0.10		mg/L	
			Dissolved Boron (B)	2017/08/23	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/08/23	<0.30		mg/L	
8732073	MSD	RPD [RT4333-01]	Dissolved Nitrite (N)	2017/08/19	NC		%	20
			Dissolved Nitrate (N)	2017/08/19	1.7		%	20
8733237	CH7	RPD [RT4333-01]	Dissolved Chloride (Cl)	2017/08/23	1.2		%	20

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8733272	CH7	RPD [RT4333-01]	Dissolved Sulphate (SO4)	2017/08/23	0.64		%	20
8731611	HG3	Matrix Spike [RT4333-05]	1,4-Difluorobenzene (sur.)	2017/08/20		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/20		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/20		108	%	70 - 130
			Benzene	2017/08/20		103	%	70 - 130
			Toluene	2017/08/20		94	%	70 - 130
			Ethylbenzene	2017/08/20		100	%	70 - 130
			m & p-Xylene	2017/08/20		98	%	70 - 130
			o-Xylene	2017/08/20		97	%	70 - 130
			F1 (C6-C10)	2017/08/20		68 (1)	%	70 - 130
8732073	MSD	Matrix Spike [RT4333-01]	Dissolved Nitrite (N)	2017/08/19		105	%	80 - 120
			Dissolved Nitrate (N)	2017/08/19		104	%	80 - 120
8733237	CH7	Matrix Spike [RT4333-01]	Dissolved Chloride (Cl)	2017/08/23		106	%	80 - 120
8733272	CH7	Matrix Spike [RT4333-01]	Dissolved Sulphate (SO4)	2017/08/23		NC	%	80 - 120
8730088	BC5	LCS	D10-ANTHRACENE (sur.)	2017/08/20		112	%	50 - 130
			TERPHENYL-D14 (sur.)	2017/08/20		140 (1)	%	50 - 130
			D8-ACENAPHTHYLENE (sur.)	2017/08/20		96	%	50 - 130
			D8-NAPHTHALENE (sur.)	2017/08/20		87	%	50 - 130
			Acenaphthene	2017/08/20		91	%	50 - 130
			Acenaphthylene	2017/08/20		94	%	50 - 130
			Acridine	2017/08/20		100	%	50 - 130
			Anthracene	2017/08/20		106	%	50 - 130
			Benzo(a)anthracene	2017/08/20		132 (1)	%	50 - 130
			Benzo(b&j)fluoranthene	2017/08/20		128	%	50 - 130
			Benzo(k)fluoranthene	2017/08/20		128	%	50 - 130
			Benzo(g,h,i)perylene	2017/08/20		123	%	50 - 130
			Benzo(c)phenanthrene	2017/08/20		129	%	50 - 130
			Benzo(a)pyrene	2017/08/20		121	%	50 - 130
			Benzo[e]pyrene	2017/08/20		135 (1)	%	50 - 130
			Chrysene	2017/08/20		123	%	50 - 130
			Dibenz(a,h)anthracene	2017/08/20		127	%	50 - 130
			Fluoranthene	2017/08/20		106	%	50 - 130
			Fluorene	2017/08/20		93	%	50 - 130
			Indeno(1,2,3-cd)pyrene	2017/08/20		111	%	50 - 130
			2-Methylnaphthalene	2017/08/20		88	%	50 - 130
			Naphthalene	2017/08/20		79	%	50 - 130
			Phenanthrene	2017/08/20		101	%	50 - 130
			Perylene	2017/08/20		128	%	50 - 130
			Pyrene	2017/08/20		99	%	50 - 130
			Quinoline	2017/08/20		96	%	50 - 130
8730089	KHO	LCS	O-TERPHENYL (sur.)	2017/08/19		97	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19		107	%	70 - 130
8730508	JR1	LCS	O-TERPHENYL (sur.)	2017/08/18		103	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/18		104	%	70 - 130
8730538	KPG	LCS	Total Dissolved Solids	2017/08/22		102	%	80 - 120
8731061	AF6	LCS	Conductivity	2017/08/18		100	%	90 - 110
8731243	AF6	LCS	Alkalinity (Total as CaCO3)	2017/08/18		98	%	80 - 120
8731246	AF6	LCS	Conductivity	2017/08/18		98	%	90 - 110
8731611	HG3	LCS	1,4-Difluorobenzene (sur.)	2017/08/19		97	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/19		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/19		111	%	70 - 130

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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8732073	MSD	LCS	Benzene	2017/08/19		99	%	70 - 130
			Toluene	2017/08/19		91	%	70 - 130
			Ethylbenzene	2017/08/19		96	%	70 - 130
			m & p-Xylene	2017/08/19		96	%	70 - 130
			o-Xylene	2017/08/19		94	%	70 - 130
			F1 (C6-C10)	2017/08/19		95	%	70 - 130
8732259	SES	LCS	Dissolved Nitrite (N)	2017/08/19		101	%	80 - 120
			Dissolved Nitrate (N)	2017/08/19		101	%	80 - 120
			1,4-Difluorobenzene (sur.)	2017/08/21		96	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/21		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/21		108	%	70 - 130
			Benzene	2017/08/21		102	%	70 - 130
8732982	KPG	LCS	Toluene	2017/08/21		95	%	70 - 130
			Ethylbenzene	2017/08/21		100	%	70 - 130
			m & p-Xylene	2017/08/21		100	%	70 - 130
			o-Xylene	2017/08/21		97	%	70 - 130
			F1 (C6-C10)	2017/08/21		71	%	70 - 130
			Total Dissolved Solids	2017/08/22		98	%	80 - 120
8733237	CH7	LCS	Dissolved Chloride (Cl)	2017/08/23		104	%	80 - 120
8733272	CH7	LCS	Dissolved Sulphate (SO4)	2017/08/23		103	%	80 - 120
8734663	APY	LCS	Dissolved Aluminum (Al)	2017/08/23		98	%	80 - 120
			Dissolved Chromium (Cr)	2017/08/23		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/08/23		99	%	80 - 120
			Dissolved Copper (Cu)	2017/08/23		98	%	80 - 120
			Dissolved Lead (Pb)	2017/08/23		98	%	80 - 120
			Dissolved Antimony (Sb)	2017/08/23		100	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/08/23		99	%	80 - 120
			Dissolved Nickel (Ni)	2017/08/23		98	%	80 - 120
			Dissolved Selenium (Se)	2017/08/23		99	%	80 - 120
			Dissolved Silver (Ag)	2017/08/23		99	%	80 - 120
			Dissolved Arsenic (As)	2017/08/23		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/08/23		98	%	80 - 120
			Dissolved Tin (Sn)	2017/08/23		99	%	80 - 120
			Dissolved Titanium (Ti)	2017/08/23		101	%	80 - 120
			Dissolved Uranium (U)	2017/08/23		96	%	80 - 120
			Dissolved Vanadium (V)	2017/08/23		100	%	80 - 120
			Dissolved Zinc (Zn)	2017/08/23		102	%	80 - 120
			Dissolved Beryllium (Be)	2017/08/23		98	%	80 - 120
8735489	YY	LCS	Phenols	2017/08/23		85	%	80 - 120
8735602	YY	LCS	Phenols	2017/08/23		92	%	80 - 120
8735840	JK9	LCS	Dissolved Iron (Fe)	2017/08/23		99	%	80 - 120
			Dissolved Lithium (Li)	2017/08/23		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/08/23		100	%	80 - 120
			Dissolved Manganese (Mn)	2017/08/23		96	%	80 - 120
			Dissolved Potassium (K)	2017/08/23		99	%	80 - 120
			Dissolved Sodium (Na)	2017/08/23		98	%	80 - 120
			Dissolved Strontium (Sr)	2017/08/23		96	%	80 - 120
			Dissolved Phosphorus (P)	2017/08/23		98	%	80 - 120
			Dissolved Barium (Ba)	2017/08/23		95	%	80 - 120
			Dissolved Silicon (Si)	2017/08/23		103	%	80 - 120
			Dissolved Boron (B)	2017/08/23		98	%	80 - 120

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Calcium (Ca)	2017/08/23		94	%	80 - 120
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. LCS: 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) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.								

Maxxam Job #: B769817
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



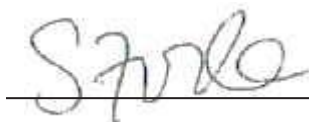
Daniel Reslan, cCT, QP, Organics Supervisor



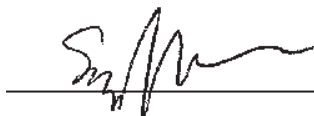
Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor



Suwan Fock, B.Sc., QP, Inorganics Senior Analyst

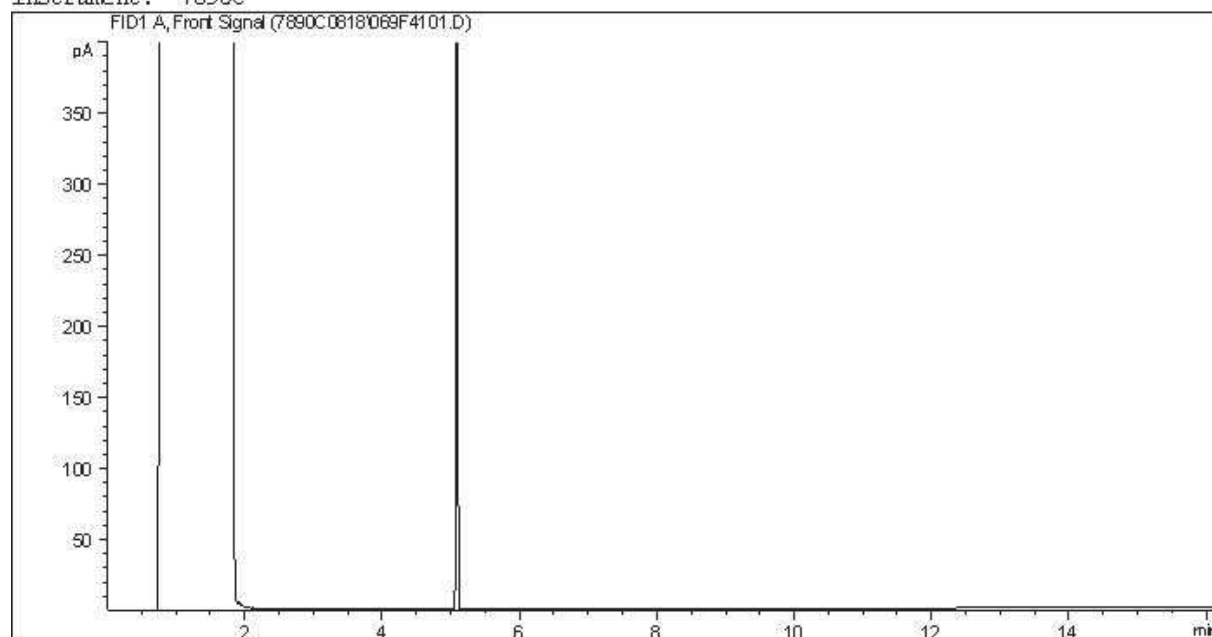


Sandy Yuan, M.Sc., Scientific Specialist

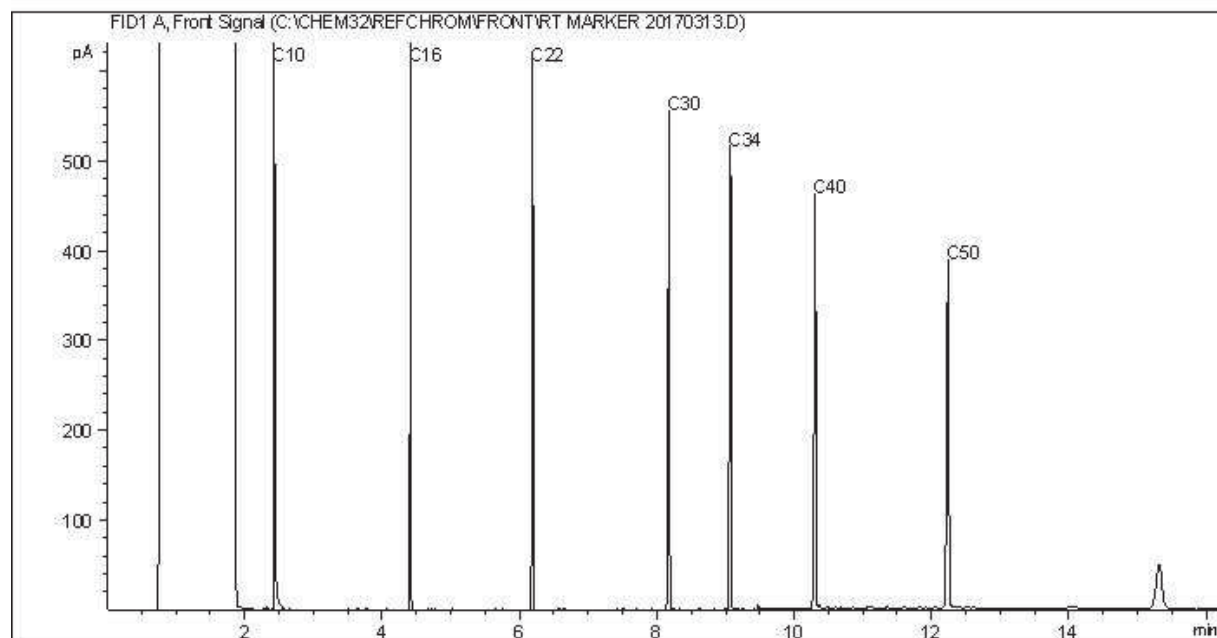
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



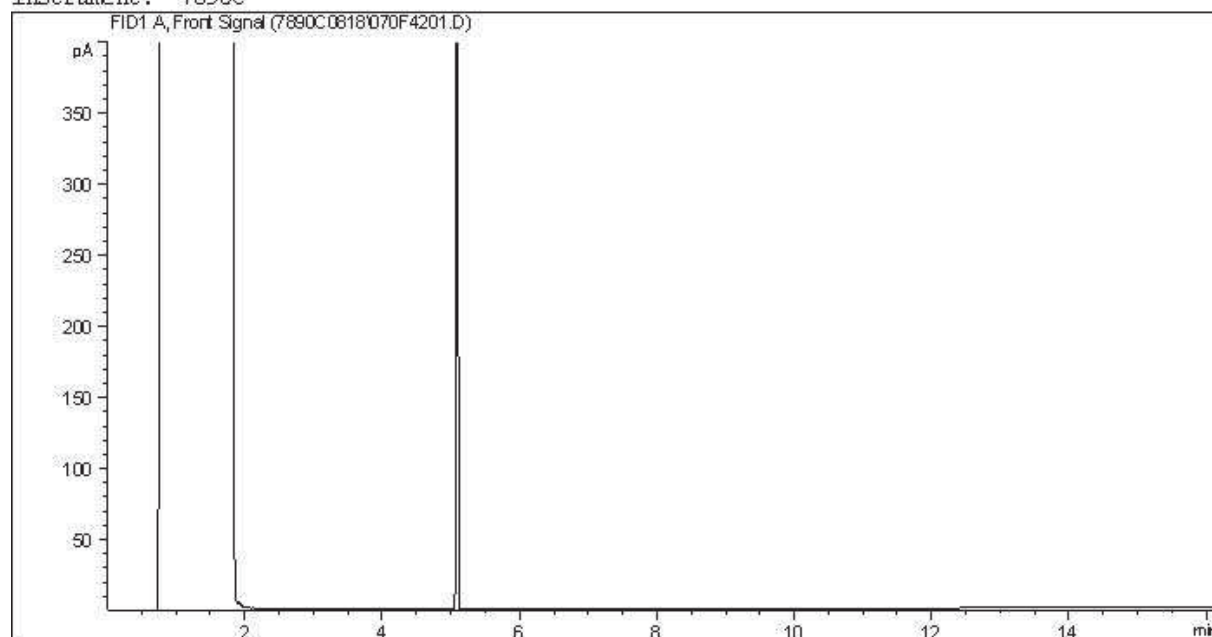
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

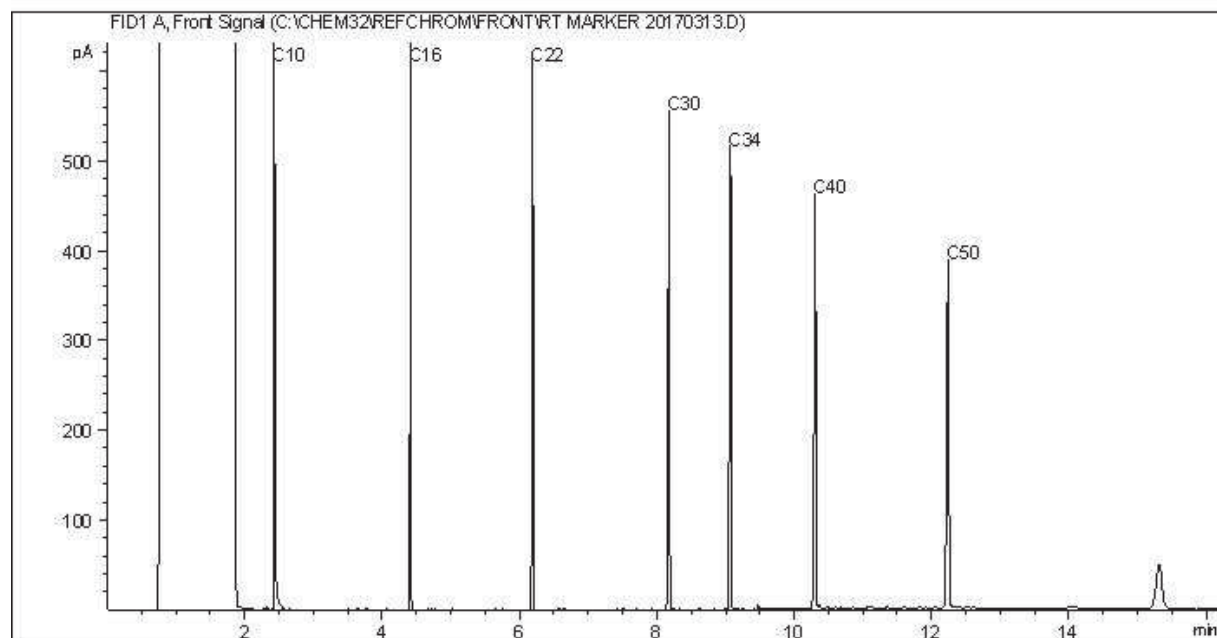
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



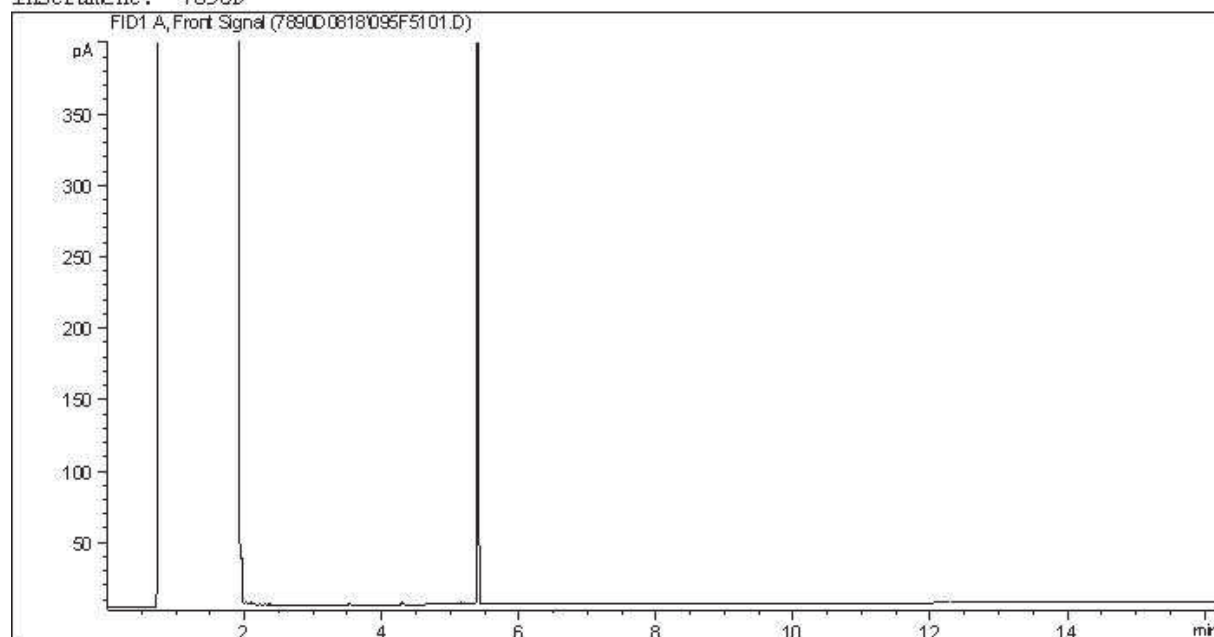
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

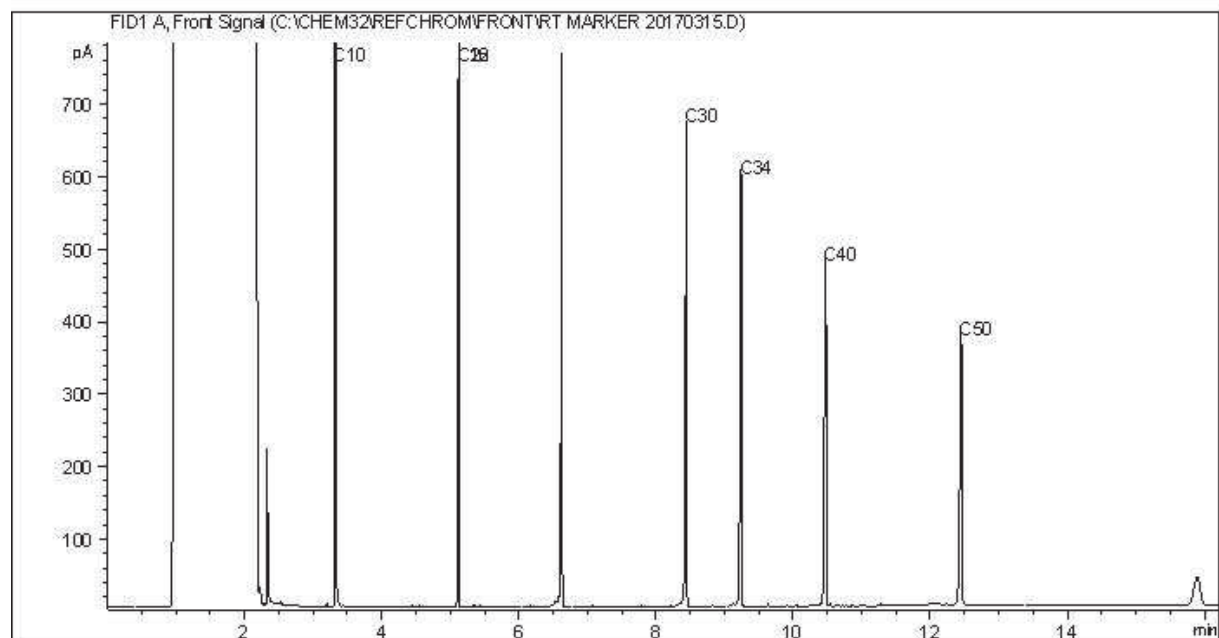
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

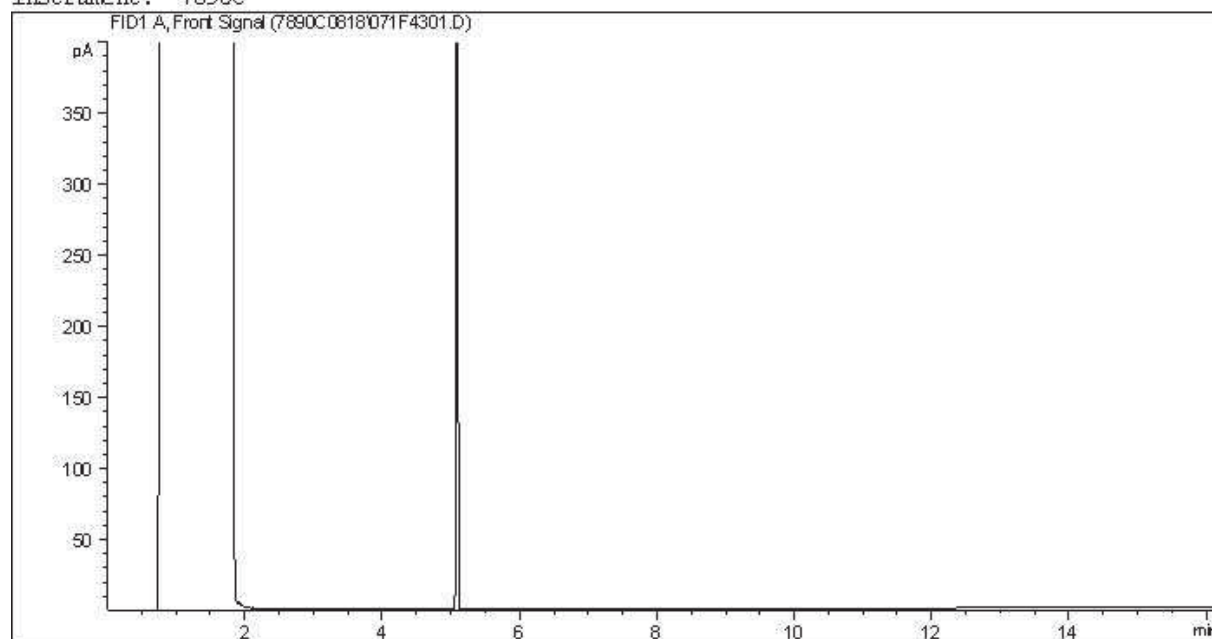
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769817
Report Date: 2017/08/24
Maxxam Sample: RT4337

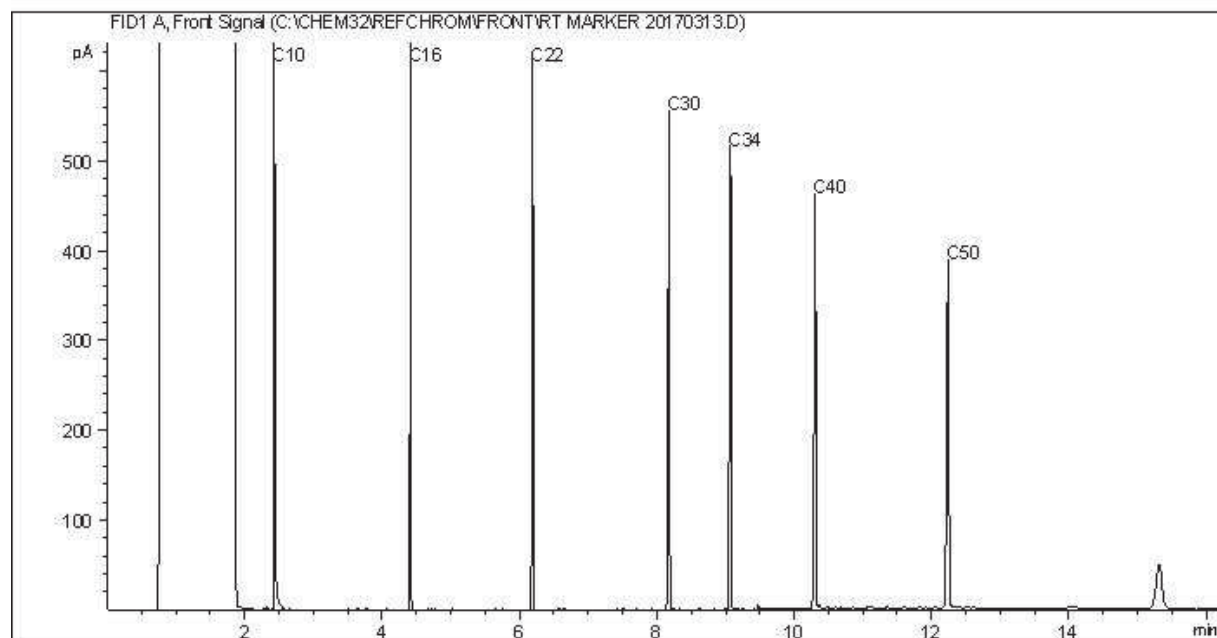
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: Norman Wells
Client ID: NWD 17-16

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

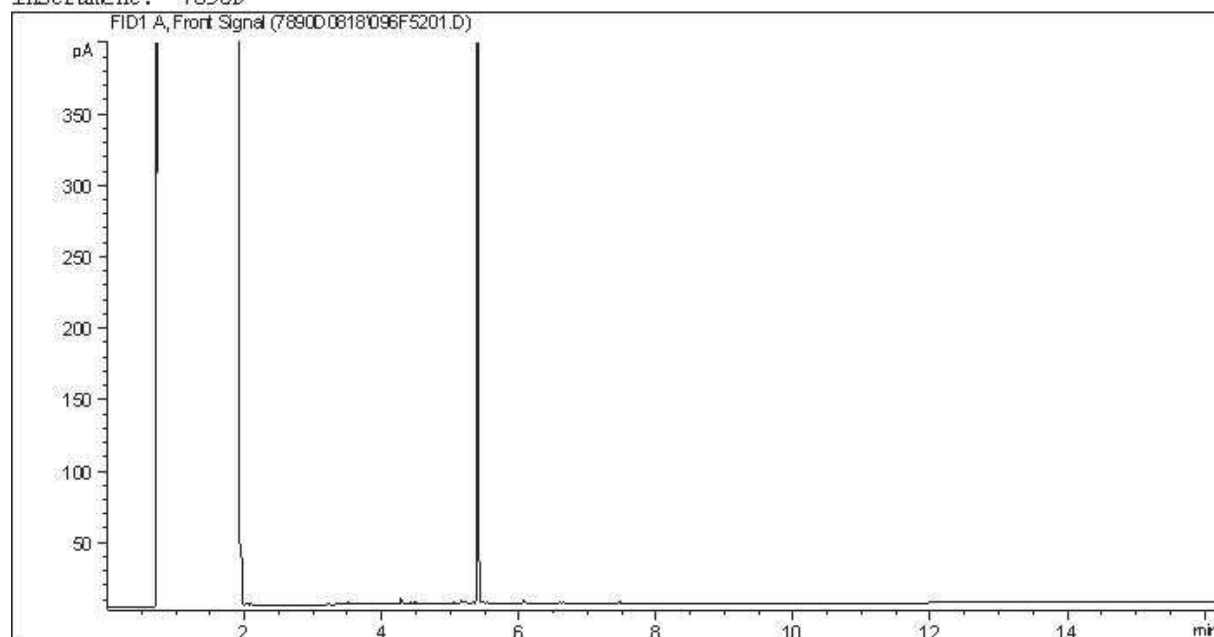
Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

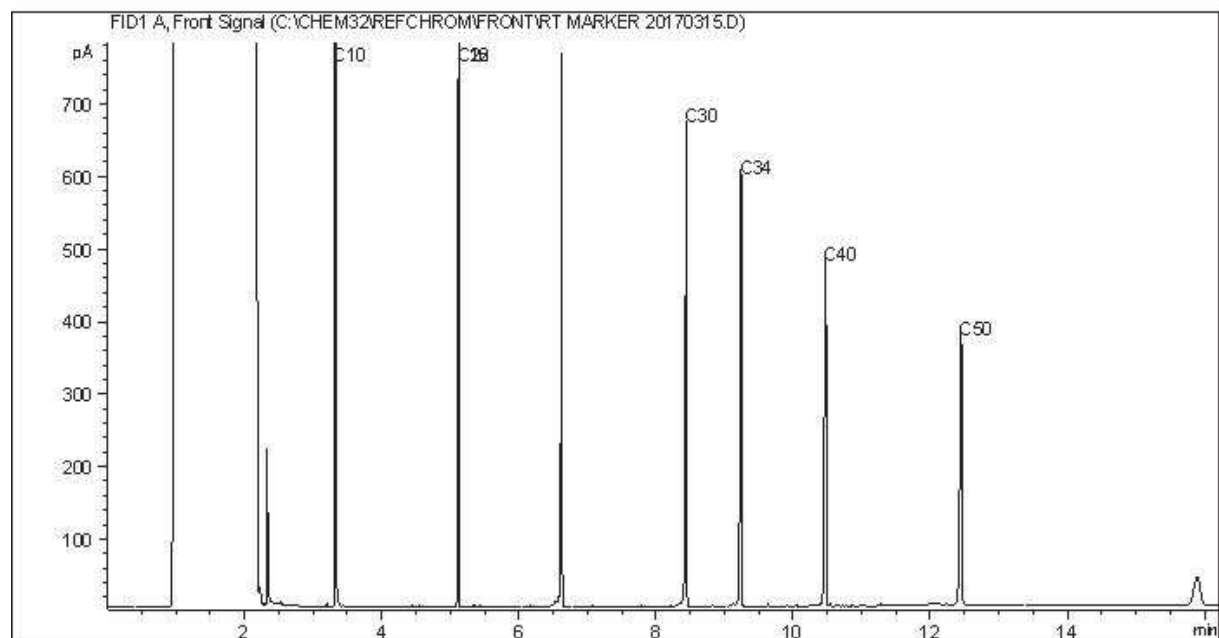
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



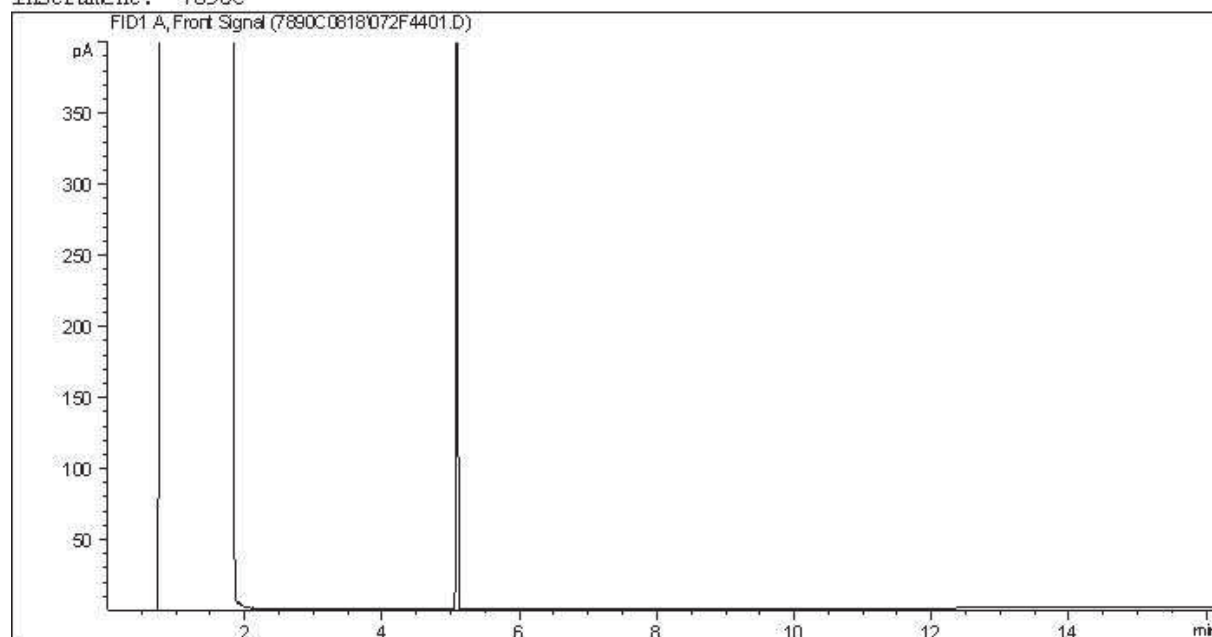
TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

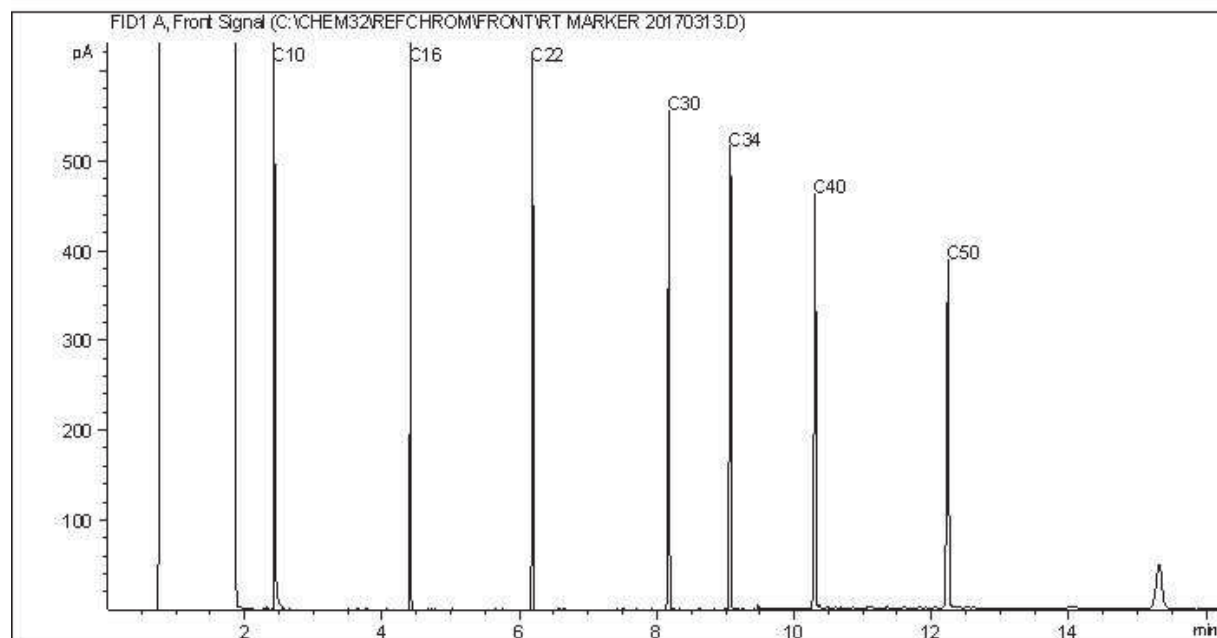
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CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890C



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED														TURNAROUND TIME					
Company Name: ☒ Imperial Oil ☐ ExxonMobil				Company Name: WorleyParsons				PHCS (FRACTIONS 1-2 PLUS BTEX)				PHCS (FRACTIONS 1-4 PLUS BTEX)				PHCS (FRACTIONS 2-4)				# JARS USED & NOT SUBMITTED							
Contact Name: Shalini Jasra				Contact Name: Stacy Gibbs				PAH				VOC				SPECIAL INSTRUCTIONS Also email:				Standard (5 days)							
Address: 505 Quarry Park Blvd SE				Address: Suite 506				LAB FILTERED & PRESERVED				TEXTURE (% SAND, SILT, CLAY)				ROUTINE POTABILITY				Rush (3 days)							
Calgary, AB T2C 5N1				Calgary, AB T3B 6B7				FIELD FILTRATION REQUIRED				GRAIN SIZE (75 MICRON)				FERTILIZER SOIL				(2 days)							
Email: g.shalini.s.jasra@esso.ca				Email: stacy.gibbs@edvision.com				DATE				PARTICLE SIZE DISTRIBUTION WITH GRAPH				FERTILIZER WATER				(1 day)							
Ph: 587-476-2461				Ph: 403-247-0200				TIME (24 HR)				TEXTURE (% SAND, SILT, CLAY)				NUTRIENTS SOIL				(same day)							
Sampler Name (Print):				Consultant Project #:				SAMPLING				TEXTURE (% SAND, SILT, CLAY)				ROUTINE POTABILITY											
Melanie Jones, Michelle Vokaty				407011-06526				DATE				TEXTURE (% SAND, SILT, CLAY)				ROUTINE POTABILITY											
								TIME (24 HR)				TEXTURE (% SAND, SILT, CLAY)				ROUTINE POTABILITY											
								TIME (24 HR)				TEXTURE (% SAND, SILT, CLAY)				ROUTINE POTABILITY											
1027-16-2-3				8 201710815 16:10				X				X				X				X				X			
2 NWD 17-2-4				8 201710815 16:15				X				X				X				X				X			
3 BIRG-12-2-4				10 201710815 13:30				X				X				X				X				X			
4 B1-08-2-3				2 201710815 13:50				X				X				X				X				X			
5 NWD 17-1-6				4 201710815 17:15				X				X				X				X				X			
6 NWR 09-3-20				4 201710815 15:30				X				X				X				X				X			
7 NWR 98-13-21				8 201710815 16:00				X				X				X				X				X			
8 B1-13-1-4				8 201710815 12:05				X				X				X				X				X			
9																											
10																											
IOL SITE LOCATION				NORMAN WELLS, NT				REGULATORY CRITERIA / DETECTION LIMITS:				CDWG				N/A				N/A							
IOL PROJECT # (if applicable)				N/A				SEOG (SK)				N/A				N/A				N/A							
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM				4502 490 593 + 00010				CCME (incl. level)				FAL				FAL				FAL							
SEAL PRESENT				YES NO				COOLER ID #				YES NO				COOLER ID #				YES NO							
SEAL INTACT				3 1 3				TEMP °C				TEMP °C				TEMP °C				TEMP °C							
COOLING MEDIA PRESENT				3 1 3				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT				COOLING MEDIA PRESENT							
RELINQUISHED BY:				DATE:				TIME (24 HR)				RECEIVED BY:				TIME (24 HR)				DATE:							
1. Melanie Jones				201710816 08:00				1. Danielle Boivin				20170817 09:35				1. Danielle Boivin				20170817 09:35							
2.								2.				2.				2.				2.							
3.								3.				3.				3.				3.							

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 15-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407011-00526-100

Sample Submission Number: B769817

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			Matrix spike recovery of F1 (C6-C10) (68%) did not meet acceptance criteria (70-130%) for sample C27-16 2-3. Laboratory control sample recovery of Benzo[e]pyrene (135%), Benzo(a)anthracene (132%) and TERPHENYL-D14 (sur.) (140%) did not meet acceptance criteria (50-130%). All other laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery		x		
Lab Control Sample Recovery		x		

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	x			All field QC samples met alert limits.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD	x			

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

Yes

Date DQW was Received: 24-Aug-17

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 01-Sep-17

Data Reviewed by (Signature):



Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400
Your C.O.C. #: 292821

Report Date: 2017/12/01

Report #: R2485164

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7A4584

Received: 2017/11/24, 10:22

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	2	AB SOP-00005	SM 22 2320 B m
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
Cadmium - low level CCME - Dissolved	2	AB WI-00065	Auto Calc
Chloride by Automated Colourimetry	2	AB SOP-00020	SM 22 4500-Cl-E m
Conductivity @25C	2	AB SOP-00005	SM 22 2510 B m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS m
Hardness	2	AB WI-00065	Auto Calc
Mercury - Low Level (Dissolved) (2)	2	EENVSOP-00031	EPA 1631E/245.1 R3 m
Elements by ICP - Dissolved (2)	2	AB SOP-00042	EPA 200.7 CFR 2012 m
Elements by ICPMS - Dissolved (2)	2	AB SOP-00043	EPA 200.8 R5.4 m
Ion Balance	2	AB WI-00065	Auto Calc
Nitrate and Nitrite	2	AB WI-00065	Auto Calc
Nitrate + Nitrite-N (calculated)	2	AB WI-00065	Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	2	AB SOP-00023	SM 23 4110 B m
Phenols (4-AAP)	2	EENVSOP-00061	MMCW 154 1996 m
Sulphate by Automated Colourimetry	2	AB SOP-00018	SM 22 4500-SO4 E m
Total Dissolved Solids (Filt. Residue)	2	AB SOP-00065	SM 22 2540 C 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. All samples were analyzed within hold time unless otherwise flagged.

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

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502488789
Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400
Your C.O.C. #: 292821

Report Date: 2017/12/01

Report #: R2485164

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7A4584

Received: 2017/11/24, 10:22

dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

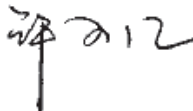
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) Silica gel clean up employed.

(2) Dissolved > Total Imbalance: Whenever applicable, Dissolved > Total for any parameter that falls within method uncertainty for duplicates is likely equivalent. If RPD is >20% samples were reanalyzed and confirmed.

Encryption Key



Mary Xu
Project Manager I
01 Dec 2017 13:49:16

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

=====

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Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		SN8944	SN8945			SN8945		
Sampling Date		2017/11/22 11:00	2017/11/22 11:30			2017/11/22 11:30		
COC Number		292821	292821			292821		
	UNITS	BIS 97-1-3	BI-13-3-4.5	RDL	QC Batch	BI-13-3-4.5 Lab-Dup	RDL	QC Batch
Ext. Pet. Hydrocarbon								
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8842083			
Volatiles								
Benzene	mg/L	<0.00040	<0.00040	0.00040	8842643	<0.00040	0.00040	8842643
Toluene	mg/L	<0.00040	<0.00040	0.00040	8842643	<0.00040	0.00040	8842643
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8842643	<0.00040	0.00040	8842643
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8842643	<0.00080	0.00080	8842643
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8842643	<0.00040	0.00040	8842643
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8842643	<0.00080	0.00080	8842643
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8842643	<0.10	0.10	8842643
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8842643	<0.10	0.10	8842643
Extraction Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	97	98		8842083			
Instrument Surrogate Recovery (%)								
1,4-Difluorobenzene (sur.)	%	98	98		8842643	99		8842643
4-Bromofluorobenzene (sur.)	%	102	103		8842643	102		8842643
D4-1,2-Dichloroethane (sur.)	%	108	105		8842643	105		8842643
RDL = Reportable Detection Limit Lab-Dup = Laboratory Initiated Duplicate								

Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		SN8944	SN8945		
Sampling Date		2017/11/22 11:00	2017/11/22 11:30		
COC Number		292821	292821		
	UNITS	BIS 97-1-3	BI-13-3-4.5	RDL	QC Batch
Low Level Elements					
Dissolved Cadmium (Cd)	mg/L	0.000030	0.000071	0.000020	8841298
Elements					
Dissolved Aluminum (Al)	mg/L	0.0094	0.0081	0.0030	8842028
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	0.00060	8842028
Dissolved Arsenic (As)	mg/L	0.0021	0.0016	0.00020	8842028
Dissolved Barium (Ba)	mg/L	0.030	0.045	0.010	8841530
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	0.0010	8842028
Dissolved Boron (B)	mg/L	<0.020	<0.020	0.020	8841530
Dissolved Calcium (Ca)	mg/L	240	280	0.30	8841530
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	0.0010	8842028
Dissolved Cobalt (Co)	mg/L	0.0028	0.0031	0.00030	8842028
Dissolved Copper (Cu)	mg/L	0.00099	0.00094	0.00020	8842028
Dissolved Iron (Fe)	mg/L	22	4.0	0.060	8841530
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	0.00020	8842028
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	0.020	8841530
Dissolved Magnesium (Mg)	mg/L	91	120	0.20	8841530
Dissolved Manganese (Mn)	mg/L	0.86	0.49	0.0040	8841530
Dissolved Molybdenum (Mo)	mg/L	0.0051	0.017	0.00020	8842028
Dissolved Nickel (Ni)	mg/L	0.0092	0.019	0.00050	8842028
Dissolved Phosphorus (P)	mg/L	<0.10	<0.10	0.10	8841530
Dissolved Potassium (K)	mg/L	3.8	2.3	0.30	8841530
Dissolved Selenium (Se)	mg/L	0.0012	0.0012	0.00020	8842028
Dissolved Silicon (Si)	mg/L	6.7	5.5	0.10	8841530
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	0.00010	8842028
Dissolved Sodium (Na)	mg/L	19	13	0.50	8841530
Dissolved Strontium (Sr)	mg/L	0.70	0.81	0.020	8841530
Dissolved Sulphur (S)	mg/L	39	250	0.20	8841530
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	0.00020	8842028
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	0.0010	8842028
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	0.0010	8842028
RDL = Reportable Detection Limit					

Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
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Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

REGULATED METALS INCLUDING MERCURY-DISS (WATER)

Maxxam ID		SN8944	SN8945		
Sampling Date		2017/11/22 11:00	2017/11/22 11:30		
COC Number		292821	292821		
	UNITS	BIS 97-1-3	BI-13-3-4.5	RDL	QC Batch
Dissolved Uranium (U)	mg/L	0.0019	0.0083	0.00010	8842028
Dissolved Vanadium (V)	mg/L	0.0013	0.0010	0.0010	8842028
Dissolved Zinc (Zn)	mg/L	0.0041	0.012	0.0030	8842028
Low Level Elements					
Dissolved Mercury (Hg)	mg/L	<0.0000020	<0.0000020	0.0000020	8845933
RDL = Reportable Detection Limit					

Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		SN8944			SN8944			SN8945		
Sampling Date		2017/11/22 11:00			2017/11/22 11:00			2017/11/22 11:30		
COC Number		292821			292821			292821		
	UNITS	BIS 97-1-3	RDL	QC Batch	BIS 97-1-3 Lab-Dup	RDL	QC Batch	BI-13-3-4.5	RDL	QC Batch
Calculated Parameters										
Hardness (CaCO ₃)	mg/L	980	0.50	8841630				1200	0.50	8841630
Ion Balance (% Difference)	%	4.2	N/A	8841631				2.9	N/A	8841631
Dissolved Nitrate (NO ₃)	mg/L	0.22	0.044	8841634				0.19	0.044	8841634
Nitrate plus Nitrite (N)	mg/L	0.068	0.014	8841635				0.043	0.014	8841635
Dissolved Nitrite (NO ₂)	mg/L	0.062	0.033	8841634				<0.033	0.033	8841634
Misc. Inorganics										
Conductivity	uS/cm	1700	2.0	8845087				1800	2.0	8848594
Total Dissolved Solids	mg/L	940 (1)	50	8843337				1500	10	8843337
Anions										
Alkalinity (PP as CaCO ₃)	mg/L	<1.0	1.0	8845086				<1.0	1.0	8848593
Alkalinity (Total as CaCO ₃)	mg/L	840	1.0	8845086				440	1.0	8848593
Bicarbonate (HCO ₃)	mg/L	1000	1.0	8845086				530	1.0	8848593
Carbonate (CO ₃)	mg/L	<1.0	1.0	8845086				<1.0	1.0	8848593
Hydroxide (OH)	mg/L	<1.0	1.0	8845086				<1.0	1.0	8848593
Dissolved Sulphate (SO ₄)	mg/L	110	1.0	8842653				700 (2)	5.0	8842653
Dissolved Chloride (Cl)	mg/L	20	1.0	8842652				6.5	1.0	8842652
Nutrients										
Dissolved Nitrite (N)	mg/L	0.019	0.010	8842307	0.019	0.010	8842307	<0.010	0.010	8842307
Dissolved Nitrate (N)	mg/L	0.050	0.010	8842307	0.050	0.010	8842307	0.043	0.010	8842307
Misc. Organics										
Phenols	mg/L	0.014	0.0020	8843613				0.0038	0.0020	8843613

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

(1) Detection limit raised based on sample volume used for analysis.

(2) Detection limits raised due to dilution to bring analyte within the calibrated range.

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Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

TEST SUMMARY

Maxxam ID: SN8944
Sample ID: BIS 97-1-3
Matrix: Water

Collected: 2017/11/22
Relinquished: 2017/11/23
Received: 2017/11/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8845086	N/A	2017/11/28	Malina Alamyar
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8842643	N/A	2017/11/26	Harneet Gill
Cadmium - low level CCME - Dissolved	ICPM/MS	8841298	N/A	2017/11/27	Automated Statchk
Chloride by Automated Colourimetry	KONE	8842652	N/A	2017/11/29	Chelsea Harmatys
Conductivity @25C	COND	8845087	N/A	2017/11/28	Malina Alamyar
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8842083	2017/11/25	2017/11/25	Kelsey Holt
Hardness	CALC	8841630	N/A	2017/11/27	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8845933	2017/11/29	2017/11/29	Andrew Payne
Elements by ICP - Dissolved	ICPA	8841530	N/A	2017/11/26	Queen Acharya
Elements by ICPMS - Dissolved	ICPM	8842028	N/A	2017/11/25	Andrew Payne
Ion Balance	CALC	8841631	N/A	2017/11/26	Automated Statchk
Nitrate and Nitrite	CALC	8841634	N/A	2017/11/27	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8841635	N/A	2017/11/27	Automated Statchk
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8842307	N/A	2017/11/26	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8843613	N/A	2017/11/27	Ying Yang
Sulphate by Automated Colourimetry	KONE	8842653	N/A	2017/11/29	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8843337	2017/11/27	2017/11/28	Kruti Patel

Maxxam ID: SN8944 Dup
Sample ID: BIS 97-1-3
Matrix: Water

Collected: 2017/11/22
Relinquished: 2017/11/23
Received: 2017/11/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8842307	N/A	2017/11/26	Krista Dawe

Maxxam ID: SN8945
Sample ID: BI-13-3-4.5
Matrix: Water

Collected: 2017/11/22
Relinquished: 2017/11/23
Received: 2017/11/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Alkalinity @25C (pp, total), CO ₃ ,HCO ₃ ,OH	AT/ALK	8848593	N/A	2017/12/01	Malina Alamyar
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8842643	N/A	2017/11/26	Harneet Gill
Cadmium - low level CCME - Dissolved	ICPM/MS	8841298	N/A	2017/11/27	Automated Statchk
Chloride by Automated Colourimetry	KONE	8842652	N/A	2017/11/29	Chelsea Harmatys
Conductivity @25C	COND	8848594	N/A	2017/12/01	Malina Alamyar
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8842083	2017/11/25	2017/11/25	Kelsey Holt
Hardness	CALC	8841630	N/A	2017/11/27	Automated Statchk
Mercury - Low Level (Dissolved)	CV/AF	8845933	2017/11/29	2017/11/29	Andrew Payne
Elements by ICP - Dissolved	ICPA	8841530	N/A	2017/11/26	Queen Acharya
Elements by ICPMS - Dissolved	ICPM	8842028	N/A	2017/11/25	Andrew Payne
Ion Balance	CALC	8841631	N/A	2017/11/26	Automated Statchk
Nitrate and Nitrite	CALC	8841634	N/A	2017/11/27	Automated Statchk
Nitrate + Nitrite-N (calculated)	CALC	8841635	N/A	2017/11/27	Automated Statchk

Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

TEST SUMMARY

Maxxam ID: SN8945
Sample ID: BI-13-3-4.5
Matrix: Water

Collected: 2017/11/22
Relinquished: 2017/11/23
Received: 2017/11/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrogen (Nitrite - Nitrate) by IC	IC/UV	8842307	N/A	2017/11/25	Krista Dawe
Phenols (4-AAP)	TECH/4AAP	8843613	N/A	2017/11/27	Ying Yang
Sulphate by Automated Colourimetry	KONE	8842653	N/A	2017/11/29	Chelsea Harmatys
Total Dissolved Solids (Filt. Residue)	BAL	8843337	2017/11/27	2017/11/28	Kruti Patel

Maxxam ID: SN8945 Dup
Sample ID: BI-13-3-4.5
Matrix: Water

Collected: 2017/11/22
Relinquished: 2017/11/23
Received: 2017/11/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8842643	N/A	2017/11/26	Harneet Gill

Maxxam Job #: B7A4584
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WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.0°C

Sample SN8944 [BIS 97-1-3] : Nitrogen (Nitrite - Nitrate) by IC completed within 48h after laboratory receipt to a maximum of five days from sampling is satisfactory for compliance purposes.

Results relate only to the items tested.

Maxxam Job #: B7A4584

Report Date: 2017/12/01

WORLEY PARSONS

Task Order#: 4502488789, Line Item: 10

Site#:

Site Location: NORMAN WELLS, NT

Project #: 407074-00828-400

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8841530	ACY	Method Blank	Dissolved Iron (Fe)	2017/11/26	<0.060		mg/L	
			Dissolved Lithium (Li)	2017/11/26	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2017/11/26	<0.20		mg/L	
			Dissolved Manganese (Mn)	2017/11/26	<0.0040		mg/L	
			Dissolved Potassium (K)	2017/11/26	<0.30		mg/L	
			Dissolved Sodium (Na)	2017/11/26	<0.50		mg/L	
			Dissolved Strontium (Sr)	2017/11/26	<0.020		mg/L	
			Dissolved Sulphur (S)	2017/11/26	<0.20		mg/L	
			Dissolved Phosphorus (P)	2017/11/26	<0.10		mg/L	
			Dissolved Barium (Ba)	2017/11/26	<0.010		mg/L	
			Dissolved Silicon (Si)	2017/11/26	<0.10		mg/L	
			Dissolved Boron (B)	2017/11/26	<0.020		mg/L	
			Dissolved Calcium (Ca)	2017/11/26	<0.30		mg/L	
8842028	APY	Method Blank	Dissolved Aluminum (Al)	2017/11/26	<0.0030		mg/L	
			Dissolved Chromium (Cr)	2017/11/26	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2017/11/26	<0.00030		mg/L	
			Dissolved Copper (Cu)	2017/11/26	<0.00020		mg/L	
			Dissolved Lead (Pb)	2017/11/26	<0.00020		mg/L	
			Dissolved Antimony (Sb)	2017/11/26	<0.00060		mg/L	
			Dissolved Molybdenum (Mo)	2017/11/26	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2017/11/26	<0.00050		mg/L	
			Dissolved Selenium (Se)	2017/11/26	<0.00020		mg/L	
			Dissolved Silver (Ag)	2017/11/26	<0.00010		mg/L	
			Dissolved Arsenic (As)	2017/11/26	<0.00020		mg/L	
			Dissolved Thallium (Tl)	2017/11/26	<0.00020		mg/L	
			Dissolved Tin (Sn)	2017/11/26	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2017/11/26	<0.0010		mg/L	
			Dissolved Uranium (U)	2017/11/26	<0.00010		mg/L	
			Dissolved Vanadium (V)	2017/11/26	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2017/11/26	<0.0030		mg/L	
			Dissolved Beryllium (Be)	2017/11/26	<0.0010		mg/L	
8842083	KHO	Method Blank	O-TERPHENYL (sur.)	2017/11/25		111	%	60 - 130
8842307	KD5	Method Blank	F2 (C10-C16 Hydrocarbons)	2017/11/25	<0.10		mg/L	
			Dissolved Nitrite (N)	2017/11/25	<0.010		mg/L	
8842643	HG3	Method Blank	Dissolved Nitrate (N)	2017/11/25	<0.010		mg/L	
			1,4-Difluorobenzene (sur.)	2017/11/26		99	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/11/26		102	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/11/26		102	%	70 - 130
			Benzene	2017/11/26	<0.00040		mg/L	
			Toluene	2017/11/26	<0.00040		mg/L	
			Ethylbenzene	2017/11/26	<0.00040		mg/L	
			m & p-Xylene	2017/11/26	<0.00080		mg/L	
			o-Xylene	2017/11/26	<0.00040		mg/L	
			Xylenes (Total)	2017/11/26	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/11/26	<0.10		mg/L	
			F1 (C6-C10)	2017/11/26	<0.10		mg/L	
8842652	CH7	Method Blank	Dissolved Chloride (Cl)	2017/11/29	<1.0		mg/L	
8842653	CH7	Method Blank	Dissolved Sulphate (SO4)	2017/11/29	<1.0		mg/L	
8843337	KPG	Method Blank	Total Dissolved Solids	2017/11/28	<10		mg/L	
8843613	YY	Method Blank	Phenols	2017/11/27	<0.0020		mg/L	
8845086	MA4	Method Blank	Alkalinity (Total as CaCO3)	2017/11/28	<1.0		mg/L	

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WORLEY PARSONS
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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8845087	MA4	Method Blank	Alkalinity (PP as CaCO ₃)	2017/11/28	<1.0		mg/L	
			Bicarbonate (HCO ₃)	2017/11/28	<1.0		mg/L	
			Carbonate (CO ₃)	2017/11/28	<1.0		mg/L	
			Hydroxide (OH)	2017/11/28	<1.0		mg/L	
			Conductivity	2017/11/28	<2.0		uS/cm	
8845933	APY	Method Blank	Dissolved Mercury (Hg)	2017/11/29	<0.0000020		mg/L	
8848593	MA4	Method Blank	Alkalinity (Total as CaCO ₃)	2017/12/01	<1.0		mg/L	
			Alkalinity (PP as CaCO ₃)	2017/12/01	<1.0		mg/L	
			Bicarbonate (HCO ₃)	2017/12/01	<1.0		mg/L	
			Carbonate (CO ₃)	2017/12/01	<1.0		mg/L	
			Hydroxide (OH)	2017/12/01	<1.0		mg/L	
8848594	MA4	Method Blank	Conductivity	2017/12/01	<2.0		uS/cm	
8842307	KD5	RPD [SN8944-01]	Dissolved Nitrite (N)	2017/11/26	1.8		%	20
			Dissolved Nitrate (N)	2017/11/26	1.0		%	20
8842643	HG3	RPD [SN8945-06]	Benzene	2017/11/26	NC		%	30
			Toluene	2017/11/26	NC		%	30
			Ethylbenzene	2017/11/26	NC		%	30
			m & p-Xylene	2017/11/26	NC		%	30
			o-Xylene	2017/11/26	NC		%	30
			Xylenes (Total)	2017/11/26	NC		%	30
			F1 (C6-C10) - BTEX	2017/11/26	NC		%	30
			F1 (C6-C10)	2017/11/26	NC		%	30
			Dissolved Nitrite (N)	2017/11/25		98	%	80 - 120
			Dissolved Nitrate (N)	2017/11/25		98	%	80 - 120
8841530	ACY	LCS	Dissolved Iron (Fe)	2017/11/26		98	%	80 - 120
			Dissolved Lithium (Li)	2017/11/26		98	%	80 - 120
			Dissolved Magnesium (Mg)	2017/11/26		97	%	80 - 120
			Dissolved Manganese (Mn)	2017/11/26		98	%	80 - 120
			Dissolved Potassium (K)	2017/11/26		102	%	80 - 120
			Dissolved Sodium (Na)	2017/11/26		96	%	80 - 120
			Dissolved Strontium (Sr)	2017/11/26		92	%	80 - 120
			Dissolved Phosphorus (P)	2017/11/26		98	%	80 - 120
			Dissolved Barium (Ba)	2017/11/26		95	%	80 - 120
			Dissolved Silicon (Si)	2017/11/26		96	%	80 - 120
			Dissolved Boron (B)	2017/11/26		100	%	80 - 120
			Dissolved Calcium (Ca)	2017/11/26		98	%	80 - 120
			Dissolved Aluminum (Al)	2017/11/26		100	%	80 - 120
			Dissolved Chromium (Cr)	2017/11/26		98	%	80 - 120
			Dissolved Cobalt (Co)	2017/11/26		98	%	80 - 120
8842028	APY	LCS	Dissolved Copper (Cu)	2017/11/26		98	%	80 - 120
			Dissolved Lead (Pb)	2017/11/26		98	%	80 - 120
			Dissolved Antimony (Sb)	2017/11/26		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2017/11/26		101	%	80 - 120
			Dissolved Nickel (Ni)	2017/11/26		97	%	80 - 120
			Dissolved Selenium (Se)	2017/11/26		100	%	80 - 120
			Dissolved Silver (Ag)	2017/11/26		97	%	80 - 120
			Dissolved Arsenic (As)	2017/11/26		99	%	80 - 120
			Dissolved Thallium (Tl)	2017/11/26		101	%	80 - 120
			Dissolved Tin (Sn)	2017/11/26		95	%	80 - 120
			Dissolved Titanium (Ti)	2017/11/26		95	%	80 - 120
			Dissolved Uranium (U)	2017/11/26		97	%	80 - 120

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WORLEY PARSONS
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QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8842083	KHO	LCS	Dissolved Vanadium (V)	2017/11/26		98	%	80 - 120
			Dissolved Zinc (Zn)	2017/11/26		95	%	80 - 120
			Dissolved Beryllium (Be)	2017/11/26		97	%	80 - 120
			O-TERPHENYL (sur.)	2017/11/25		97	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/11/25		98	%	70 - 130
8842307	KD5	LCS	Dissolved Nitrite (N)	2017/11/25		100	%	80 - 120
			Dissolved Nitrate (N)	2017/11/25		100	%	80 - 120
8842643	HG3	LCS	1,4-Difluorobenzene (sur.)	2017/11/27		95	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/11/27		104	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/11/27		101	%	70 - 130
			Benzene	2017/11/27		98	%	70 - 130
			Toluene	2017/11/27		95	%	70 - 130
			Ethylbenzene	2017/11/27		103	%	70 - 130
			m & p-Xylene	2017/11/27		103	%	70 - 130
			o-Xylene	2017/11/27		102	%	70 - 130
			F1 (C6-C10)	2017/11/27		96	%	70 - 130
8842652	CH7	LCS	Dissolved Chloride (Cl)	2017/11/29		107	%	80 - 120
8842653	CH7	LCS	Dissolved Sulphate (SO4)	2017/11/29		101	%	80 - 120
8843337	KPG	LCS	Total Dissolved Solids	2017/11/28		101	%	80 - 120
8843613	YY	LCS	Phenols	2017/11/27		95	%	80 - 120
8845086	MA4	LCS	Alkalinity (Total as CaCO3)	2017/11/28		99	%	80 - 120
8845087	MA4	LCS	Conductivity	2017/11/28		100	%	90 - 110
8845933	APY	LCS	Dissolved Mercury (Hg)	2017/11/29		100	%	80 - 120
8848593	MA4	LCS	Alkalinity (Total as CaCO3)	2017/12/01		98	%	80 - 120
8848594	MA4	LCS	Conductivity	2017/12/01		100	%	90 - 110
8845933	APY	SRM	Dissolved Mercury (Hg)	2017/11/29		96	%	80 - 120

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.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

LCS: 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.

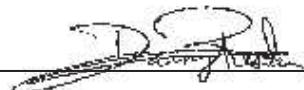
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

Maxxam Job #: B7A4584
Report Date: 2017/12/01

WORLEY PARSONS
Task Order#: 4502488789, Line Item: 10
Site#:
Site Location: NORMAN WELLS, NT
Project #: 407074-00828-400

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Daniel Reslan, cCT, QP, Organics Supervisor

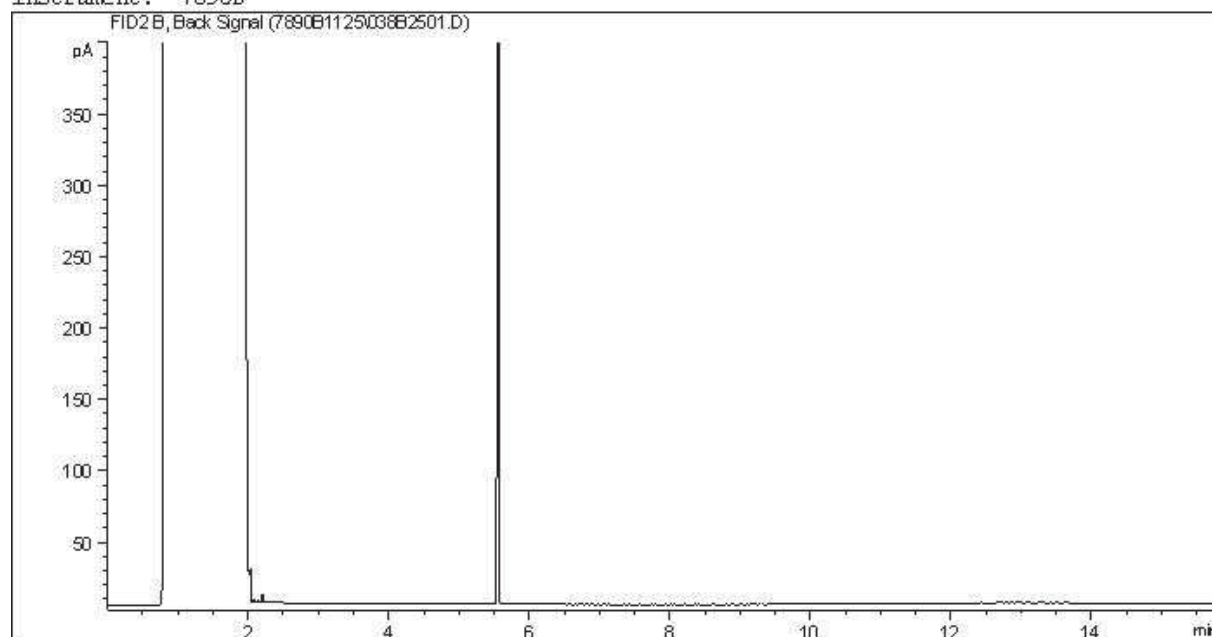


Winnie Au, B.Sc., QP, Scientific Specialist

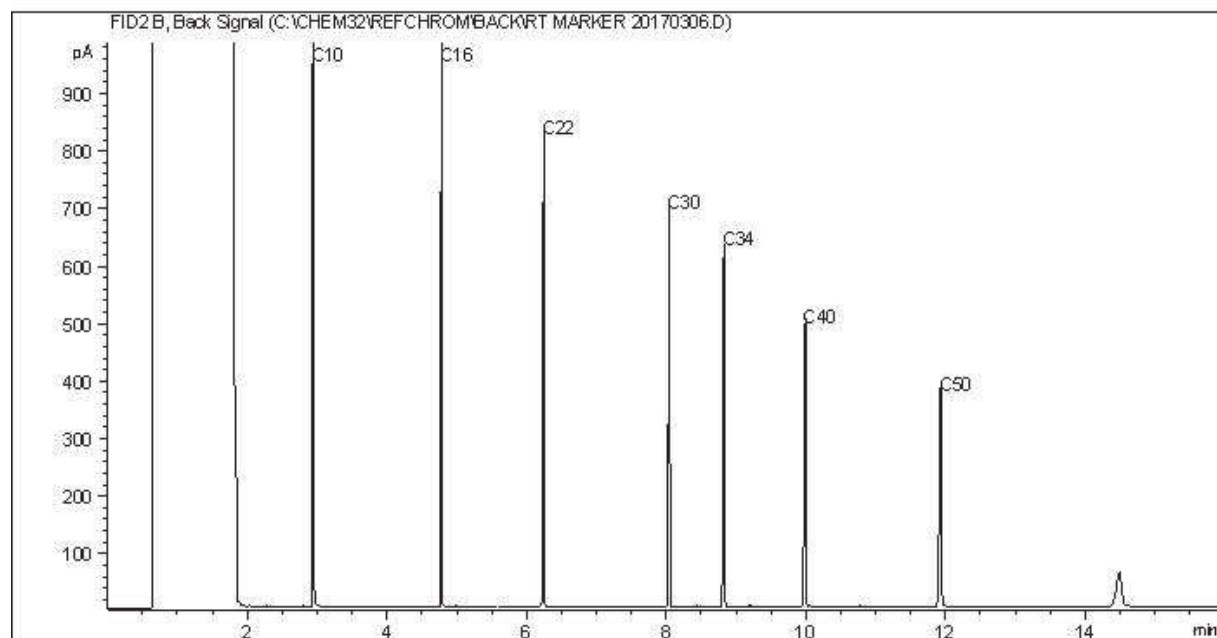
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

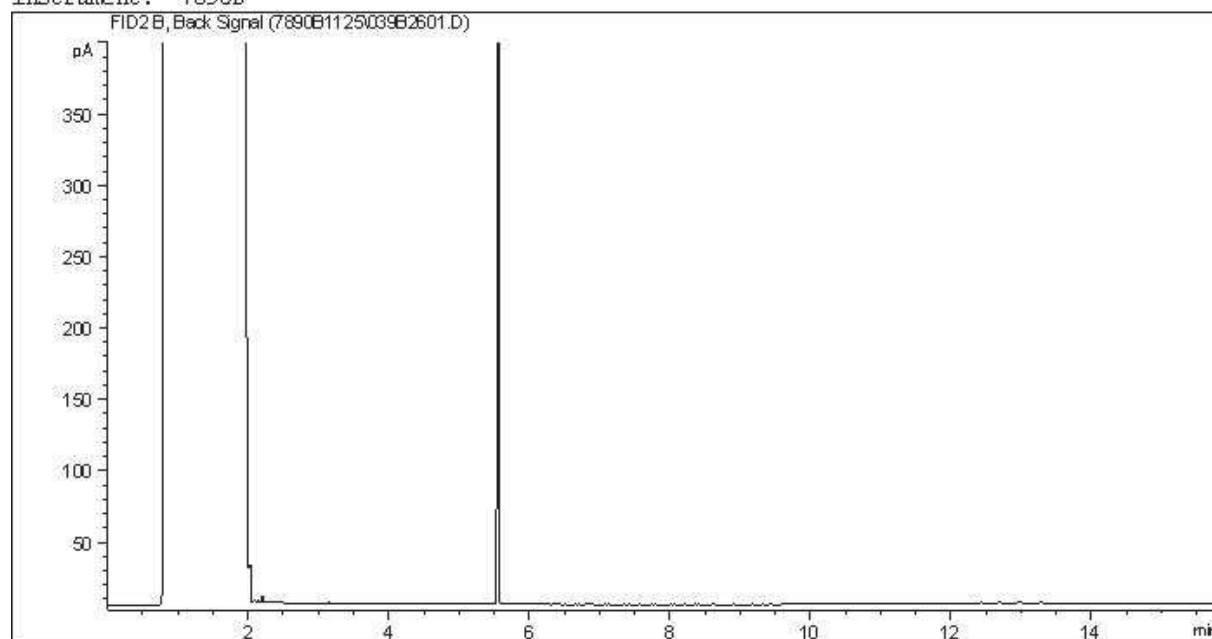
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B7A4584
Report Date: 2017/12/01
Maxxam Sample: SN8945

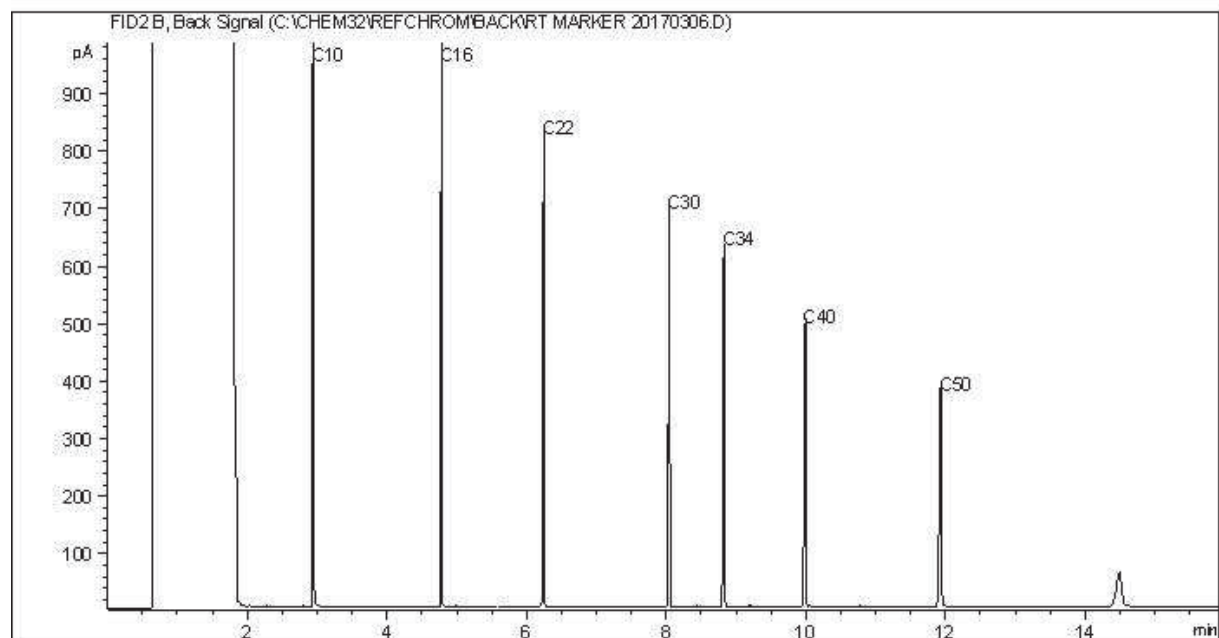
WORLEY PARSONS
Task Order#:450248878910Line Item:10
Site#:
Site Location: NORMAN WELLS, NT
Client ID: BI-13-3-4.5

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED																							
Company Name: ☒ Imperial Oil ☐ ExxonMobil				Company Name: <u>WorleyParsons</u>																											
Contact Name: <u>Sloan Leavitt</u>				Contact Name: <u>Stacy Gibb</u>																											
Address: <u>Bay 5000</u> <u>Norman Wells, NT</u> <u>XOE 000</u>				Address: <u>Suite 500,</u> <u>151 Canada Olympic Rd SW</u> <u>73B 687 Calgary, AB</u>																											
Email: <u>Sloan.Leavitt@esso.ca</u>				Email: <u>Stacy.gibb@advison.com</u>																											
Ph: <u>537-476-4449</u>				Ph: <u>403-247-0200</u>																											
Sampler Name (Print): <u>Devon Greves/Michelle Volaty</u>				Consultant Project #: <u>407074-00328-400</u>																											
FIELD SAMPLE ID		MATRIX		SAMPLING		LAB FILTERED & PRESERVED (24 HR)																									
GROUND WATER	SURFACE WATER	SOIL	OTHER	DATE (YYYY/MM/DD)	TIME	LAB FILTERED & PRESERVED (24 HR)	REQUIRED	VOC	PAH	PHCS (FRACTIONS 1-2 PLUS BTEX)	PHCS (FRACTIONS 1-4 PLUS BTEX)	PHCS (FRACTIONS 2-4)	TEXTURE (% SAND, SILT, CLAY)	PARTICLE SIZE DISTRIBUTION WITH GRAPH	REGULATED METALS TOT ☐ DIS ☒	MERCURY TOTAL ☐ DISSOLVED ☒	SALINITY SOIL	FERTILIZER SOIL	FERTILIZER WATER	NUTRIENTS SOIL	ROUTINE POTABILITY	PH ☐ EC ☐ ALKALINITY ☐	BASIC CLASS II LANDFILL PKG	Phenols (by HPLC)							
X				8/2017/11/22	11:00	X				X						X					X										
X				8/2017/11/22	11:30	X				X						X					X										
3																															
4																															
5																															
6																															
7																															
8																															
9																															
10																															
IOL SITE LOCATION <u>Norman Wells, NT</u>				REGULATORY CRITERIA / DETECTION LIMITS: ☐ Alberta Tier 1 ☐ SEQG (SK) ☒ CCME (incl. level)				SPECIAL INSTRUCTIONS <u>also email: standard norman wells email list</u> <u>devon.greves@advison.com</u> <u>IES A2601436</u>				# JARS USED & NOT SUBMITTED Enter N/A for Water <u>N/A</u>				TURNAROUND TIME Standard (5 days) ☒ Rush (3 days) ☐ (2 days) ☐ (1 day) ☐ (same day) ☐															
IOL PROJECT # (if applicable) <u>N/A</u>																															
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM <u>4502 438 789 100610</u>																															
SEAL PRESENT	YES	NO	COOLER ID #	TEMP °C	1	2	3	SEAL PRESENT	YES	NO	COOLER ID #	TEMP °C	1	2	3	SEAL PRESENT	YES	NO	COOLER ID #	TEMP °C	1	2	3	SEAL PRESENT	YES	NO	COOLER ID #	TEMP °C	1	2	3
SEAL INTACT	☒	☐						SEAL INTACT	☒	☐						SEAL INTACT	☒	☐						SEAL INTACT	☒	☐					
COOLING MEDIA PRESENT	☒	☐						COOLING MEDIA PRESENT	☒	☐						COOLING MEDIA PRESENT	☒	☐						COOLING MEDIA PRESENT	☒	☐					
RELINQUISHED BY: <u>Michelle Volaty</u>				DATE: <u>2017/11/23</u>				RECEIVED BY: <u>Danielle Boisvert</u>				DATE: <u>2017/11/24</u>				TIME (24 HR): <u>10:22</u>															
1. <u>Michelle Volaty</u>				2. <u></u>				3. <u></u>				1. <u></u>				2. <u></u>				3. <u></u>											
COC-1010 (05/2016) IOL-7AB																															

White: Maxxam Yellow: Client

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: <u>Advisian</u>		Sampling Date: <u>22-Nov-17</u>	
Location: <u>Norman Wells</u>		Laboratory : <u>Maxxam Edmonton</u>	
Consultant Project Number: <u>407074-00828-400</u>		Sample Submission Number: <u>B7A4584</u>	

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD	x			
Matrix Spike Recovery	x			
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration			x	No field QC samples submitted.
Trip Blank Concentration			x	
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Were all samples analyzed within hold times (Yes/No)?:

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

Is Chain of Custody completed and signed (Yes/No)?:

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes	<u> </u>
Yes	<u> </u>
Yes	<u> </u>
n/a	<u> </u>
Yes	<u> </u>
Yes	<u> </u>

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

Date Issued: n/a Date of Response: No

Date Issued: n/a Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

If answer is "No", describe and provide rationale:

 Yes

Data Reviewed by (Print): <u>Vivian Baptista</u>	Data Reviewed by (Signature): <u></u>
Date: <u>06-Dec-17</u>	

Attention:STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526
Your C.O.C. #: 294845

Report Date: 2017/08/21

Report #: R2431121

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B768371

Received: 2017/08/14, 09:40

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS 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. All samples were analyzed within hold time unless otherwise flagged.

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) Silica gel clean up employed.

Encryption Key



Jenna Chernuka
Project Manager
21 Aug 2017 13:09:33

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

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.

Maxxam Job #: B768371
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RS6051	RS6052		
Sampling Date		2017/08/12 16:50	2017/08/12 16:45		
COC Number		294845	294845		
	UNITS	NWD 17-03	NWD 17-13	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8728120
Volatiles					
Benzene	mg/L	<0.00040	<0.00040	0.00040	8726457
Toluene	mg/L	<0.00040	<0.00040	0.00040	8726457
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8726457
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8726457
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8726457
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8726457
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8726457
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8726457
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	93	92		8728120
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	97	97		8726457
4-Bromofluorobenzene (sur.)	%	100	99		8726457
D4-1,2-Dichloroethane (sur.)	%	99	101		8726457
RDL = Reportable Detection Limit					

Maxxam Job #: B768371
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RS6051
Sample ID: NWD 17-03
Matrix: Water

Collected: 2017/08/12
Relinquished: 2017/08/13
Received: 2017/08/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8726457	N/A	2017/08/15	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8728120	2017/08/16	2017/08/16	Grace Guo

Maxxam ID: RS6052
Sample ID: NWD 17-13
Matrix: Water

Collected: 2017/08/12
Relinquished: 2017/08/13
Received: 2017/08/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8726457	N/A	2017/08/15	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8728120	2017/08/16	2017/08/16	Grace Guo

Maxxam Job #: B768371
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Results relate only to the items tested.

Maxxam Job #: B768371
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8726457	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/15		97	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/15		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/15		97	%	70 - 130
			Benzene	2017/08/15	<0.00040		mg/L	
			Toluene	2017/08/15	<0.00040		mg/L	
			Ethylbenzene	2017/08/15	<0.00040		mg/L	
			m & p-Xylene	2017/08/15	<0.00080		mg/L	
			o-Xylene	2017/08/15	<0.00040		mg/L	
			Xylenes (Total)	2017/08/15	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/15	<0.10		mg/L	
			F1 (C6-C10)	2017/08/15	<0.10		mg/L	
8728120	GG3	Method Blank	O-TERPHENYL (sur.)	2017/08/16		93	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/16	<0.10		mg/L	
8726457	SES	LCS	1,4-Difluorobenzene (sur.)	2017/08/15		95	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/15		103	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/15		102	%	70 - 130
			Benzene	2017/08/15		97	%	70 - 130
			Toluene	2017/08/15		91	%	70 - 130
			Ethylbenzene	2017/08/15		101	%	70 - 130
			m & p-Xylene	2017/08/15		101	%	70 - 130
			o-Xylene	2017/08/15		102	%	70 - 130
			F1 (C6-C10)	2017/08/15		108	%	70 - 130
			O-TERPHENYL (sur.)	2017/08/16		94	%	60 - 130
8728120	GG3	LCS	F2 (C10-C16 Hydrocarbons)	2017/08/16		100	%	70 - 130

LCS: 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.

Maxxam Job #: B768371
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

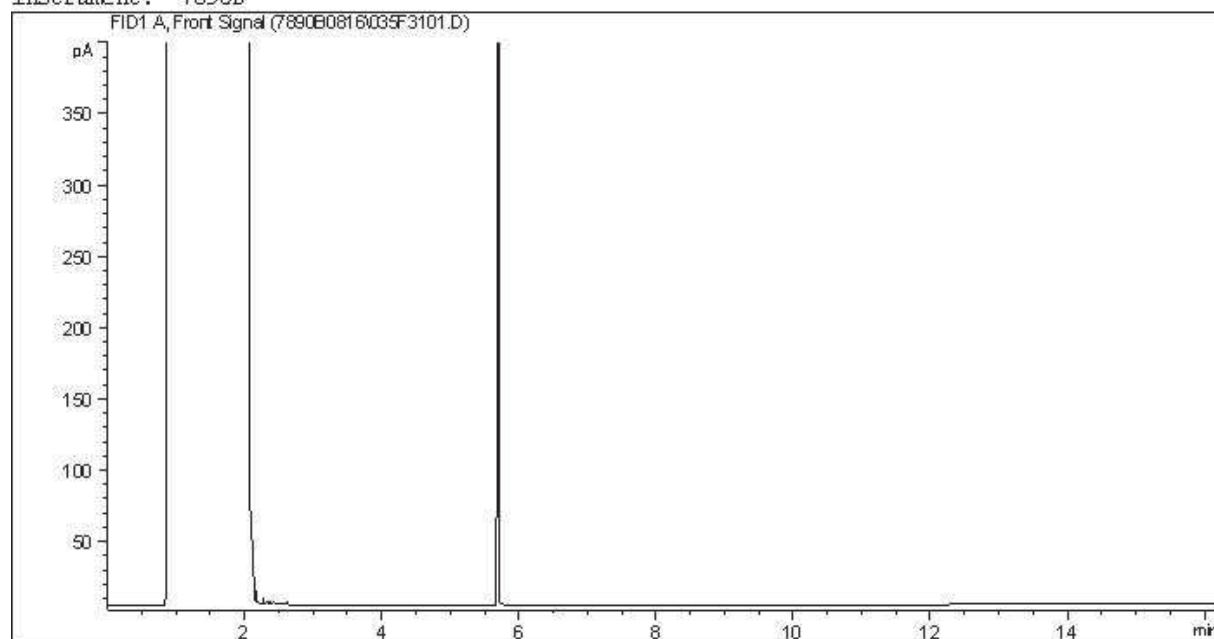
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Maxxam Job #: B768371
Report Date: 2017/08/21
Maxxam Sample: RS6051

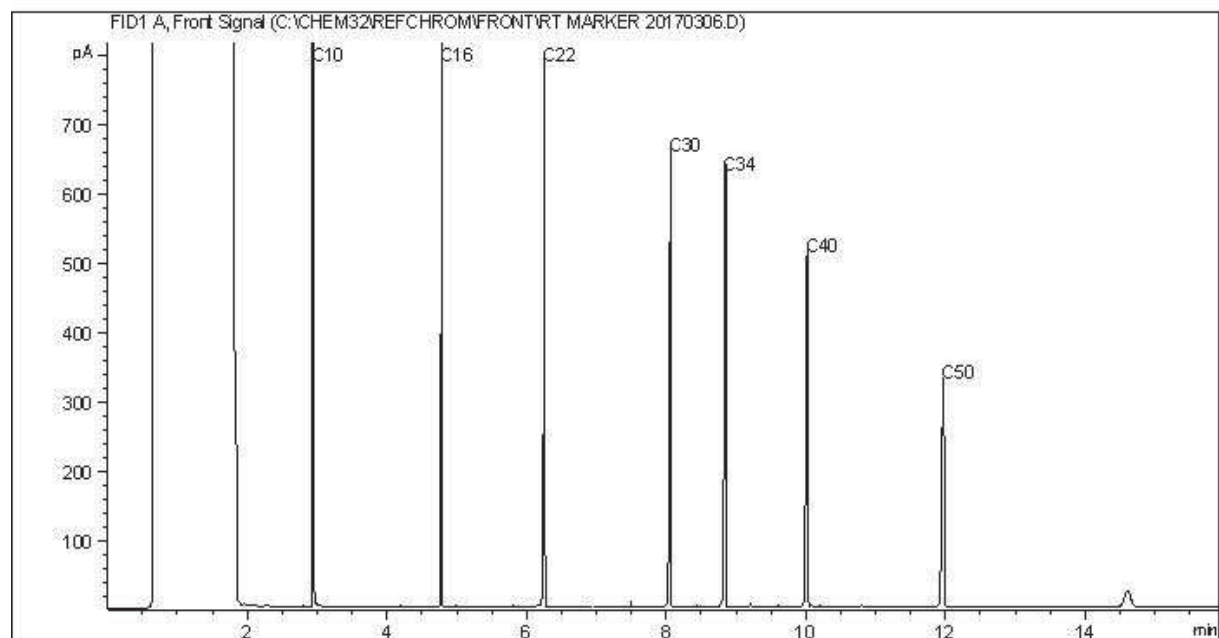
WORLEY PARSONS
Task Order#: 450249059310 Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Client ID: NWD 17-03

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

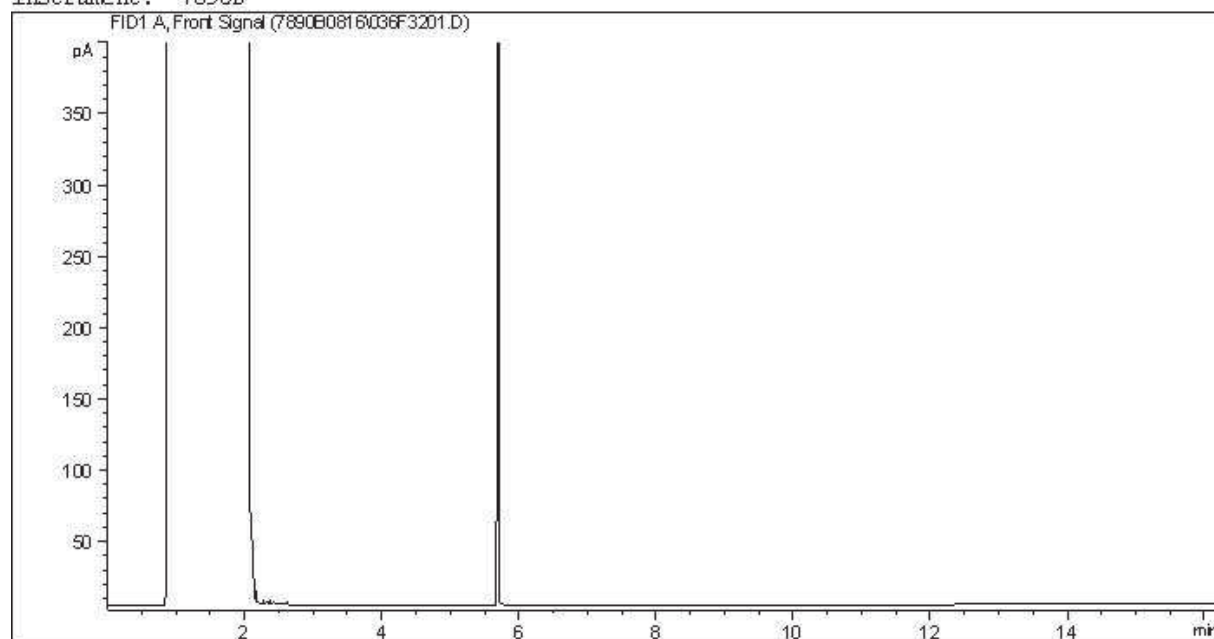
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B768371
Report Date: 2017/08/21
Maxxam Sample: RS6052

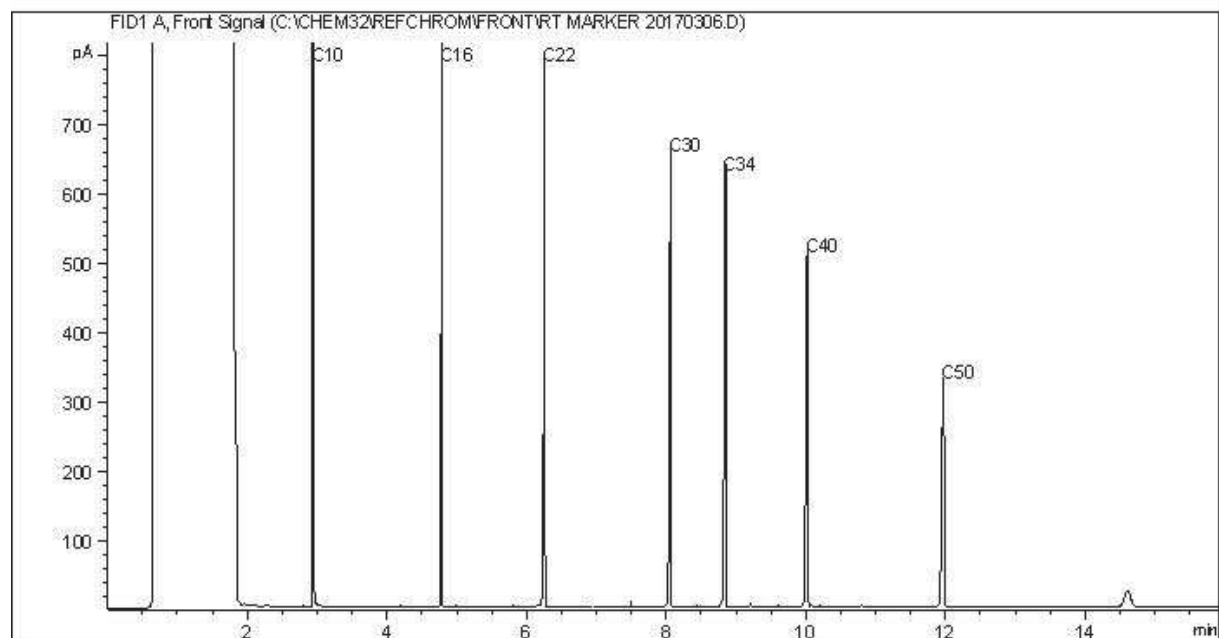
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS, NT
Client ID: NWD 17-13

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: <u>Advisian</u>	Sampling Date: <u>12-Aug-17</u>
Location: <u>Norman Wells</u>	Laboratory : <u>Maxxam Calgary</u>
Consultant Project Number: <u>407011-00526-100</u>	Sample Submission Number: <u>B768371</u>

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	x			All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Were all samples analyzed within hold times (Yes/No)?:

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

Is Chain of Custody completed and signed (Yes/No)?:

Were sample temperatures acceptable when they reached lab (Yes/No)?:

	<u>Yes</u>
	<u>Yes</u>
	<u>Yes</u>
	<u>n/a</u>
	<u>Yes</u>
	<u>Yes</u>

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): <u>Vivian Baptista</u>	Data Reviewed by (Signature): <u></u>
Date: <u>07-Sep-17</u>	

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526
Your C.O.C. #: 294838

Report Date: 2017/08/21
Report #: R2431133
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B769642

Received: 2017/08/17, 09:35

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS m

Remarks:

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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. All samples were analyzed within hold time unless otherwise flagged.

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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.

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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) Silica gel clean up employed.

Encryption Key



Jenna Chernuka
Project Manager
21 Aug 2017 15:29:49

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

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Maxxam Job #: B769642
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT3455	RT3456		
Sampling Date		2017/08/14 16:00	2017/08/14 14:35		
COC Number		294838	294838		
	UNITS	NWD 17-05	NWD 17-15	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8730086
Volatiles					
Benzene	mg/L	<0.00040	<0.00040	0.00040	8730130
Toluene	mg/L	<0.00040	<0.00040	0.00040	8730130
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8730130
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8730130
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8730130
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8730130
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8730130
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8730130
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	98	108		8730086
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	101	100		8730130
4-Bromofluorobenzene (sur.)	%	101	101		8730130
D4-1,2-Dichloroethane (sur.)	%	104	103		8730130
RDL = Reportable Detection Limit					

Maxxam Job #: B769642
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT3455
Sample ID: NWD 17-05
Matrix: Water

Collected: 2017/08/14
Relinquished: 2017/08/15
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730130	N/A	2017/08/17	Ying (Emma) Zhu
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730086	2017/08/18	2017/08/19	Kelsey Holt

Maxxam ID: RT3456
Sample ID: NWD 17-15
Matrix: Water

Collected: 2017/08/14
Relinquished: 2017/08/15
Received: 2017/08/17

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8730130	N/A	2017/08/17	Ying (Emma) Zhu
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8730086	2017/08/18	2017/08/19	Kelsey Holt

Maxxam Job #: B769642
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.0°C

Results relate only to the items tested.

Maxxam Job #: B769642
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8730086	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/19		104	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19	<0.10		mg/L	
8730130	YZ3	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/17		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/17		103	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/17		101	%	70 - 130
			Benzene	2017/08/17	<0.00040		mg/L	
			Toluene	2017/08/17	<0.00040		mg/L	
			Ethylbenzene	2017/08/17	<0.00040		mg/L	
			m & p-Xylene	2017/08/17	<0.00080		mg/L	
			o-Xylene	2017/08/17	<0.00040		mg/L	
			Xylenes (Total)	2017/08/17	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/17	<0.10		mg/L	
			F1 (C6-C10)	2017/08/17	<0.10		mg/L	
8730086	KHO	LCS	O-TERPHENYL (sur.)	2017/08/19		96	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/19		107	%	70 - 130
8730130	YZ3	LCS	1,4-Difluorobenzene (sur.)	2017/08/17		97	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/17		101	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/17		101	%	70 - 130
			Benzene	2017/08/17		103	%	70 - 130
			Toluene	2017/08/17		96	%	70 - 130
			Ethylbenzene	2017/08/17		103	%	70 - 130
			m & p-Xylene	2017/08/17		103	%	70 - 130
			o-Xylene	2017/08/17		100	%	70 - 130
			F1 (C6-C10)	2017/08/17		101	%	70 - 130

LCS: 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.

Maxxam Job #: B769642
Report Date: 2017/08/21

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: Norman Wells
Project #: 407011-00526

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

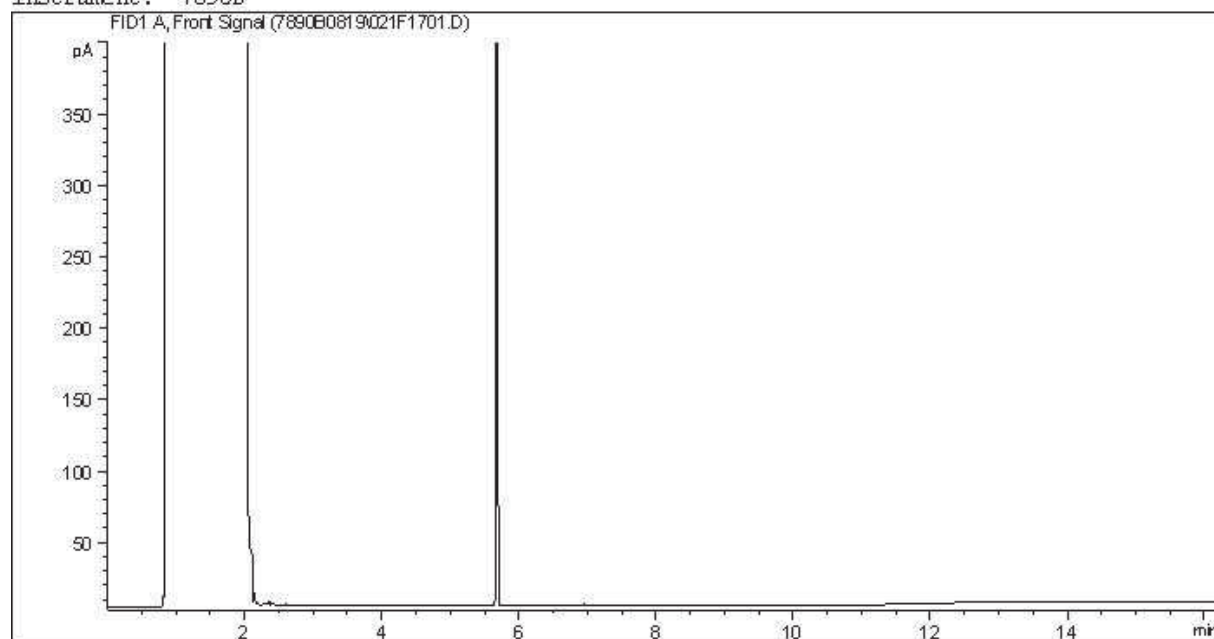
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Maxxam Job #: B769642
Report Date: 2017/08/21
Maxxam Sample: RT3455

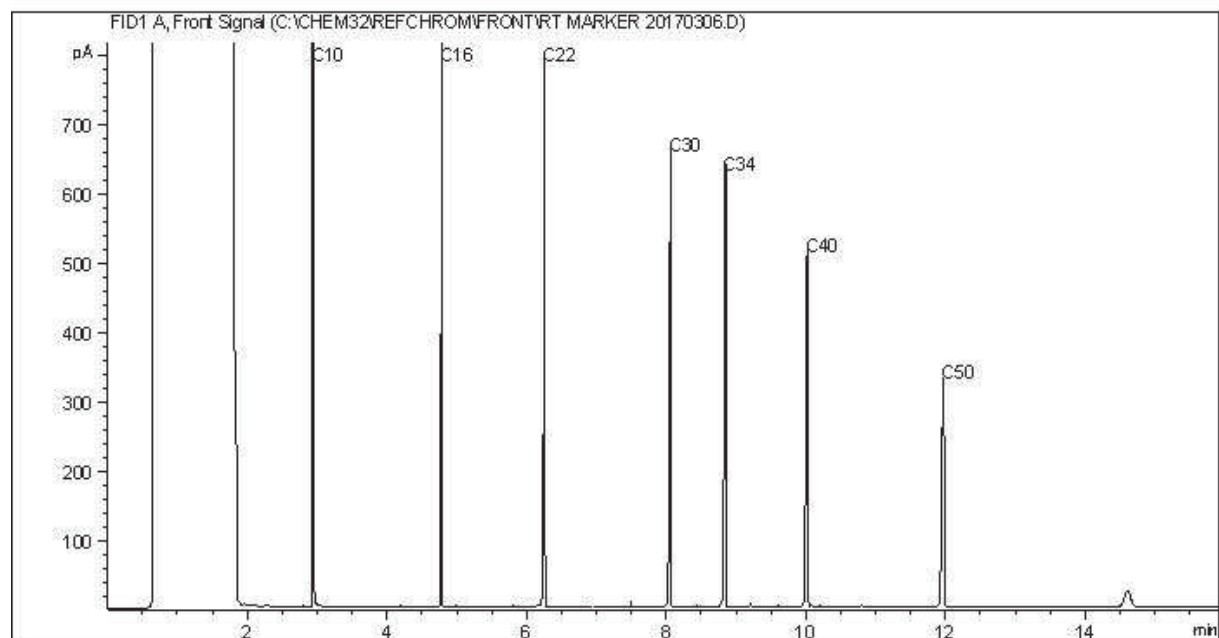
WORLEY PARSONS
Task Order#: 450249059310 Line Item: 10
Site#: N/A
Site Location: Norman Wells
Client ID: NWD 17-05

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

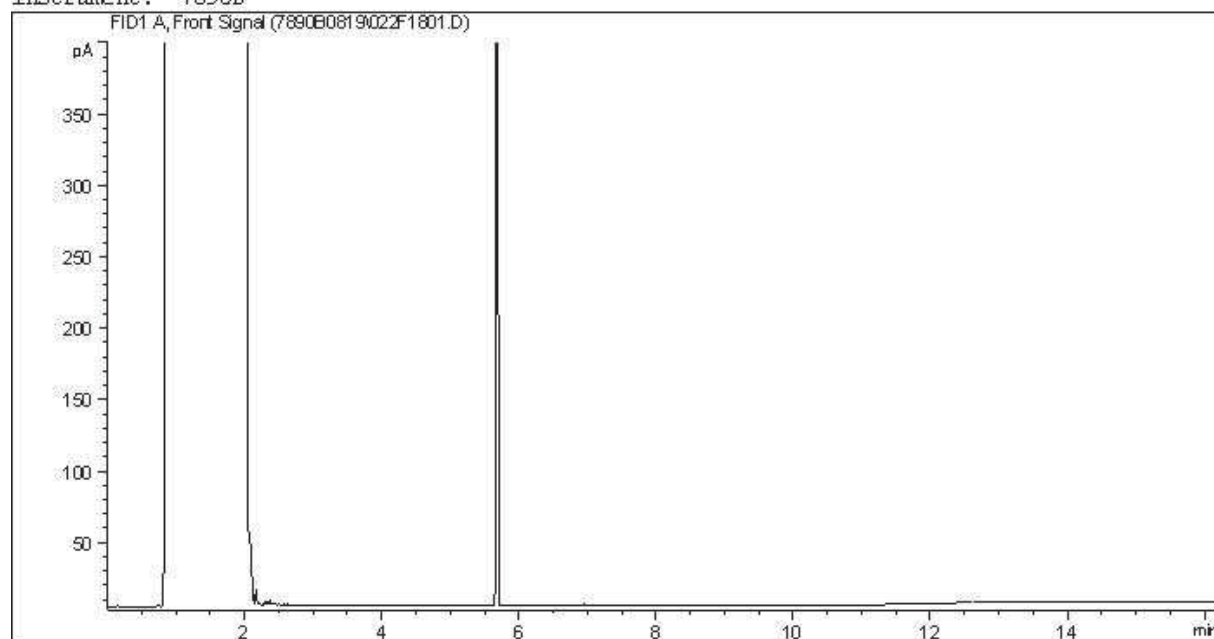
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam Job #: B769642
Report Date: 2017/08/21
Maxxam Sample: RT3456

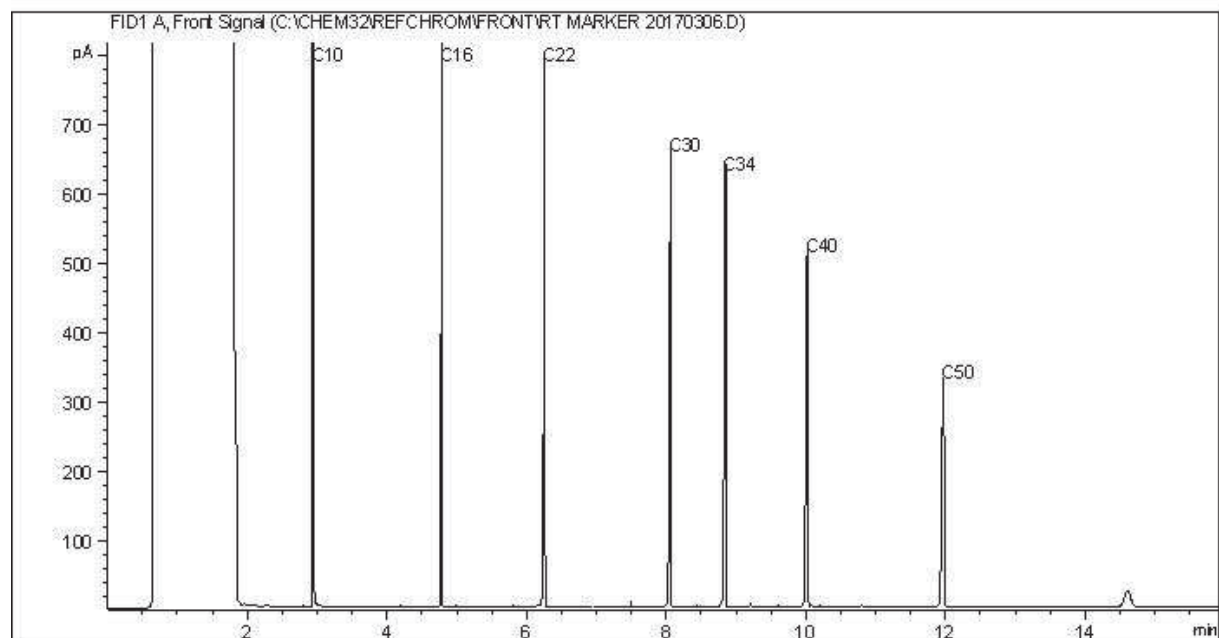
WORLEY PARSONS
Task Order#: 450249059310 Line Item: 10
Site#: N/A
Site Location: Norman Wells
Client ID: NWD 17-15

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED																
Company Name: Imperial Oil ☐ ExxonMobil				Company Name: WorleyParsons																				
Contact Name: Shalini Jasra				Contact Name: Stacy Gibb																				
Address: 505 Quarry Park Blvd SE				Address: Suite 500																				
Calgary, AB T2C 5N1				151 Canada Olympic Rd SW																				
Email: shalini.s.jasra@esso.ca				Calgary, AB T3B 6B7																				
Ph: 583-476-2461				Email: stacy.gibb@advision.com																				
Sampler Name (Print): Melanie Jones				Ph: 403-247-0200																				
Melissa Lord, Douglas Hanley				Consultant Project #: 407011-00526																				
FIELD SAMPLE ID		MATRIX		CONTAINERS		SAMPLING																		
GROUND WATER	SURFACE WATER	SOIL	OTHER	DATE (YYYY/MM/DD)	TIME (24 HR)	FIELD FILTERED & PRESERVED	VOC	PAH	PHCs (FRACTIONS 1-2 PLUS BTEX)	PHCs (FRACTIONS 1-4 PLUS BTEX)	PHCs (FRACTIONS 2-4)	PHCs (FRACTION 1 PLUS BTEX)	GRAIN SIZE (75 MICRON)	TEXTURE (% SAND, SILT, CLAY)	PARTICLE SIZE DISTRIBUTION WITH GRAPH	REGULATED METALS TOT DIS	MERCURY TOTAL DISSOLVED	SALINITY SOIL	FERTILIZER SOIL	FERTILIZER WATER	NUTRIENTS SOIL	ROUTINE POTABILITY	PH EC ALKALINITY	BASIC CLASS II LANDFILL PKG
1 NWD 17-05			X	4	2017/08/14	16:00																		
2 NWD 17-15			X	4	2017/08/14	14:35																		
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
IOL SITE LOCATION Norman Wells, NT				REGULATORY CRITERIA / DETECTION LIMITS:				SPECIAL INSTRUCTIONS also e-mail:				# JARS USED & NOT SUBMITTED				TURNAROUND TIME								
IOL PROJECT # (if applicable) N/A				☐ Alberta Tier 1 ☐ SEQG (SK) ☒ CCME (incl. level)				Standard Norman Wells email list -melissa.lord@advision.com				Enter N/A for Water N/A				Standard (5 days) Rush (3 days) (2 days) (1 day) (same day)								
MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM 4502 490 593 + 00010				YES NO COOLER ID # TEMP °C SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT				YES NO COOLER ID # TEMP °C SEAL PRESENT SEAL INTACT COOLING MEDIA PRESENT				DATE: 2017/08/15 TIME (24 HR) RECEIVED BY:				DATE: 2017/08/15 TIME (24 HR) RECEIVED BY:								
1. Melissa Lord				1. Daniel Dore				1. Daniel Dore				1. Daniel Dore				1. Daniel Dore								
2. Melissa Lord				2. Melissa Lord				2. Melissa Lord				2. Melissa Lord				2. Melissa Lord								
3. Melissa Lord				3. Melissa Lord				3. Melissa Lord				3. Melissa Lord				3. Melissa Lord								
COC-1010 (06/2016) IOL-AB				White: Maxxam				Yellow: Client				Labeled BY: KVT				Samples VERIFIED BY: LNW								

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: <u>Advisian</u>	Sampling Date: <u>14-Aug-17</u>
Location: <u>Norman Wells</u>	Laboratory : <u>Maxxam Edmonton</u>
Consultant Project Number: <u>407011-00526</u>	Sample Submission Number: <u>B769642</u>

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	x			All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?: _____ Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?: _____ Yes

Were all samples analyzed within hold times (Yes/No)?: _____ Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?: _____ n/a

Is Chain of Custody completed and signed (Yes/No)?: _____ Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?: _____ Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?: _____ No

Date Issued: n/a Date of Response: n/a

Is data considered to be reliable (Yes/No)?: _____ Yes

If answer is "No", describe and provide rationale: _____

Data Reviewed by (Print): <u>Vivian Baptista</u> Date: <u>05-Dec-17</u>	Data Reviewed by (Signature): <u></u>

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526
Your C.O.C. #: 294871

Report Date: 2017/08/24

Report #: R2433635

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B770628

Received: 2017/08/20, 09:40

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS 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. All samples were analyzed within hold time unless otherwise flagged.

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.

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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) Silica gel clean up employed.

Rhecie Phayouphone
Project Manager
28 Aug 2017 16:09:27

Encryption Key



Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

cosign

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Maxxam Job #: B770628
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RT9581	RT9582		
Sampling Date		2017/08/17 16:30	2017/08/17 12:00		
	UNITS	NWD 17-08	NWD 17-18	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8732835
Volatiles					
Benzene	mg/L	<0.00040	<0.00040	0.00040	8733408
Toluene	mg/L	<0.00040	<0.00040	0.00040	8733408
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8733408
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8733408
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8733408
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8733408
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8733408
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8733408
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	95	105		8732835
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	102	101		8733408
4-Bromofluorobenzene (sur.)	%	100	100		8733408
D4-1,2-Dichloroethane (sur.)	%	104	102		8733408
RDL = Reportable Detection Limit					

Maxxam Job #: B770628
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RT9581
Sample ID: NWD 17-08
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8732835	2017/08/21	2017/08/23	Kelsey Holt

Maxxam ID: RT9582
Sample ID: NWD 17-18
Matrix: Water

Collected: 2017/08/17
Relinquished: 2017/08/18
Received: 2017/08/20

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8733408	N/A	2017/08/22	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8732835	2017/08/21	2017/08/23	Kelsey Holt

Maxxam Job #: B770628
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.0°C

Results relate only to the items tested.

Maxxam Job #: B770628
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8732835	KHO	Method Blank	O-TERPHENYL (sur.)	2017/08/23		110	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/23	<0.10		mg/L	
8733408	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/22		103	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/22		99	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/22		103	%	70 - 130
			Benzene	2017/08/22	<0.00040		mg/L	
			Toluene	2017/08/22	<0.00040		mg/L	
			Ethylbenzene	2017/08/22	<0.00040		mg/L	
			m & p-Xylene	2017/08/22	<0.00080		mg/L	
			o-Xylene	2017/08/22	<0.00040		mg/L	
			Xylenes (Total)	2017/08/22	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/22	<0.10		mg/L	
			F1 (C6-C10)	2017/08/22	<0.10		mg/L	
8732835	KHO	LCS	O-TERPHENYL (sur.)	2017/08/23		94	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/23		109	%	70 - 130
8733408	SES	LCS	1,4-Difluorobenzene (sur.)	2017/08/22		98	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/22		97	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/22		106	%	70 - 130
			Benzene	2017/08/22		103	%	70 - 130
			Toluene	2017/08/22		97	%	70 - 130
			Ethylbenzene	2017/08/22		105	%	70 - 130
			m & p-Xylene	2017/08/22		103	%	70 - 130
			o-Xylene	2017/08/22		98	%	70 - 130
			F1 (C6-C10)	2017/08/22		109	%	70 - 130

LCS: 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.

Maxxam Job #: B770628
Report Date: 2017/08/24

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Justin Geisel, B.Sc., Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

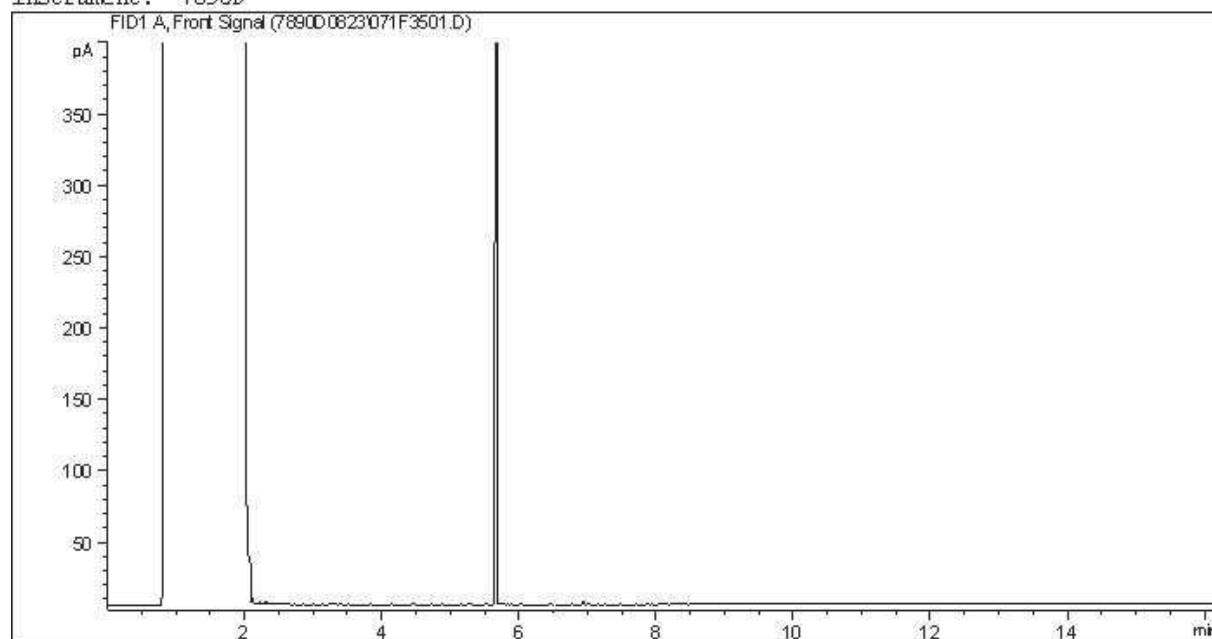
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Maxxam Job #: B770628
Report Date: 2017/08/24
Maxxam Sample: RT9581

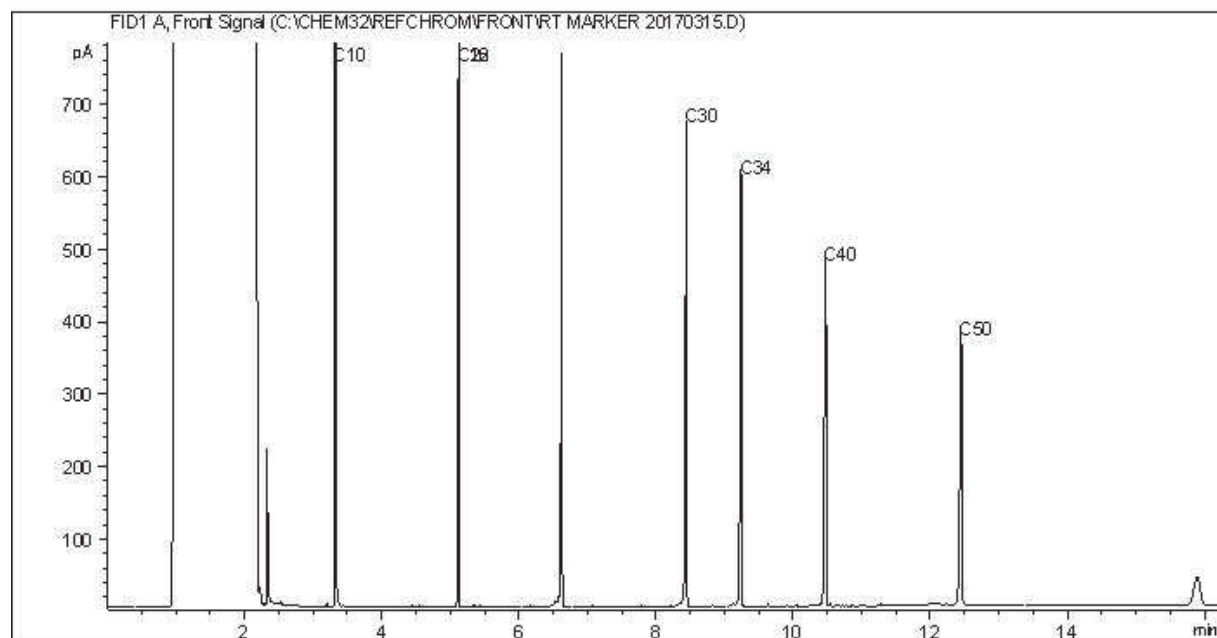
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS, NT
Client ID: NWD 17-08

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

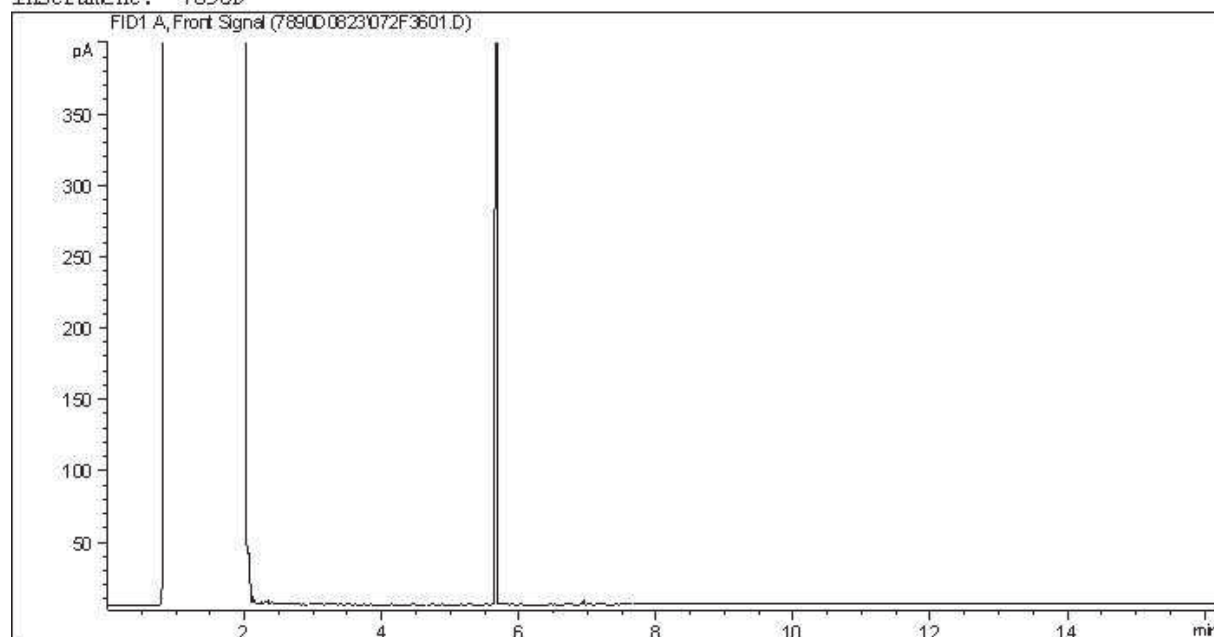
Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

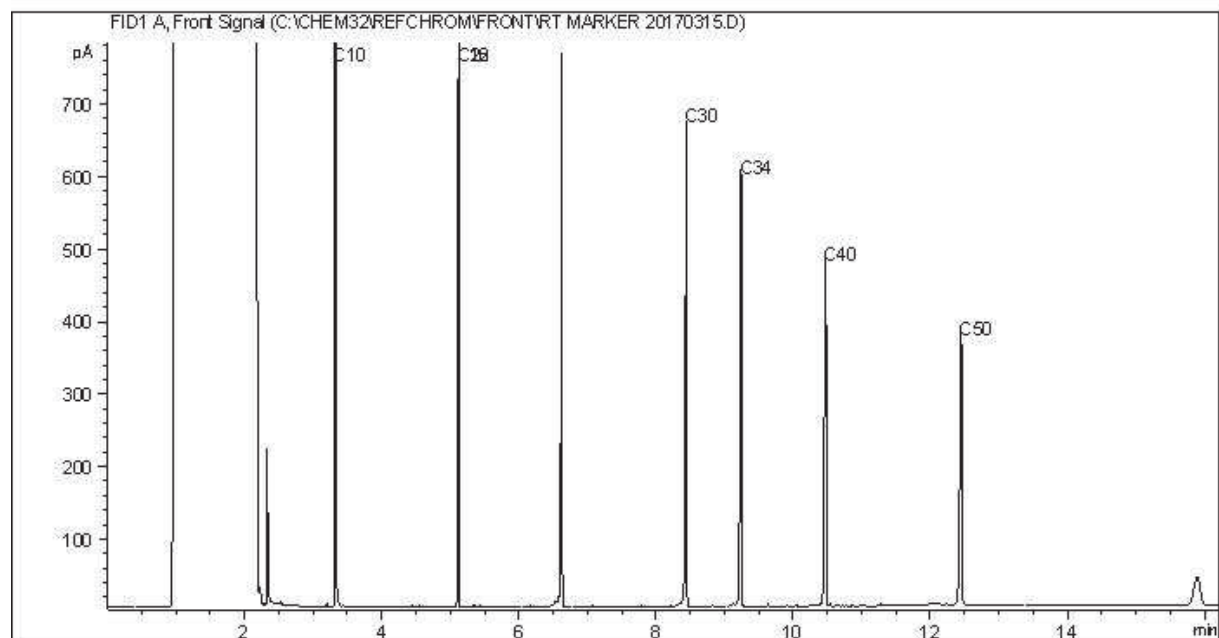
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890D



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.



Calgary
4000 19th St. NE, T2E 6P8
Phone: (403) 291-3077
Fax: (403) 291-3077
Toll Free: (800) 386-7247

Edmonton
5331 48 Street, T6B 2P4
Phone: (780) 577-7100
Fax: (780) 450-4187
Toll Free: (800) 386-7247

EXXON MOBIL/IMPERIAL OIL - MAXXAM CHAIN-OF-CUSTODY RECORD

Page 1 of 1
C of C # 294871

INVOICE INFORMATION

Company Name: ☒ Imperial Oil ☐ ExxonMobil
Contact Name: Shelini Jastro
Address: 505 Quarry Park Blvd SE
Calgary AB T2C 5N1
Email: shelini.s.jastro@esso.ca
Ph: 587-476-2416
Sampler Name (Print): Melissa Lord, Douglas Haney

REPORT INFORMATION

Company Name: Worky Parsons
Contact Name: Stacy Gibb
Address: Suite 500
151 Canada Olympic Rd SW
Calgary AB T3B 6G7
Email: stacy.gibb@advision.com
Ph: 403-247-0200
Consultant Project #: 407011-00526

ANALYSIS REQUESTED

FIELD SAMPLE ID	MATRIX			SAMPLING		ANALYSIS REQUESTED									
	GROUND WATER	SURFACE WATER	SOIL	OTHER	# CONTAINERS	DATE (YYYY/MM/DD)	TIME (24 HR)	LAB FILTRATION REQUIRED	VOC	PAH	PHCs (FRACTIONS 1-2 PLUS BTEX)	PHCs (FRACTIONS 2-4)	PHCs (FRACTION 1 PLUS BTEX)	GRAIN SIZE (% SAND, SILT, CLAY)	PARTICLE SIZE DISTRIBUTION WITH GRAPH
1 NWD 17-08	☒	☒	☒	☒	4	2017/08/17	16:30								
2 NWD 17-18	☒	☒	☒	☒	4	2017/08/17	12:00								
3															
4															
5															
6															
7															
8															
9															
10															

10 IOL SITE LOCATION Norman Wells INT

IOL PROJECT # (if applicable) N/A

MAXXAM TASK ORDER # OR SERVICE ORDER # + LINE ITEM 4502 490 593 + 00010

REGULATORY CRITERIA / DETECTION LIMITS:
☐ Alberta Tier 1
☐ SEQG (SK)
☒ CCME FAL (incl. level)

SPECIAL INSTRUCTIONS Also email: -standard Norman Wells email list -melissa.lord@advision.com

JARS USED & NOT SUBMITTED Enter N/A for Water N/A

TURNAROUND TIME
Standard (5 days) ☒
Rush (3 days) ☐
(2 days) ☐
(1 day) ☐
(same day) ☐

Date Required 2017/08/18

LAB USE ONLY
MAXXAM JOB # 3770628

SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒

TEMP °C 4 4 4 4

RECEIVED BY: Melissa Lord 2017/08/18 08:00

RELINQUISHED BY: Shelini Jastro 2017/08/18 09:40

1. Shelini Jastro 2017/08/18 09:40

2. Melissa Lord 2017/08/18 08:00

3. Shelini Jastro 2017/08/18 09:40

SAMPLES LABELED BY: NYU VERIFIED BY: MSA

Yellow Client

DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 17-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407011-00526

Sample Submission Number: B770628

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	x			All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista

Date: 20-Sep-17

Data Reviewed by (Signature):

Vivian Baptista

Attention: STACY GIBB

WORLEY PARSONS
500, 151 Canada Olympic RD SW
Calgary, AB
Canada T3B 6B7

Task Order#: 4502490593
Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526
Your C.O.C. #: 294876

Report Date: 2017/08/30

Report #: R2436426

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B771328

Received: 2017/08/22, 15:15

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Laboratory Method	Primary Reference
BTEX/F1 in Water by HS GC/MS/FID	2	AB SOP-00039	CCME CWS/EPA 8260c m
CCME Hydrocarbons in Water (F2; C10-C16) (1)	2	AB SOP-00037	CCME PHC-CWS 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. All samples were analyzed within hold time unless otherwise flagged.

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) Silica gel clean up employed.

Encryption Key



Jenna Chernuka
Project Manager
30 Aug 2017 11:02:32

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Jenna Chernuka, Project Manager

Email: JChernuka@maxxam.ca

Phone# (780)577-7178

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.

Maxxam Job #: B771328
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS,NT
Project #: 407011-00526

AT1 BTEX AND F1-F2 IN WATER (WATER)

Maxxam ID		RU2863	RU2864		
Sampling Date		2017/08/20 17:00	2017/08/20 11:30		
COC Number		294876	294876		
	UNITS	NWD 17-10	NWD 17-20	RDL	QC Batch
Ext. Pet. Hydrocarbon					
F2 (C10-C16 Hydrocarbons)	mg/L	<0.10	<0.10	0.10	8736108
Volatiles					
Benzene	mg/L	<0.00040	<0.00040	0.00040	8735467
Toluene	mg/L	<0.00040	<0.00040	0.00040	8735467
Ethylbenzene	mg/L	<0.00040	<0.00040	0.00040	8735467
m & p-Xylene	mg/L	<0.00080	<0.00080	0.00080	8735467
o-Xylene	mg/L	<0.00040	<0.00040	0.00040	8735467
Xylenes (Total)	mg/L	<0.00080	<0.00080	0.00080	8735467
F1 (C6-C10) - BTEX	mg/L	<0.10	<0.10	0.10	8735467
F1 (C6-C10)	mg/L	<0.10	<0.10	0.10	8735467
Extraction Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	102	106		8736108
Instrument Surrogate Recovery (%)					
1,4-Difluorobenzene (sur.)	%	99	101		8735467
4-Bromofluorobenzene (sur.)	%	101	101		8735467
D4-1,2-Dichloroethane (sur.)	%	100	102		8735467
RDL = Reportable Detection Limit					

Maxxam Job #: B771328
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS,NT
Project #: 407011-00526

TEST SUMMARY

Maxxam ID: RU2863
Sample ID: NWD 17-10
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8735467	N/A	2017/08/23	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8736108	2017/08/24	2017/08/25	Kanveet Kaur

Maxxam ID: RU2864
Sample ID: NWD 17-20
Matrix: Water

Collected: 2017/08/20
Relinquished: 2017/08/21
Received: 2017/08/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
BTEX/F1 in Water by HS GC/MS/FID	HSGC/MS	8735467	N/A	2017/08/23	Seema Singh
CCME Hydrocarbons in Water (F2; C10-C16)	GC/FID	8736108	2017/08/24	2017/08/25	Kanveet Kaur

Maxxam Job #: B771328
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.0°C

Results relate only to the items tested.

Maxxam Job #: B771328
Report Date: 2017/08/30

WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS,NT
Project #: 407011-00526

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8735467	SES	Method Blank	1,4-Difluorobenzene (sur.)	2017/08/24		105	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/24		100	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/24		101	%	70 - 130
			Benzene	2017/08/24	<0.00040		mg/L	
			Toluene	2017/08/24	<0.00040		mg/L	
			Ethylbenzene	2017/08/24	<0.00040		mg/L	
			m & p-Xylene	2017/08/24	<0.00080		mg/L	
			o-Xylene	2017/08/24	<0.00040		mg/L	
			Xylenes (Total)	2017/08/24	<0.00080		mg/L	
			F1 (C6-C10) - BTEX	2017/08/24	<0.10		mg/L	
			F1 (C6-C10)	2017/08/24	<0.10		mg/L	
8736108	KK5	Method Blank	O-TERPHENYL (sur.)	2017/08/25		111	%	60 - 130
			F2 (C10-C16 Hydrocarbons)	2017/08/25	<0.10		mg/L	
8735467	SES	LCS	1,4-Difluorobenzene (sur.)	2017/08/23		94	%	70 - 130
			4-Bromofluorobenzene (sur.)	2017/08/23		98	%	70 - 130
			D4-1,2-Dichloroethane (sur.)	2017/08/23		98	%	70 - 130
			Benzene	2017/08/23		101	%	70 - 130
			Toluene	2017/08/23		97	%	70 - 130
			Ethylbenzene	2017/08/23		103	%	70 - 130
			m & p-Xylene	2017/08/23		103	%	70 - 130
			o-Xylene	2017/08/23		100	%	70 - 130
			F1 (C6-C10)	2017/08/23		103	%	70 - 130
			O-TERPHENYL (sur.)	2017/08/25		102	%	60 - 130
8736108	KK5	LCS	F2 (C10-C16 Hydrocarbons)	2017/08/25		117	%	70 - 130

LCS: 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.

Maxxam Job #: B771328
Report Date: 2017/08/30

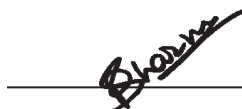
WORLEY PARSONS
Task Order#: 4502490593, Line Item: 10
Site#: N/A
Site Location: NORMAN WELLS, NT
Project #: 407011-00526

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Daniel Reslan, cCT, QP, Organics Supervisor



Poonam Sharma, cCT, Organics Supervisor

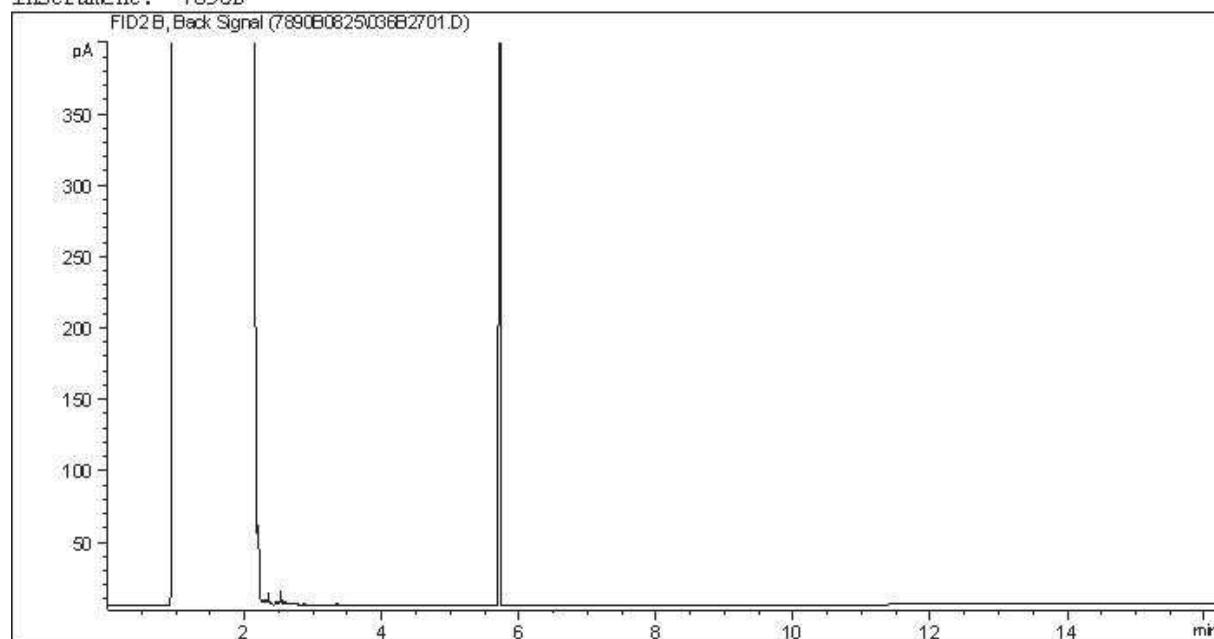
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B771328
Report Date: 2017/08/30
Maxxam Sample: RU2863

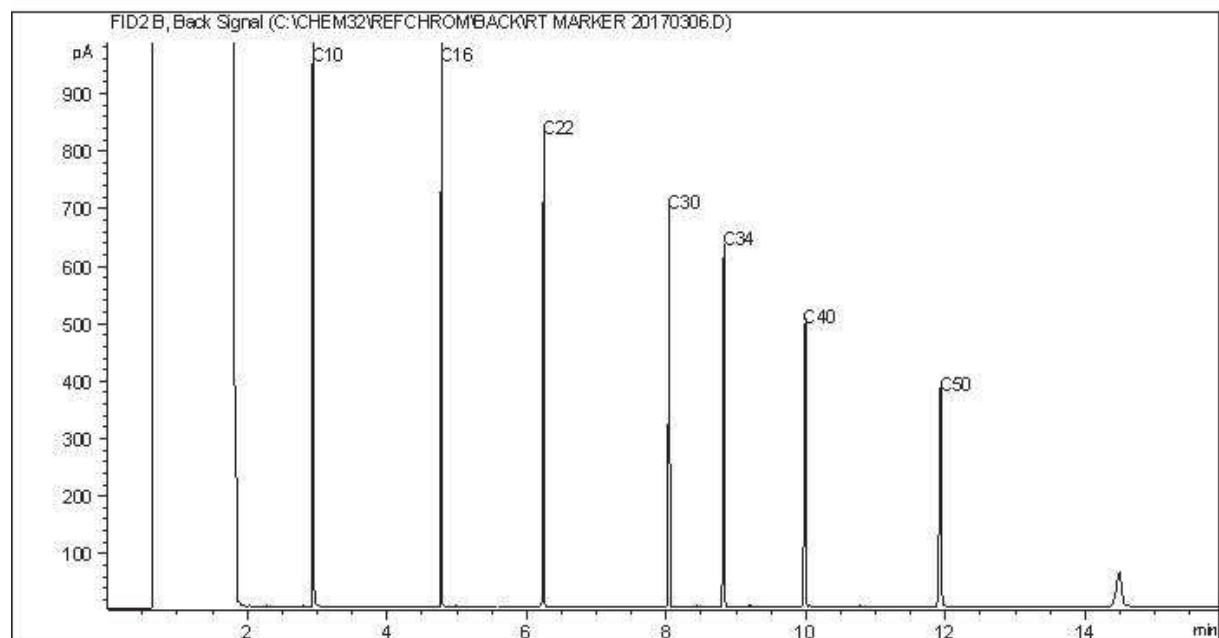
WORLEY PARSONS
Task Order#:450249059310Line Item:10
Site#: N/A
Site Location: NORMAN WELLS,NT
Client ID: NWD 17-10

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

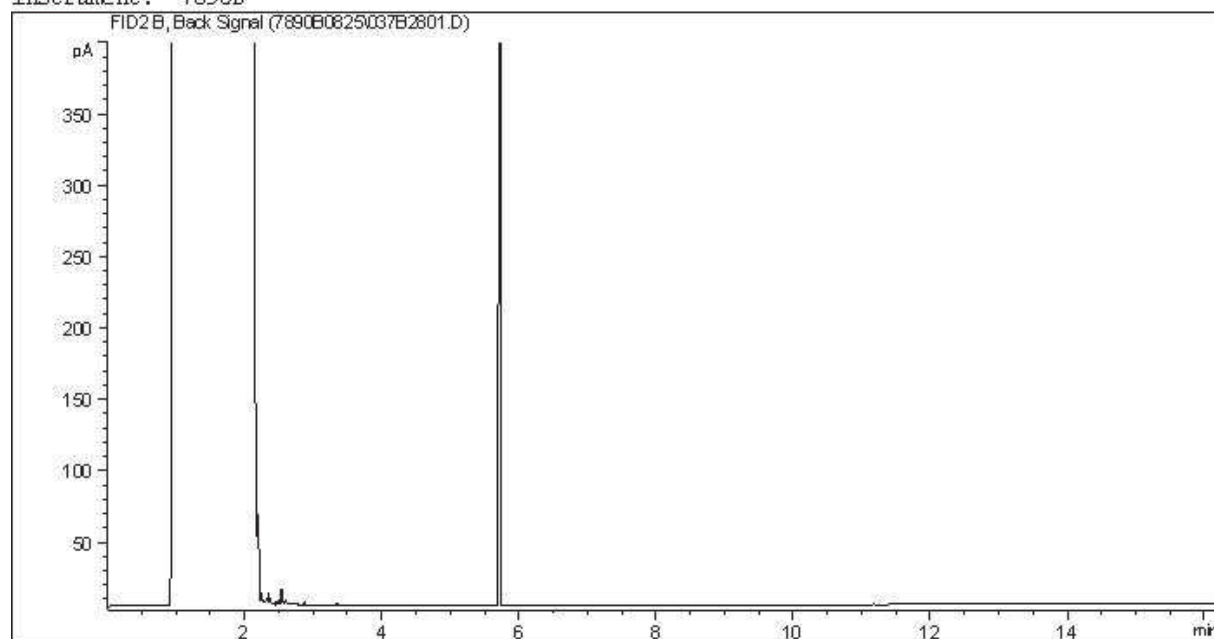
Gasoline: C4 - C12
Varsol: C8 - C12
Kerosene: C7 - C16

Diesel: C8 - C22
Lubricating Oils: C20 - C40
Crude Oils: C3 - C60+

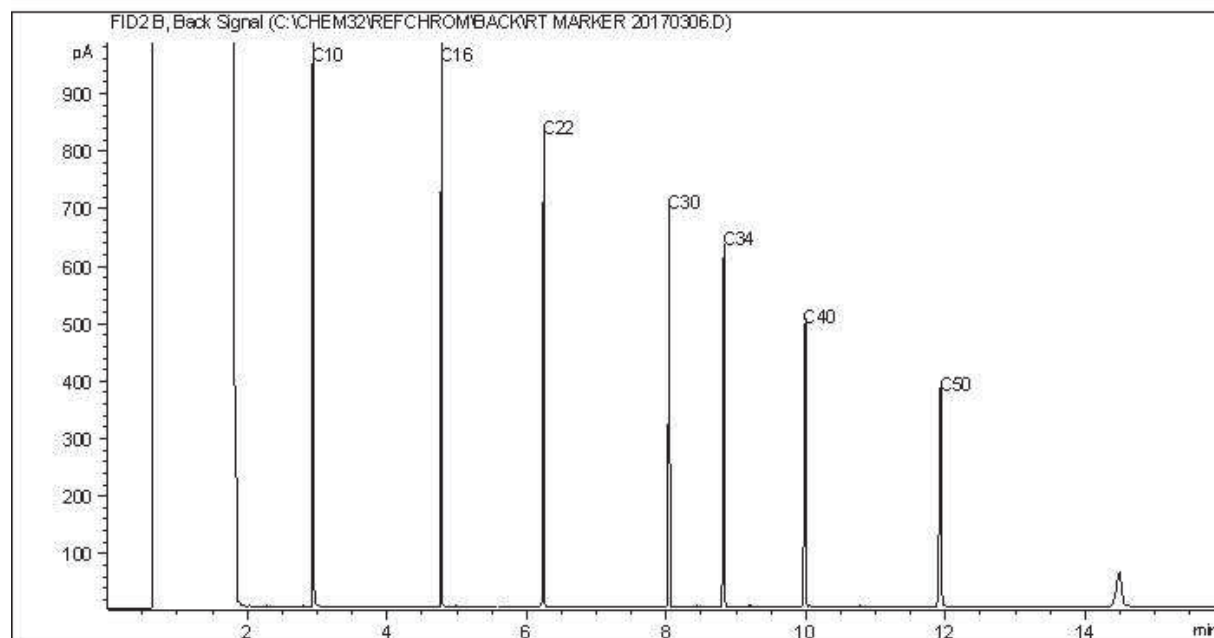
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

CCME Hydrocarbons in Water (F2; C10-C16) Chromatogram

Instrument: 7890B



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

INVOICE INFORMATION				REPORT INFORMATION				ANALYSIS REQUESTED												TURNAROUND TIME							
Company Name: Imperial Oil ☐ ExxonMobil ☒				Company Name: WorleyParsons				PHCS (FRACTIONS 1-2 PLUS BTEX) ☒ PHCS (FRACTIONS 2-4) ☒ PHCS (FRACTION 1 PLUS BTEX) ☒ GRAIN SIZE (75 MICRON) ☐ TEXTURE (% SAND, SILT, CLAY) ☐ PARTICLE SIZE DISTRIBUTION WITH GRAPH ☐ REGULATED METALS TOT ☐ DIS ☐ MERCURY TOTAL ☐ DISSOLVED ☐ SALINITY SOIL ☐ FERTILIZER SOIL ☐ FERTILIZER WATER ☐ NUTRIENTS SOIL ☐ ROUTINE POTABILITY ☐ pH ☐ EC ☐ ALKALINITY ☐ BASIC CLASS II LANDFILL PKG ☐												Standard ☒ (5 days) Rush ☐ (3 days) (2 days) ☐ (1 day) ☐ (same day) ☐							
Company Name: WorleyParsons Contact Name: Stacy Gibb Address: Suite 500 151 Canada Olympic Rd SW Calgary, AB T3B 6B7 Email: stacy.gibb@advisian.com Ph: 403-247-0200 Consultant Project #: 407011-00526				Company Name: WorleyParsons Contact Name: Stacy Gibb Address: Suite 500 151 Canada Olympic Rd SW Calgary, AB T3B 6B7 Email: stacy.gibb@advisian.com Ph: 403-247-0200 Consultant Project #: 407011-00526				PHCS (FRACTIONS 1-2 PLUS BTEX) ☒ PHCS (FRACTIONS 2-4) ☒ PHCS (FRACTION 1 PLUS BTEX) ☒ GRAIN SIZE (75 MICRON) ☐ TEXTURE (% SAND, SILT, CLAY) ☐ PARTICLE SIZE DISTRIBUTION WITH GRAPH ☐ REGULATED METALS TOT ☐ DIS ☐ MERCURY TOTAL ☐ DISSOLVED ☐ SALINITY SOIL ☐ FERTILIZER SOIL ☐ FERTILIZER WATER ☐ NUTRIENTS SOIL ☐ ROUTINE POTABILITY ☐ pH ☐ EC ☐ ALKALINITY ☐ BASIC CLASS II LANDFILL PKG ☐												Standard ☒ (5 days) Rush ☐ (3 days) (2 days) ☐ (1 day) ☐ (same day) ☐							
Field Sample ID 1 NWD 17-10 2 NWD 17-20 3 4 5 6 7 8 9 10				MATRIX GROUND WATER ☒ SURFACE WATER ☐ SOIL ☐ OTHER ☐				SAMPLING DATE 2017/08/20 TIME 11:00 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30 4 11:30				REGULATORY CRITERIA / DETECTION LIMITS: ☐ Alberta Tier 1 ☐ CDWG ☐ SEQ (SK) ☒ CCME (incl. level) FAL				SPECIAL INSTRUCTIONS also email: -Standard Norman Wells email list -melissa.lord@advisian.com				# JARS USED & NOT SUBMITTED Enter N/A for Water N/A				TURNAROUND TIME Standard ☒ (5 days) Rush ☐ (3 days) (2 days) ☐ (1 day) ☐ (same day) ☐			
RELINQUISHED BY: 1. Melisa Lord 2. 3.				RECEIVED BY: 1. Danielle Boireau 2. 3.				DATE: 2017/08/21 08:00 2017/08/21 13:15				TIME (24 HR) 08:00 13:15				LABORATORY JOB # 3771328				DATE REQUIRED LAB USE ONLY							
SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒				SEAL PRESENT ☒ SEAL INTACT ☒ COOLING MEDIA PRESENT ☒							
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DATA QUALITY REVIEW CHECKLIST - IMPERIAL OIL PROJECTS

Consultant: Advisian

Sampling Date: 20-Aug-17

Location: Norman Wells

Laboratory : Maxxam Edmonton

Consultant Project Number: 407011-00526

Sample Submission Number: B771328

Are All Laboratory QC Within Acceptance Criteria (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Instrument Surrogate Recovery	x			All laboratory QC met acceptance criteria.
Extraction Surrogate Recovery	x			
Method Blank Concentration	x			
Matrix Duplicate RPD			x	
Matrix Spike Recovery			x	
Lab Control Sample Recovery	x			

Are All Field QC Samples Within Alert Limits (Yes, No, Not Applicable)?

	Yes	No	NA	Comments
Field Blank Concentration	x			All field QC samples met alert limits.
Trip Blank Concentration	x			
Equipment Blank Concentration			x	
Field Duplicate RPD			x	

Has CoA been signed off (Yes/No)?:

Yes

Has lab warranted all tests were analyzed following SOP's in CoA (Yes/No)?:

Yes

Were all samples analyzed within hold times (Yes/No)?:

Yes

All volatiles samples methanol extracted (if required) within 48 hours (Yes/No)?:

n/a

Is Chain of Custody completed and signed (Yes/No)?:

Yes

Were sample temperatures acceptable when they reached lab (Yes/No)?:

Yes

Was a Data Quality Waiver (DQW) issued (Yes/No)?:

No

Date Issued: n/a

Date of Response: n/a

Is data considered to be reliable (Yes/No)?:

Yes

If answer is "No", describe and provide rationale:

Data Reviewed by (Print): Vivian Baptista
Date: 20-Sep-17

Data Reviewed by (Signature): 



Advisian
WorleyParsons Group

Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendix D Quality Assurance and Quality Control



Quality Assurance/Quality Control

The field QA/QC for the Surveillance Network Program consisted of three field duplicate samples for the analysis of dissolved chloride and BTEX parameters. Six trip blank samples and four field blank samples were collected and submitted to the laboratory for analysis of BTEX and PHC fractions F1 and F2.

For the field duplicate sample, evaluations of the QA/QC results were determined by calculating the relative percent difference (RPD) between the field duplicates and original sample results and comparison of the RPD to designated alert limits.

RPDs are calculated using the following formula:

$$\text{RPD \%} = \left(\frac{|x_1 - x_2|}{(x_1 + x_2)/2} \right) * 100$$

Where x_1 = original field sample

x_2 = blind field duplicate sample

Consistent with laboratory practices and to permit reliable calculations, a RPD is only calculated when the original and duplicate sample concentrations are at least five times the reportable detection limit.

The designated field duplicate RPD alert limits are 80% for BTEX, F1 and F2 and 50% for all other analyses. As indicated on the analytical tables, all of the RPDs were within alert limits except for the ion balances in two of the duplicate pairs.

Coded trip blank samples consist of mega-pure distilled water (i.e. hydrocarbon-free) and were requested from Maxxam and analyzed for BTEX, F1 and F2. The purpose of a trip blank is to identify whether the inadvertent introduction of hydrocarbons has occurred during sample handling, transport, or in the laboratory.

Field blank samples are created by filling clean sample bottles with mega-pure distilled water (i.e. hydrocarbon-free) in the same locations and following the same sampling procedures as during collection of groundwater samples.

The designated trip and field blank alert limits are >5X reportable detection limit (RDL) for BTEX and >2X RDL for PHC fractions F1 and F2. The trip and field blank results were below the reportable detection limits and are presented in Table D-1.

The laboratory QA/QC program consists of one or more of the following analyses: (a) instrument and extraction surrogate recoveries for water samples that were analyzed, and (b) the analysis of method blank, laboratory duplicate, matrix spike and/or laboratory control samples for the sample analytical batches that were analyzed. The laboratory QA/QC results are presented in the certificates of analysis (Appendix C).



Quality Assurance and Quality Control: Petroleum Hydrocarbons (PHCs)

PROJECT No.: 407074-00828-400

Monitoring Station	Sample ID	Date (dd-mmm-yyyy)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (Total) (mg/L)
CCME CEQG Freshwater Aquatic Life ^{#1}			0.37	0.002	0.09	--
QAQC						
Groundwater Field Blank	NWD17-15	14-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-16	15-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-18	17-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-20	20-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
Groundwater Trip Blank	NWD17-03	12-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-05	14-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-06	15-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-08	17-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	NWD17-10	20-Aug-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080
	SNP-Dup2	12-Sep-2017	< 0.00040	< 0.00040	< 0.00040	< 0.00080

NOTES:

1. --- in guideline row(s) denotes no criteria for that parameter.
2. --- in detail data row(s) denotes parameter not analyzed.
3. Highlighting indicates parameters above applied guideline.
4. Highlighting indicates detection limit above applied guideline.
5. Highlighting indicates parameters at applied guideline.
6. Superscript ^{#1}denotes values exceeding
(CCME. 2015. Canadian Environmental Quality Guidelines
Summary Table. Water Quality Guidelines for the Protection of
Freshwater Aquatic Life. September 2015.)



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Norman Wells, NT



Appendix E

Mann-Kendall Statistical Analyses and Hydrochemical Trend Charts



Table E-1
Mann-Kendall Statistical Analysis (1997-2017) - Chloride

Filtered Trend Results, two-sided p-value < 0.05 And Normalized Slope > ± 10%/Year

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)
MEBG-10-1-3	11	-31	0.01	-0.2899	-12	2.2	2.4	5

Full Mann-Kendall Analysis, Sorted by two-sided p-value

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)
TF 03-12-3	18	-70	0.00	-5.3713	-3	120	175.0	280
MEBG-10-1-3	11	-31	0.01	-0.2899	-12	2.2	2.4	5
MTF 97-1-5	17	-58	0.01	-0.0658	-5	< 1.0	1.3	3.4
C38 08-1-4	13	-37	0.02	-0.5484	-2	14	22.0	25
BIS 97-1-3	17	-48	0.05	-0.3637	-2	18	22.0	35
CPF 98-8-3	22	-63	0.07	-0.2094	-2	7.1	13.0	22
BI-13-3-4.5	6	-10	0.08	-1.4188	-14	6.5	9.85	13
BI-13-1-4	5	-8	0.08	-0.7336	-9	6.2	7.9	9.5
GIBG-10-2-3	11	-23	0.08	-0.5149	-18	< 1.0	2.9	9
CPF 97-7-5	22	70	0.05	0.3179	2	7.7	13.5	23
WSY 97-1-5	23	-55	0.15	-0.3728	-2	6.5	18.0	64
GIP11 09-1-4	7	-9	0.23	-4.5933	-66	3.6	7.0	110
BIBG-12-1-7	4	-4	0.30	-0.5959	-7	7.5	8.65	11
BISS2-09-DP-1	10	9	0.47	0.3803	8	1.8	4.6	12
ARB-12-3-3	9	-7	0.52	-1.3280	-7	8.7	18.0	32
BISS2-09-DP-2	9	6	0.60	0.1143	2	2.4	4.8	10
GIQ8-10-2-4	8	0	1.00	0.0936	1	5.8	11.7	20

Table E-2
Mann-Kendall Statistical Analysis (1998-2017) - Benzene

Filtered Trend Results, two-sided p-value < 0.05 And Normalized Slope > ± 10%/Year

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)

Full Mann-Kendall Analysis, Sorted by two-sided p-value

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)
CPF 98-8-3	22	-123	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
CPF 97-7-5	21	-112	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
WSY 97-1-5	19	-78	0.00	0.0000	0	< 0.0004	0.0002	< 0.0005
TF 03-12-3	18	-61	0.00	0.0000	0	< 0.0004	0.0002	0.0017
BIS 97-1-3	13	-42	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0005
MTF 97-1-5	13	-30	0.01	0.0000	0	< 0.0004	0.0002	< 0.0005
C38 08-1-4	13	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
BISS2-09-DP-1	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIBG-10-2-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
MEBG-10-1-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
ARB-12-3-3	9	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BISS2-09-DP-2	8	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIQ8-10-2-4	8	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
GIP11 09-1-4	7	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
BI-13-3-4.5	6	1	1.00	0.0000	0	< 0.00040	0.0002	0.00042
BI-13-1-4	5	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BIBG-12-1-7	4	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040

Table E-3
Mann-Kendall Statistical Analysis (1998-2017) - Toluene

Filtered Trend Results, two-sided p-value < 0.05 And Normalized Slope > ± 10%/Year

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)

Full Mann-Kendall Analysis, Sorted by two-sided p-value

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)
CPF 98-8-3	22	-129	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
CPF 97-7-5	21	-117	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
WSY 97-1-5	19	-78	0.00	0.0000	0	< 0.0004	0.0002	< 0.0005
TF 03-12-3	18	-56	0.00	0.0000	0	< 0.0004	0.0002	< 0.0005
BIS 97-1-3	13	-42	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0005
MTF 97-1-5	13	-30	0.01	0.0000	0	< 0.0004	0.0002	< 0.0005
BISS2-09-DP-1	11	-7	0.62	0.0000	0	< 0.00040	0.00079	0.0023
C38 08-1-4	13	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIBG-10-2-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
MEBG-10-1-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
ARB-12-3-3	9	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BISS2-09-DP-2	8	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIQ8-10-2-4	8	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
GIP11 09-1-4	7	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
BI-13-3-4.5	6	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BI-13-1-4	5	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BIBG-12-1-7	4	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040

Table E-4
Mann-Kendall Statistical Analysis (1998-2017) - Ethylbenzene

Filtered Trend Results, two-sided p-value < 0.05 And Normalized Slope > ± 10%/Year

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)

Full Mann-Kendall Analysis, Sorted by two-sided p-value

Location	Count	Mann-Kendall S	Two-sided p-value (for MK test)	Slope (mg/L/year)	Normalized Slope (%/year)	Min (mg/L)	Median (mg/L)	Max (mg/L)
CPF 98-8-3	22	-123	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
CPF 97-7-5	21	-112	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0050
WSY 97-1-5	19	-78	0.00	0.0000	0	< 0.0004	0.0002	< 0.0005
TF 03-12-3	18	-56	0.00	0.0000	0	< 0.0004	0.0002	< 0.0005
BIS 97-1-3	13	-42	0.00	0.0000	-2	< 0.0004	0.0002	< 0.0005
MTF 97-1-5	13	-30	0.01	0.0000	0	< 0.0004	0.0002	< 0.0005
C38 08-1-4	13	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
BISS2-09-DP-1	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIBG-10-2-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
MEBG-10-1-3	11	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
ARB-12-3-3	9	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BISS2-09-DP-2	8	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
GIQ8-10-2-4	8	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
GIP11 09-1-4	7	0	1.00	0.0000	0	< 0.0004	0.0002	< 0.0004
BI-13-3-4.5	6	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BI-13-1-4	5	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040
BIBG-12-1-7	4	0	1.00	0.0000	0	< 0.00040	0.0002	< 0.00040

Project No.: 407074-00828-400			Trend Analysis								Upper Control Limit Analysis			Lower Control Limit Analysis			Basic Analysis								Guideline Analysis				
		Hydrostratigraphic Unit	Parameter	P Value of Two Tailed Test		Inferred Confidence Level (of Trend Present in Data Set)	Slope (%/L/yr)	Normalized Slope (%/yr)	Meets Trend Assumptions? ⁷	Statistically Significant Mann-Kendall Trend ⁵	Visual Trend Assessment ¹⁰	Upper Control Limit Analysis			Lower Control Limit Analysis			Historical							Reporting Period		Guideline Analysis		
Location	Monitoring Station			UCL ⁶	2017 Values Greater than UCL							Meets UCL Assumptions? ⁷	LCL ⁶	2017 Values Less than LCL	Meets LCL Assumptions? ⁷	Count	Min (mg/L)	Median (mg/L)	Max (mg/L)	Range (mg/L)	Variability ⁴	Average (mg/L)	Standard Deviation (mg/L)	Count	Max (mg/L)	Guideline Value ⁹ (mg/L)	2017 Guideline Exceedances		
	ARB-12-3-3	ARB-12-3-3	Surficial Sediments	Chloride	0.53	47%	-1.3	-7	Y	---	---	51.71	0	Y	NC	NA	N (LCL < 0)	9	8.7	18	32	23.3	1.29444	18.41	7.399	2	22	120	0
	ARB-12-3-3		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	9	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.00040	0.37	0
	ARB-12-3-3		Toluene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	9	< 0.0004	NC	< 0.00040	NC	NC	NC	NC	2	< 0.00040	0.002	0
	ARB-12-3-3		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	9	< 0.0004	NC	< 0.00040	NC	NC	NC	NC	2	< 0.00040	0.09	0
	BIBG-12-1-7	BIBG-12-1-7	Surficial Sediments	Chloride	0.31	69.20%	NC	NC	Y	---	---	NC	NA	N (Ins. CL data)	NC	NA	N (Ins. CL data)	4	7.5	8.65	11	3.5	0.40	8.95	1.54	0	---	120	0
	BIBG-12-1-7		Benzene	NC	NC	NC	NC		N (No new data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	4	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	0	---	0.37	0
	BIBG-12-1-7		Toluene	NC	NC	NC	NC		N (No new data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	4	< 0.0005	NC	< 0.0005	NC	NC	NC	NC	0	---	0.002	0
	BIBG-12-1-7		Ethylbenzene	NC	NC	NC	NC		N (No new data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	4	< 0.0004	NC	< 0.00040	NC	NC	NC	NC	0	---	0.09	0
	BISS2-09-DP-1	BISS2-09-DP-1	Surficial Sediments	Chloride	0.47	53%	0.4	8	Y	---	---	22	0	Y	NC	NA	N (LCL < 0)	10	1.8	4.6	12	10.2	2.22	5.48	3.59	2	6.9	120	0
	BISS2-09-DP-1		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	11	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.00040	0.37	0
	BISS2-09-DP-1		Toluene	0.62	38%	NC	NC		N (Ins. trend data)	---	---	0.0040	0	Y	NC	NA	N (LCL < 0)	11	< 0.0004	0.00079	0.0023	NC	NC	0.00085	0.00073	2	< 0.00040	0.002	0
	BISS2-09-DP-1		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	11	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.00040	0.09	0
	BISS2-09-DP-2	BISS2-09-DP-2	Surficial Sediments	Chloride	0.60	40%	0.1	2	Y	---	---	16.88	0	Y	NC	NA	N (LCL <0)	9	2.4	4.8	10	7.6	1.58	5.72	2.48	2	4.8	120	0
	BISS2-09-DP-2		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	8	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.00040	0.37	0
	BISS2-09-DP-2		Toluene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	8	< 0.0005	NC	< 0.0005	NC	NC	NC	NC	2	< 0.00040	0.002	0
	BISS2-09-DP-2		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	8	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.00040	0.09	0
	BI-13-1-4	BI-13-1-4	Surficial Sediments	Chloride	0.09	91.40%	-0.7	-9	Y	---	---	NC	NA	N (Ins. CL data)	NC	NA	N (Ins. CL data)	5	6.2	7.9	9.5	3.3	0.42	7.94	1.20	1	6.2	120	0
	BI-13-1-5		Benzene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	5	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	1	< 0.00040	0.37	0
	BI-13-1-6		Toluene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	5	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	1	< 0.00040	0.002	0
	BI-13-1-7		Ethylbenzene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	5	< 0.0004	NC	< 0.00040	NC	NC	NC	NC	1	< 0.00040	0.09	0
	BI-13-3-4.5	BI-13-3-4.5	Surficial Sediments	Chloride	0.09	91.50%	NC	NC	Y	---	---	NC	NA	N (Ins. CL data)	NC	NA	N (Ins. CL data)	6	6.5	9.85	13	6.5	0.66	9.78	2.32	2	8.7	120	0
	BI-13-3-4.6		Benzene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	6	< 0.0004	NC	0.00042	NC	NC	NC	NC	2	< 0.00040	0.37	0
	BI-13-3-4.7		Toluene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	6	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.00040	0.002	0
	BI-13-3-4.8		Ethylbenzene	NC	NC	NC	NC		N (Ins. trend data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	6	< 0.0004	NC	< 0.00040	NC	NC	NC	NC	2	< 0.00040	0.09	0
	BIS 97-1-3	BIS 97-1-3	Surficial Sediments	Chloride	0.05	94.90%	-0.4	-2	Y	---	---	43.49	0	N (Ins. CL data)	4.46	0	Y	17	18	22	35	17	0.77	23.97	4.33	1	20	120	0
	BIS 97-1-4		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	1	< 0.00040	0.37	0
	BIS 97-1-5		Toluene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	1	< 0.00040	0.002	0
	BIS 97-1-6		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	1	< 0.00040	0.09	0
	C38 08-1-4	C38 08-1-4	Surficial Sediments	Chloride	0.03	98%	-0.5	-2	Y	---	---	35	0	Y	7.5	0	Y	13	14	22	25	11	0.50	21.08	3.01	2	14	120	0
	C38 08-1-4		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.0004	0.37	0
	C38 08-1-4		Toluene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.0004	0.002	0
	C38 08-1-4		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0004	NC	NC	NC	NC	2	< 0.0004	0.09	0
	CPF 97-7-5	CPF 97-7-5	Surficial Sediments	Chloride	0.10	91%	0.3	2	Y	---	---	33.05*	0	Y	NC	NA	N (LCL < 0)	23	7.7	14	190	182.3	13.02	21.93	4.25*	2	19	120	0
	CPF 97-7-5		Benzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	21	< 0.0004	NC	< 0.0050	NC	NC	NC	NC	2	< 0.00040	0.37	0
	CPF 97-7-5		Toluene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	21	< 0.0004	NC	< 0.0050	NC	NC	NC	NC	2	< 0.00040	0.002	0
	CPF 97-7-5		Ethylbenzene	NC	NC	NC	NC		N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	21	< 0.0004	NC	< 0.0050	NC	NC	NC	NC	2	< 0.00040	0.09	0
	CPF 98-8-3	CPF 98-8-3	Surficial Sediments	Chloride	0.08	92%																							

Project No.: 407074-00828-400				Trend Analysis							Upper Control Limit Analysis			Lower Control Limit Analysis			Basic Analysis								Guideline Analysis				
Location		Monitoring Station	Hydrostratigraphic Unit	Parameter	Trend Analysis							Upper Control Limit Analysis			Lower Control Limit Analysis			Historical							Reporting Period		Guideline Analysis		
																		Count	Min	Median	Max	Range	Variability ⁴	Average	Standard Deviation	Count			Max
					P Value of Two Tailed Test (-)	Inferred Confidence Level (of Trend Present in Data Set) (%)	Slope (mg/L/yr)	Normalized Slope (%/yr)	Meets Trend Assumptions? ⁷	Statistically Significant Mann-Kendall Trend ⁵	Visual Trend Assessment ¹⁰	UCL ⁶ (mg/L)	2017 Values Greater than UCL	Meets UCL Assumptions? ⁷	LCL ⁶ (mg/L)	2017 Values Less than LCL	Meets LCL Assumptions? ⁷	Count	Min (mg/L)	Median (mg/L)	Max (mg/L)	Range (mg/L)	Variability ⁴	Average (mg/L)	Standard Deviation (mg/L)	Count	Max (mg/L)	Guideline Value ⁹ (mg/L)	2017 Guideline Exceedances
	MTF 97-1-5	MTF 97-1-5	Surficial Sediments	Chloride	0.02	98%	-0.1	-5	Y	---	---	4.96	0	Y	NC	NA	N (LCL < 0)	17	< 1.0	1.3	3.4	NC	NC	1.44	0.78	2	1.5	120	0
	Benzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.37	0		
	Toluene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.002	0		
	Ethylbenzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	13	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.09	0		
	TF 03-12-3	TF 03-12-3	Surficial Sediments	Chloride	0.01	99%	-5.4	-3	Y	---	---	384	0	Y	NC	NA	N (LCL < 0)	18	120	175	280	160	0.91	181.39	44.94	2	190	120	1
	Benzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	18	< 0.0004	0.0002	0.0017	NC	NC	NC	NC	2	< 0.0004	0.37	0		
	Toluene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	18	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.002	0		
	Ethylbenzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	18	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.09	0		
	WSY 97-1-5	WSY 97-1-5	Surficial Sediments	Chloride	0.15	85%	-0.4	-2	Y	---	---	70.4	0	Y	NC	NA	N (LCL < 0)	23	6.5	18	64	57.5	3.19	19.15	11.39	2	26	120	0
	Benzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	19	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.37	0		
	Toluene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	19	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.002	0		
	Ethylbenzene		NC	NC	NC	NC	N (Ins. >DL data)	---	---	NC	NA	N (Ins. >DL data)	NC	NA	N (Ins. >DL data)	19	< 0.0004	NC	< 0.0005	NC	NC	NC	NC	2	< 0.0004	0.09	0		

1. Bold formatting indicates a value is above the applied guideline

- The following results have been checked against the guideline: minimum, median, maximum, average, LCL, UCL

2. Shading in the parameter column indicates one or more analyses returned notable results (analysis-specific shading is further specified below)

3. Basic analysis performed with the following conditions:

- Historical: all data before 01-Jan-2017

- Reporting period is defined as 01-Jan-2017 to 22-Nov-2017 (inclusive)

- Non-detect multiplier of 0.5 applied to <DL sample data

4. Variability calculated as range / median

5. Trend Analysis:

- Analyses performed on all sample data before 22-Nov-2017 (inclusive)

- Non-detect multiplier of 0.5 applied to <DL sample data

- Statistically significant trend defined as:

-- Inferred confidence level greater than 95%

(in other words, P-value of two-tailed test is less than or equal to 0.05)

-- Absolute value of Sen's normalized slope is greater than 10%

-- Absolute slope criteria met for individual parameters (see criteria below)

- U: Denotes statistically significant upward trend

- D: Denotes statistically significant downward trend

- "---": Denotes no trend

- Shading of trend analysis cells indicates a Mann-Kendall trend has been detected

6. Upper Control Limit (UCL) and Lower Control Limit (LCL) calculated as follows:

- Calculated on all data before 31-Dec-2017 (inclusive)

- Minimum 8 data points; no maximum number of data points

- Non-detect multiplier of 0.5 applied to <DL sample data

- Control limit exceedances reported on sample data between 01-Jan-2017 and 31-Dec-2017 (inclusive)

- Shading of control limit cells indicates one or more control limit exceedances were detected

7. Legend for control limit/trend assumptions:

- Y: All conditions are met

- N: Not all conditions are met, specified as follows:

-- No new data: No sample data present for years reported

-- LCL < 0: calculated LCL was less than 0

-- Ins. CL data: insufficient data to calculate a control limit

-- Ins. >DL data: Less than 50% of control limit data was above detection limit

-- Ins. >DL data: Less than 50% of trend data was above detection limit

-- UCL <2x/<5x RDL: The UCL is less than twice/less than 5 times the reporting detection limit

-- U Trend: An upward Mann-Kendall trend is present

-- D Trend: A downward Mann-Kendall trend is present

8. Parameter dependent criteria as follows:

- Chloride - control limit criteria: 5.0 mg/L (5x the reporting detection limit); absolute slope criteria: 2.0 mg/L

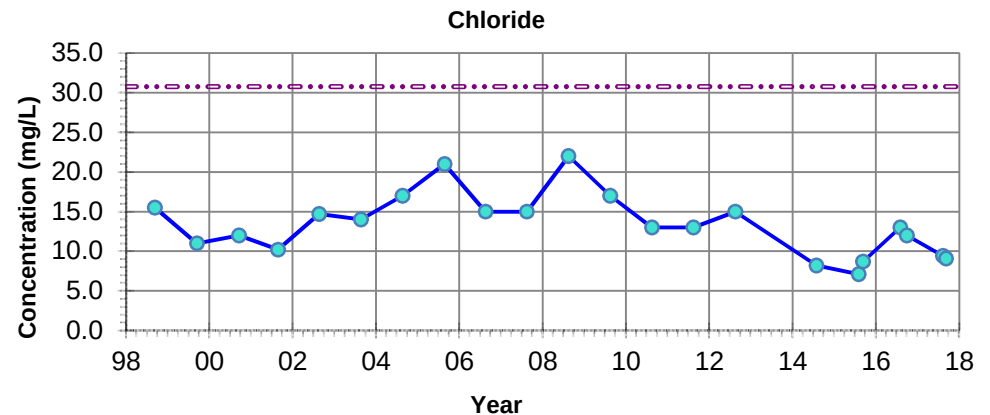
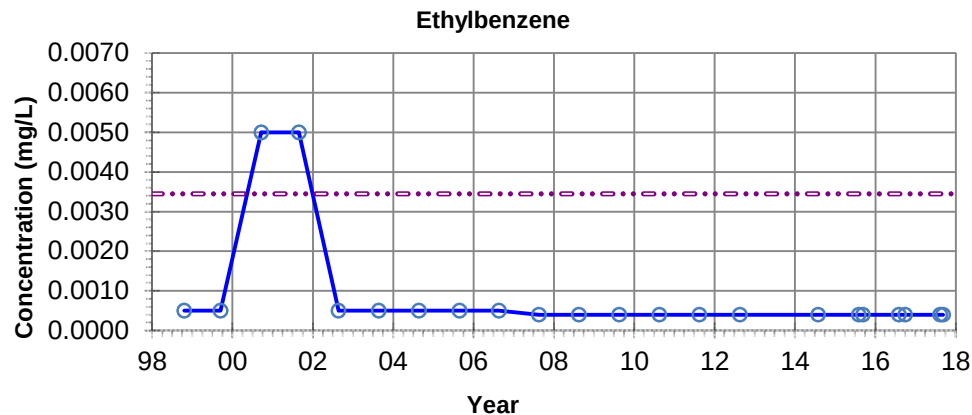
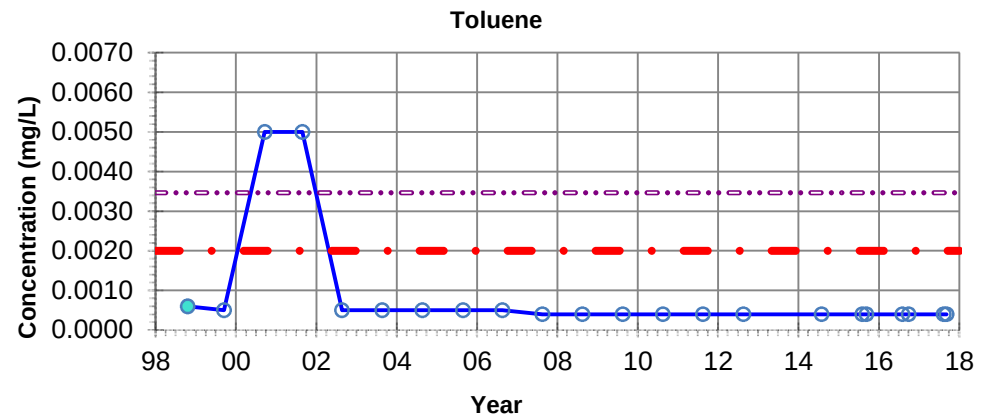
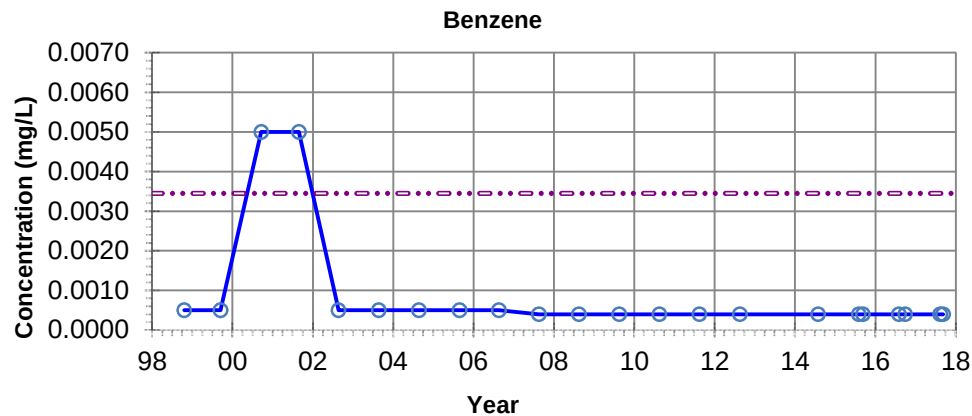
9. Guideline: Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. Sept, 2014.

- Chloride guideline based on chronic exposure

10. Visual Trend Assessment includes: trend reversals, trend stabilizations, possible developing trends, and probable (monotonic) trends

11. NC: not calculated due to assumptions not being met

12. * indicates outlier removed from calculation. Outliers were determined using a Dixon's outlier test (5% significance level).



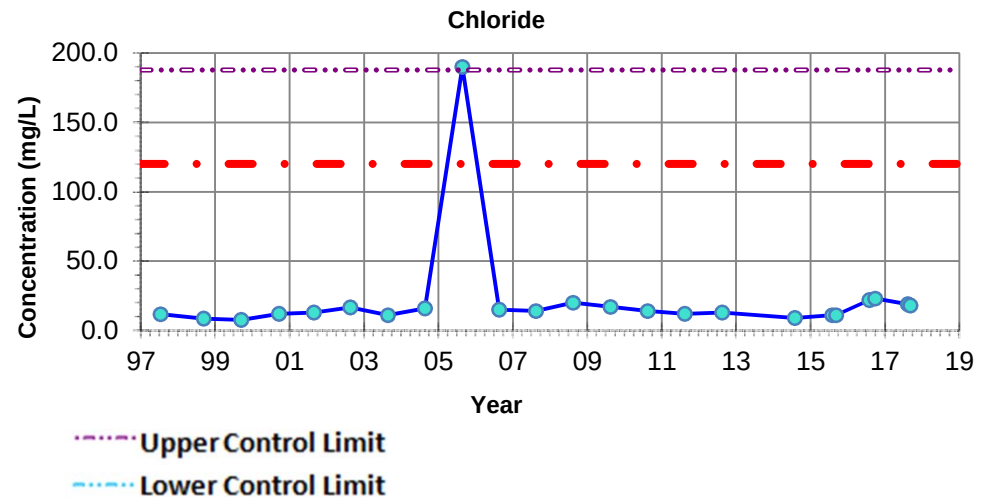
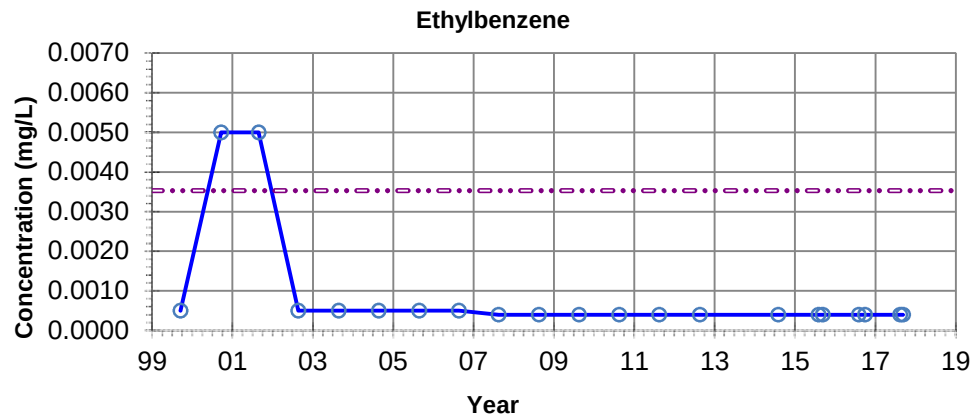
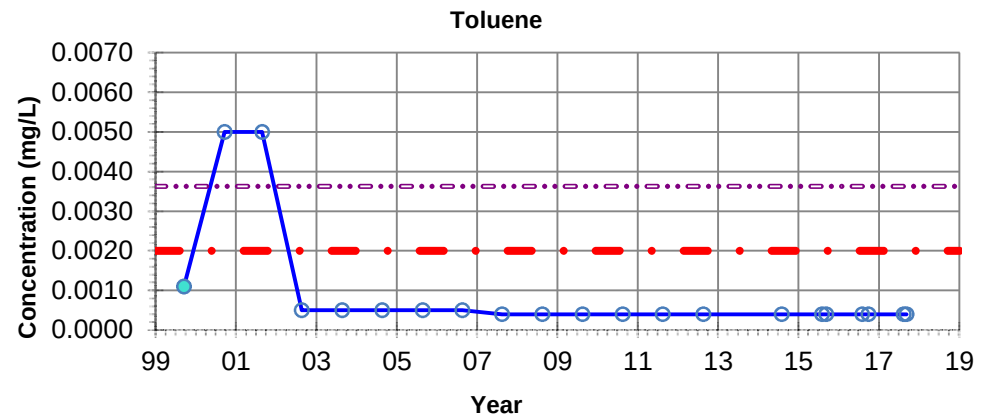
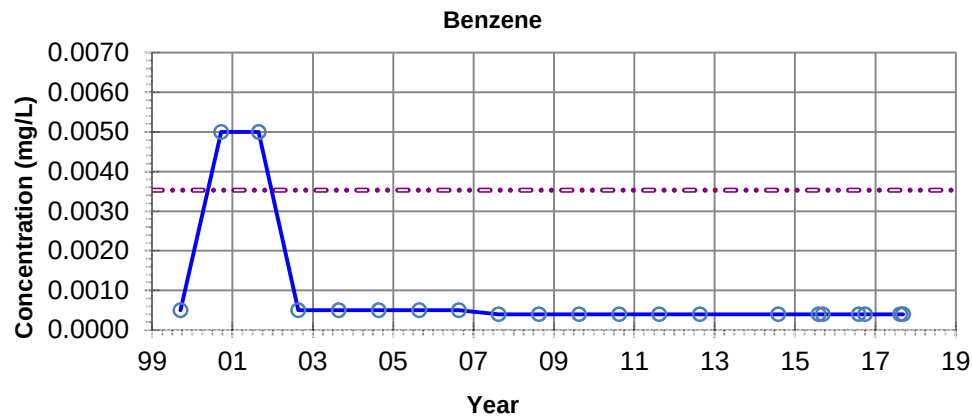
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment											
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: CPF 98-8-3					 Advisian WorleyParsons Group						
12-Dec-2017		date	NA	edited by	JC	drawn by	NA	app by	PROJECT NUMBER: 407074-00828.400		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.										Figure E-1	

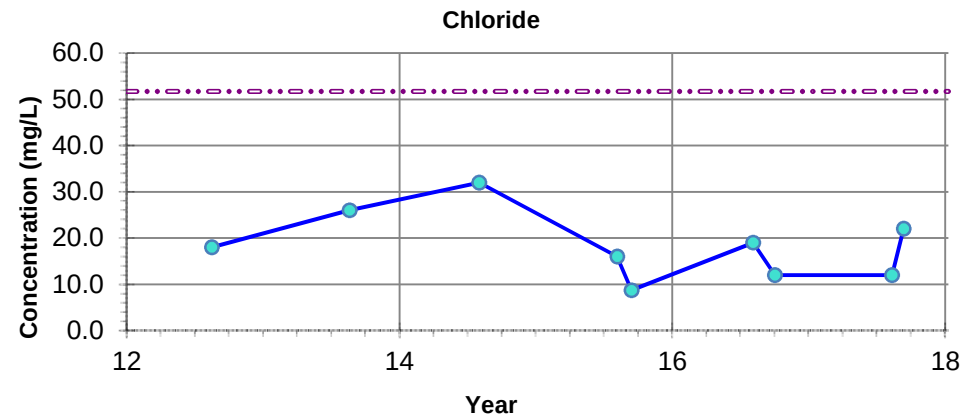
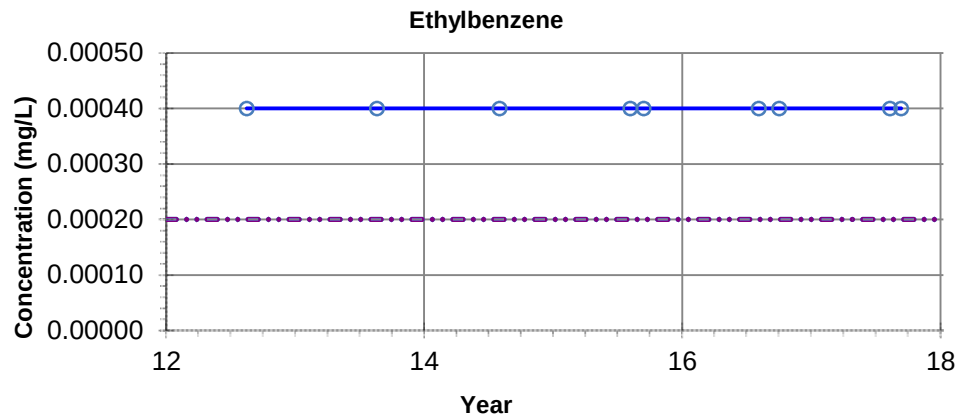
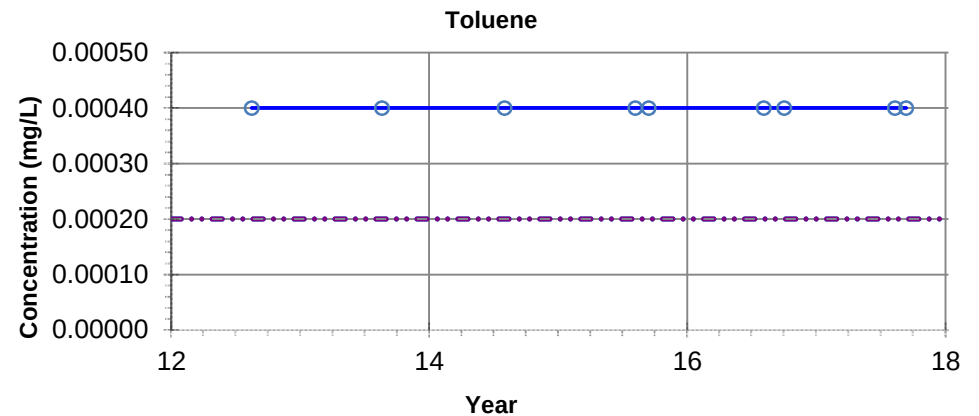
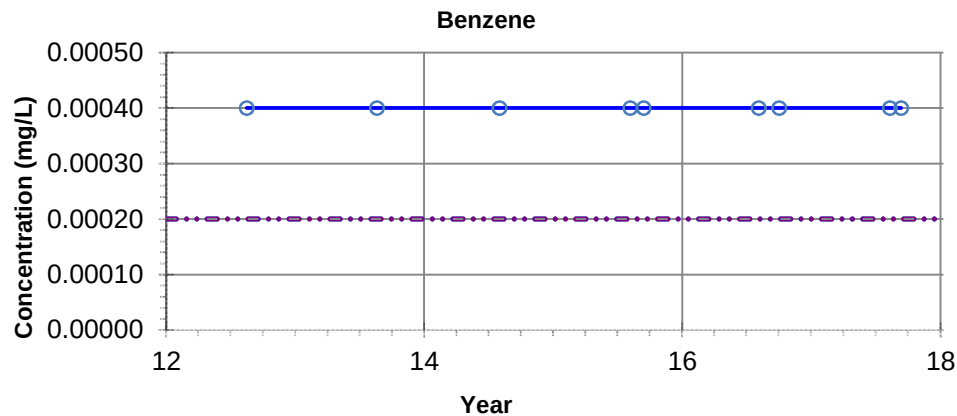


NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

GUIDELINE:
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program					
Concentrations Monitoring Well: CPF 97-7-5			PROJECT NUMBER: 407074-00828.400		
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			Figure E-2		



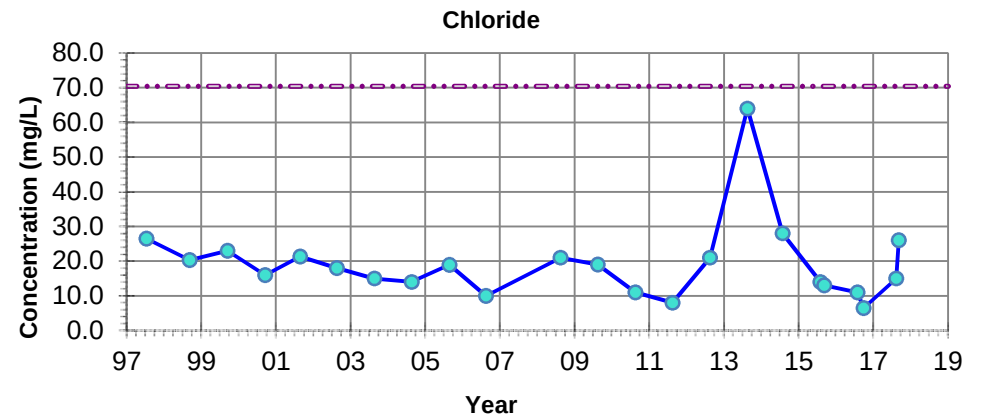
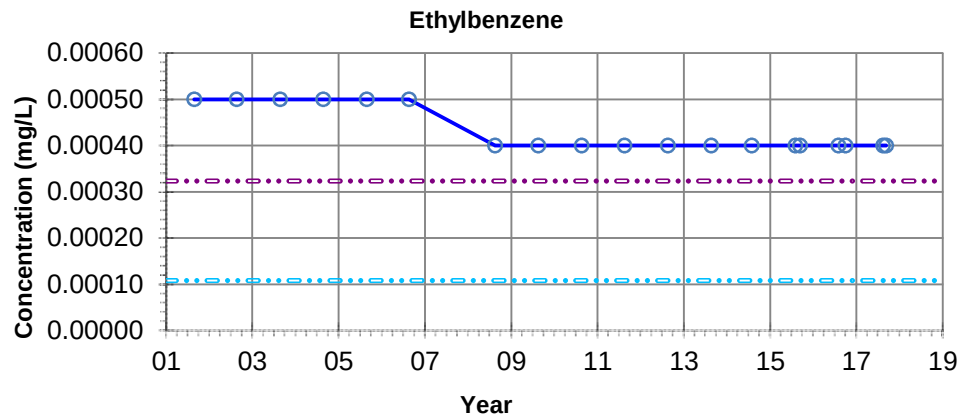
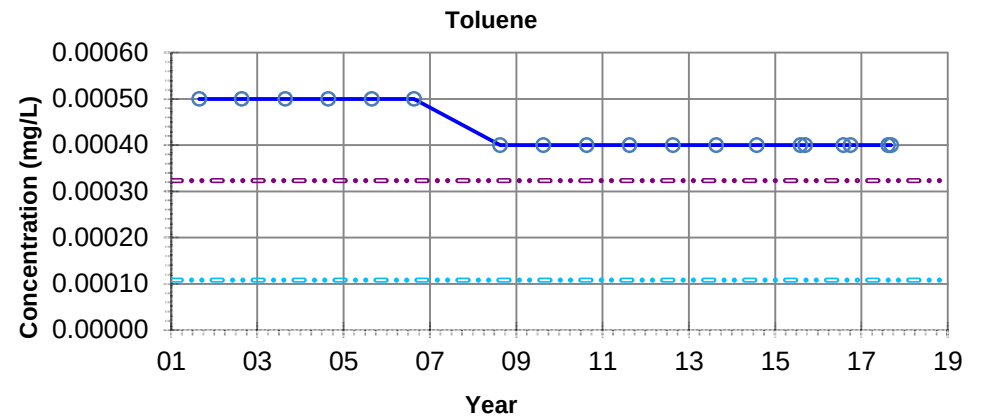
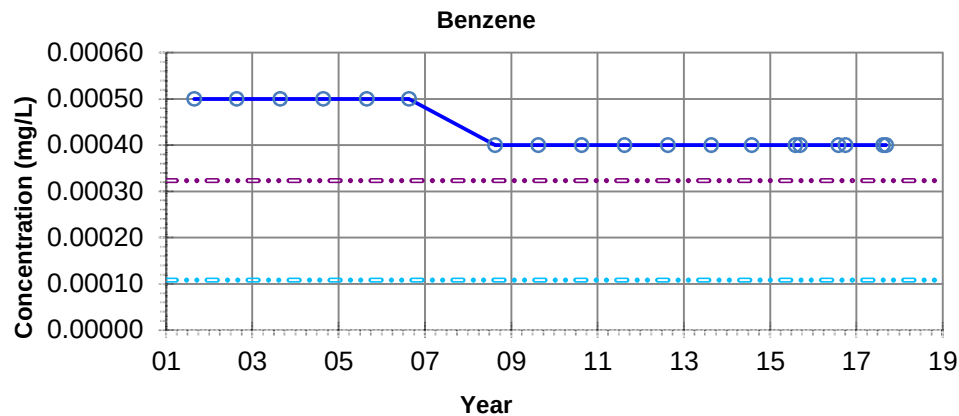
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: ARB-12-3-3					
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			PROJECT NUMBER: 407074-00828.400		Figure E-3



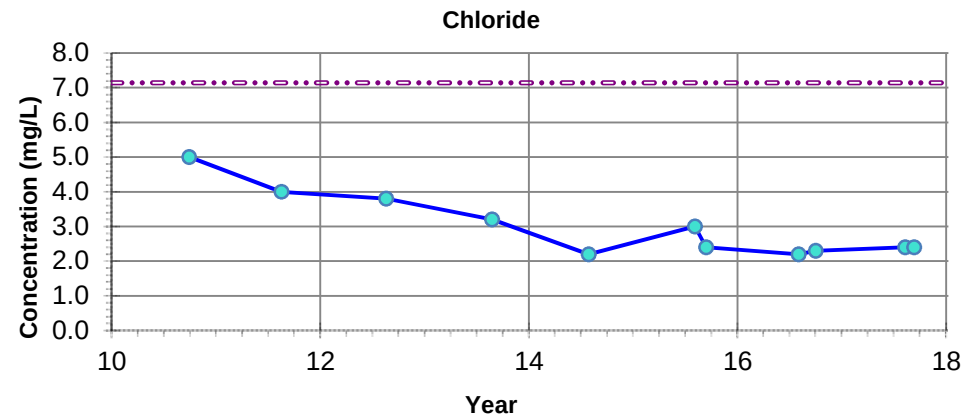
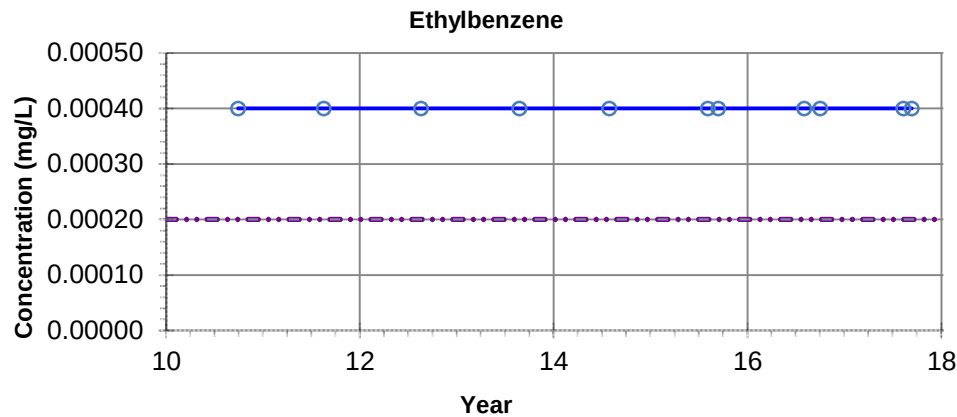
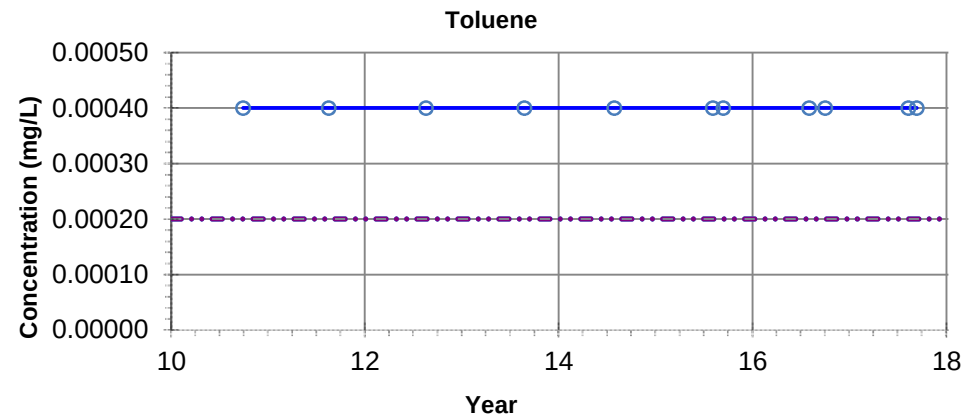
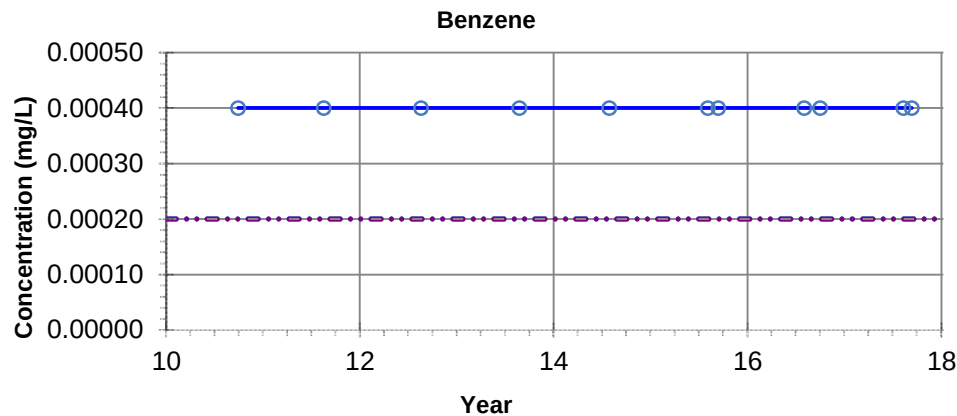
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: WSY 97-1-5			PROJECT NUMBER: 407074-00828.400		
12-Dec-2017	date	NA	edited by	JC	drawn by
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			NA	app by	
			Figure		E-4



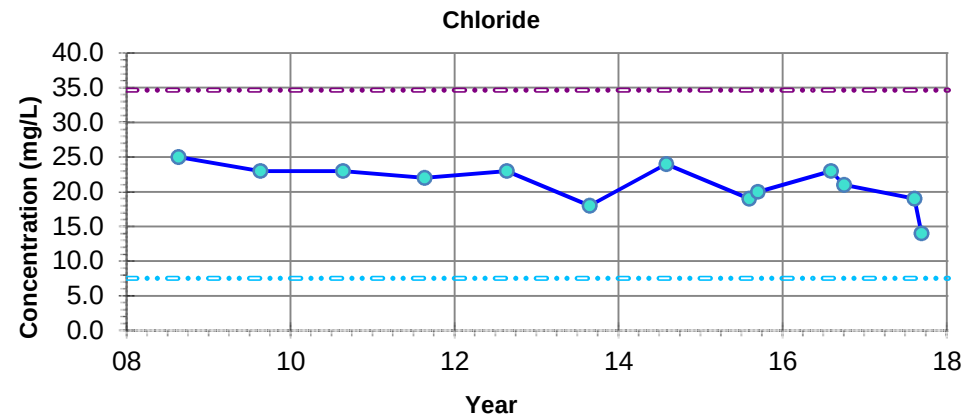
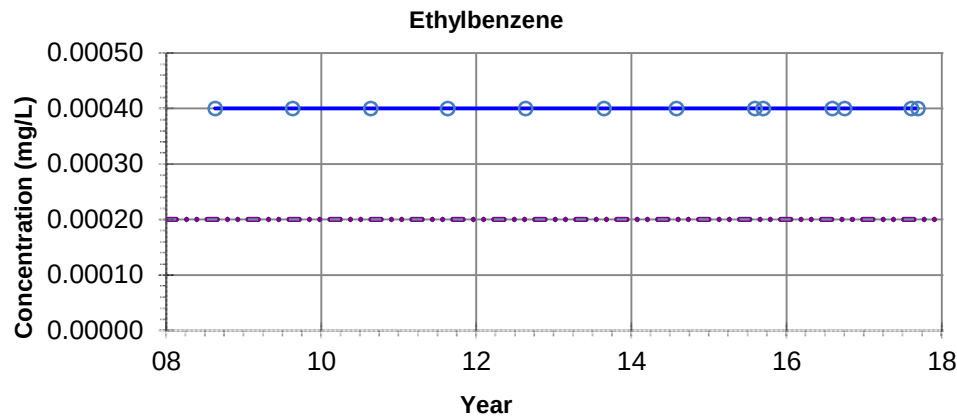
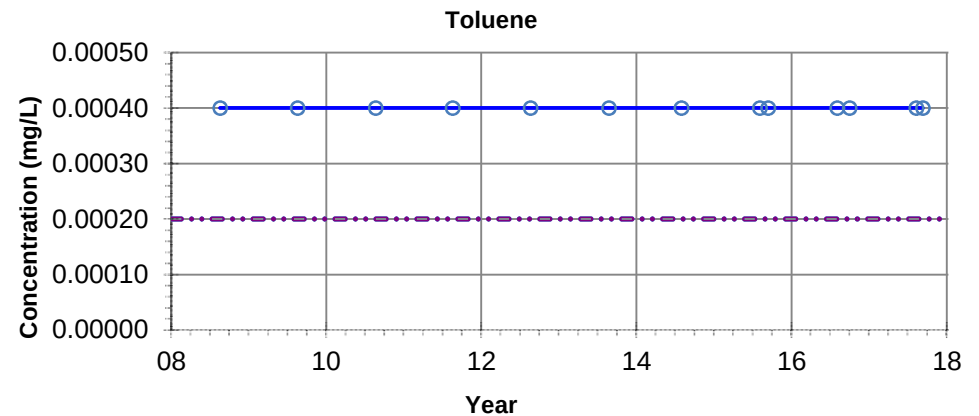
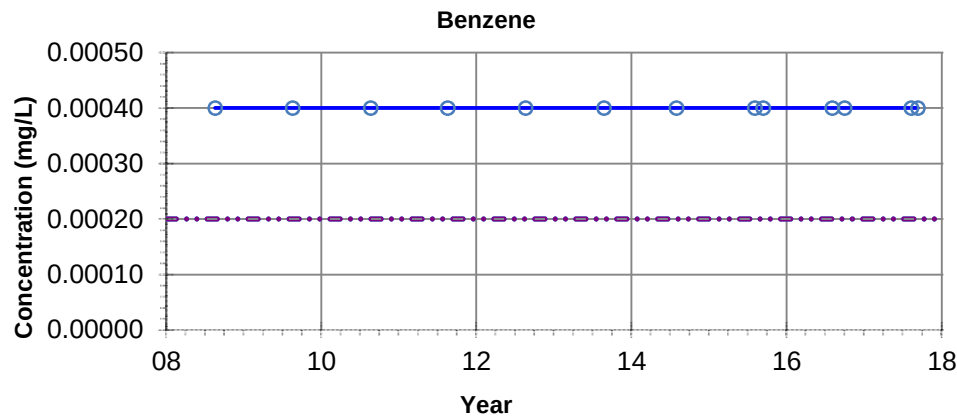
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: MEBG-10-1-3					
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			PROJECT NUMBER: 407074-00828.400		Figure E-5



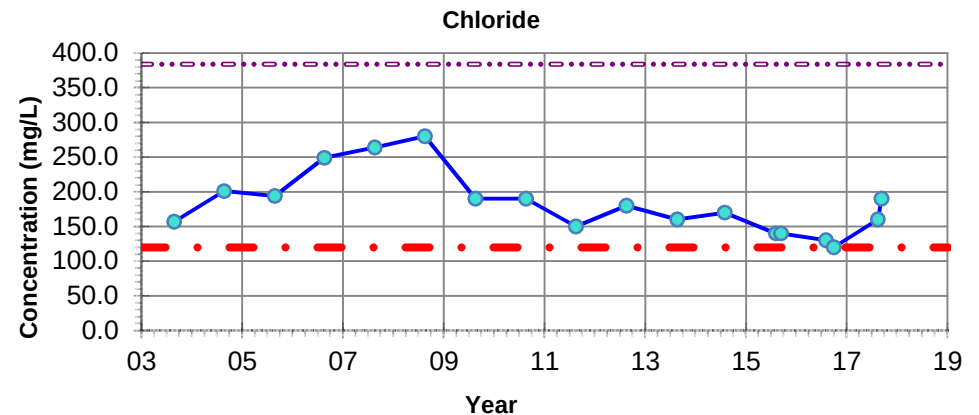
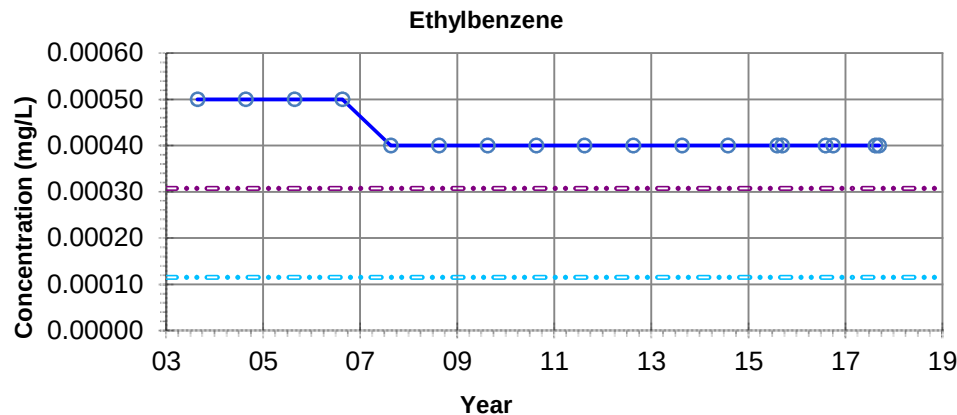
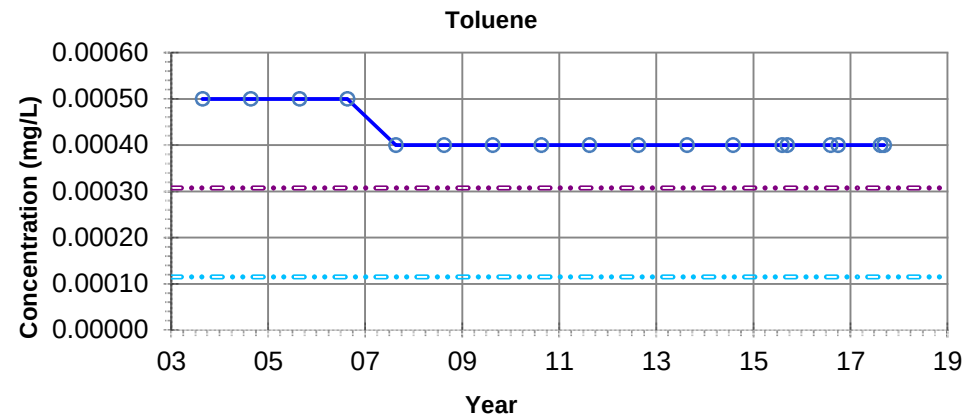
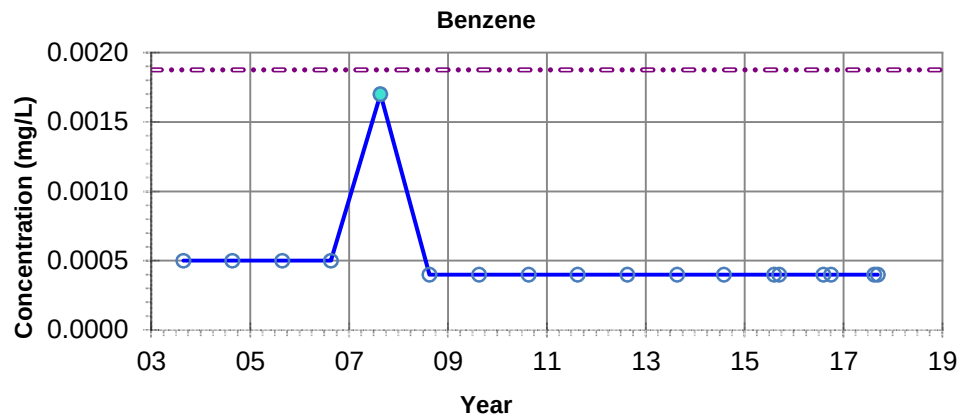
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: C38 08-1-4					
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			PROJECT NUMBER: 407074-00828.400		Figure E-6



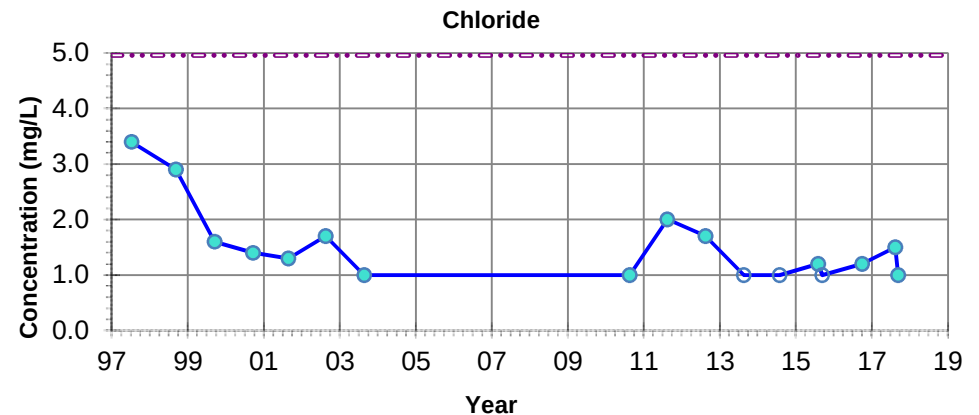
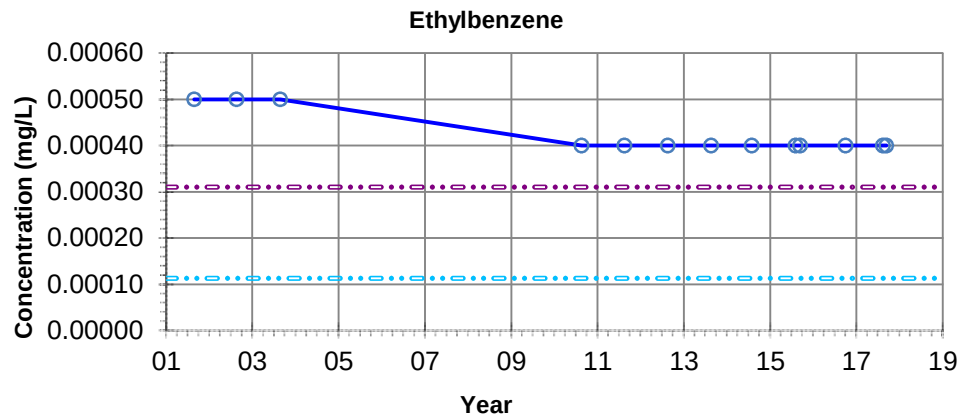
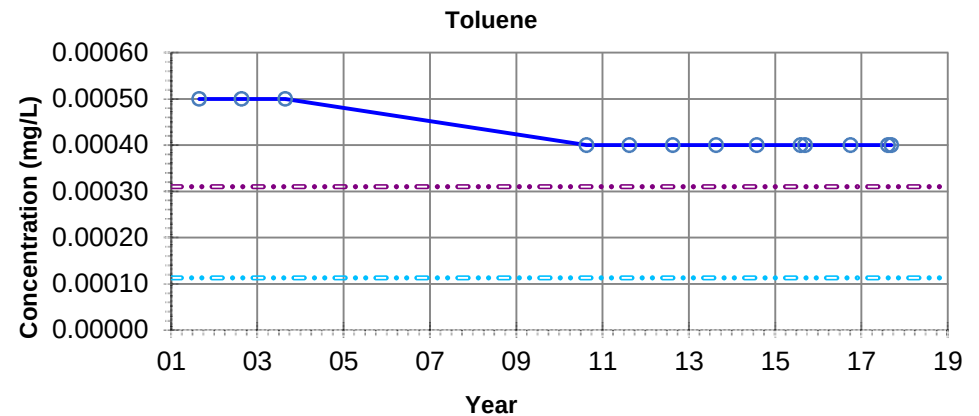
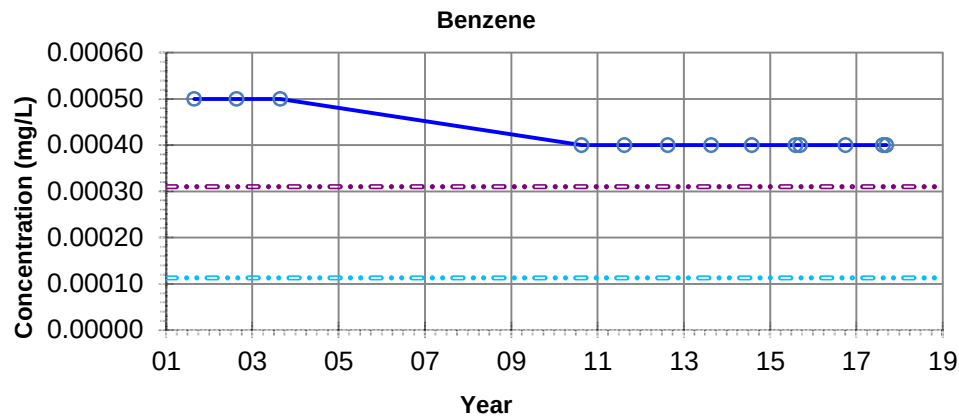
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

----- Upper Control Limit
 ----- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: TF 03-12-3				 Advisian WorleyParsons Group	
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by	PROJECT NUMBER:	
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.				407074-00828.400	
				Figure E-7	



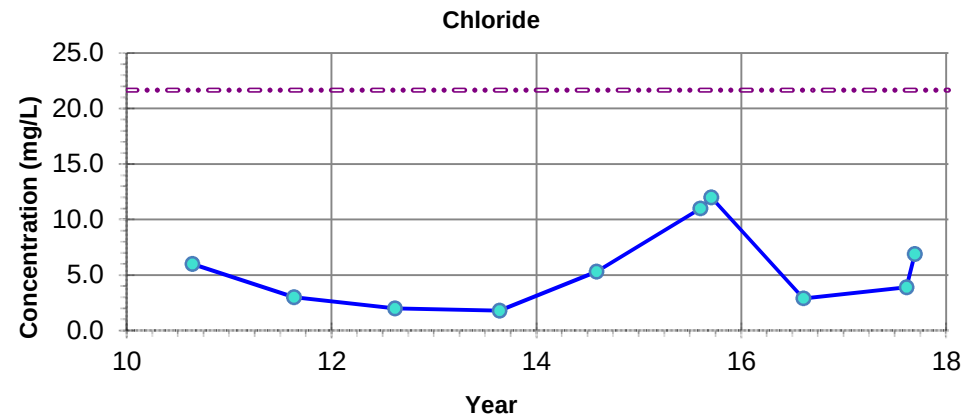
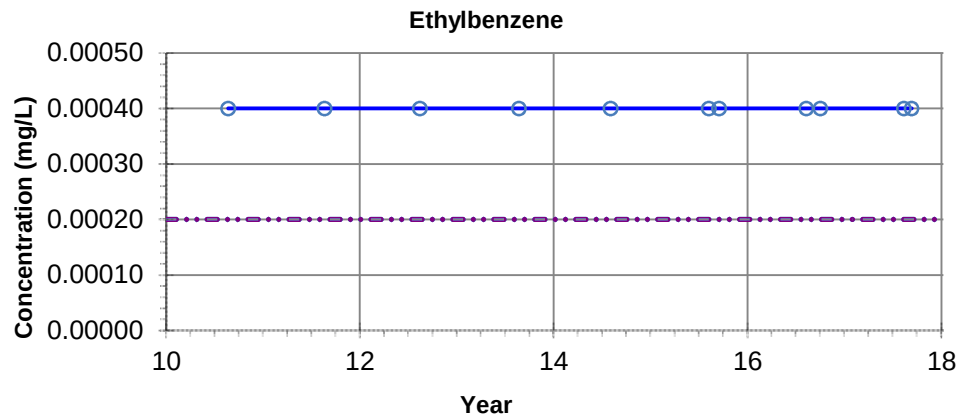
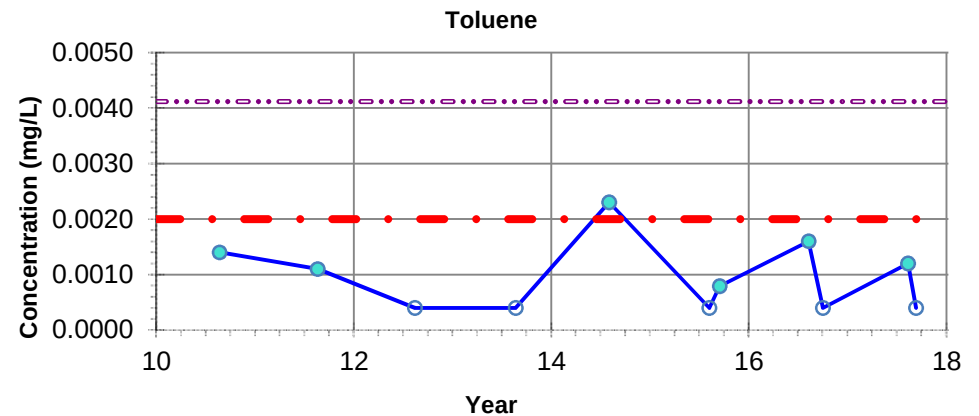
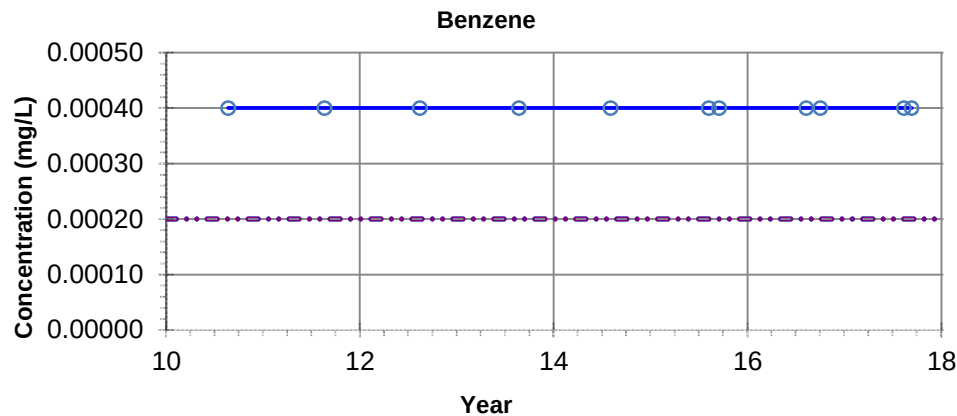
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment							
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: MTF 97-1-5					 Advisian WorleyParsons Group		
12-Dec-2017	date	NA	edited by	JC	drawn by	NA	app by
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.					PROJECT NUMBER: 407074-00828.400		Figure E-8



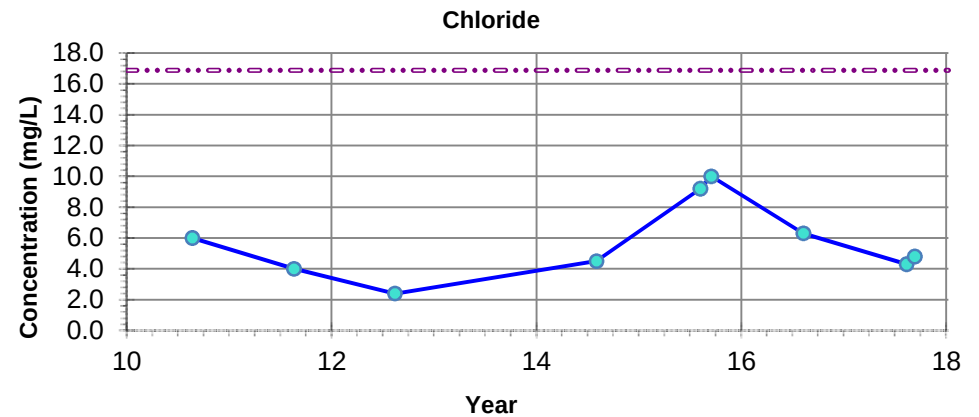
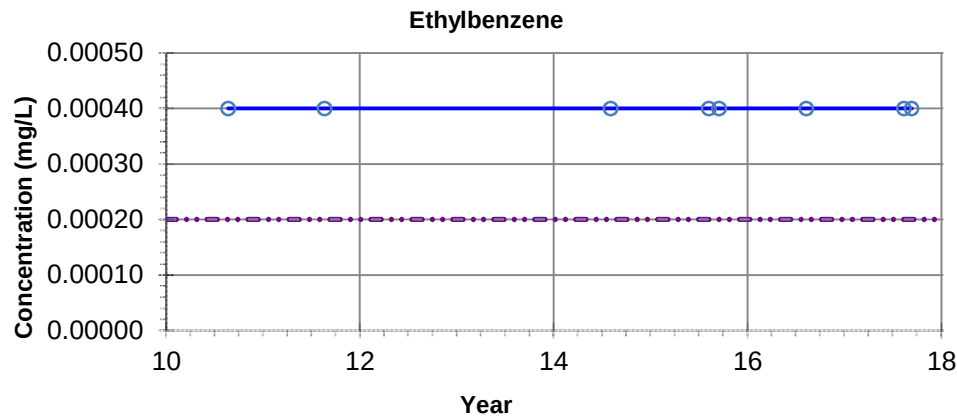
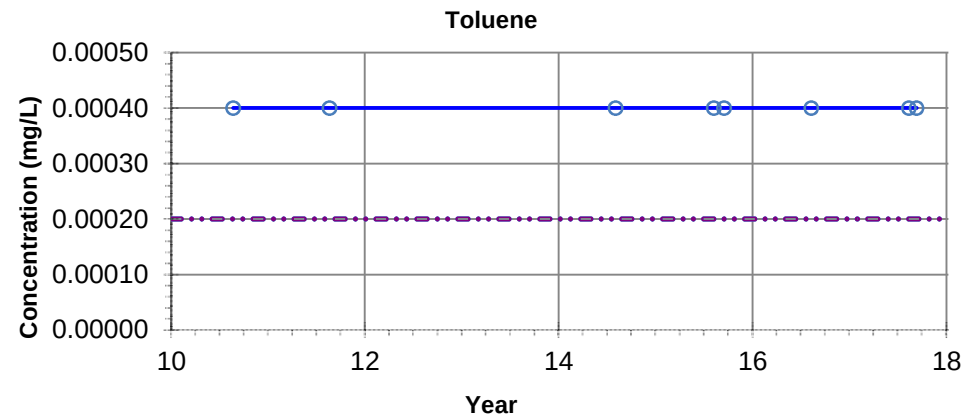
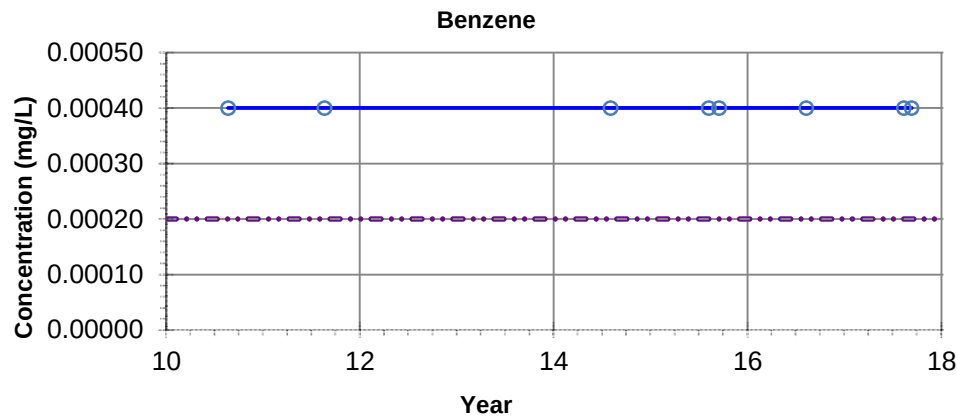
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: BISS2-09-DP-1				 Advisian WorleyParsons Group	
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.				PROJECT NUMBER: 407074-00828.400	
				Figure E-9	



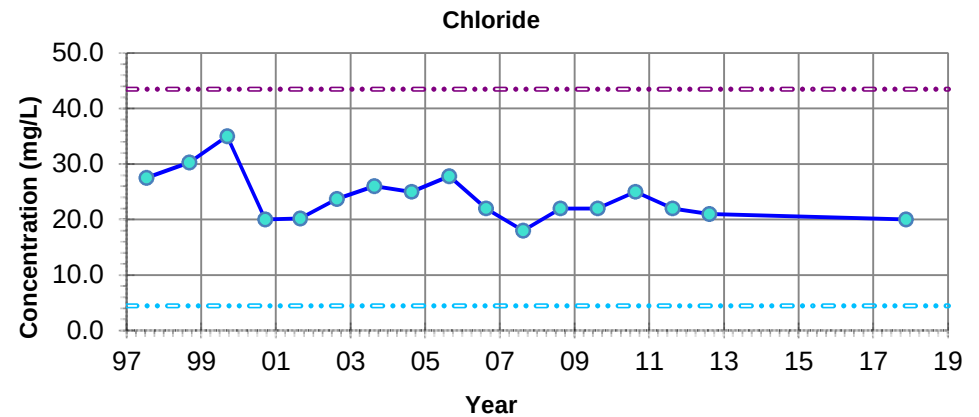
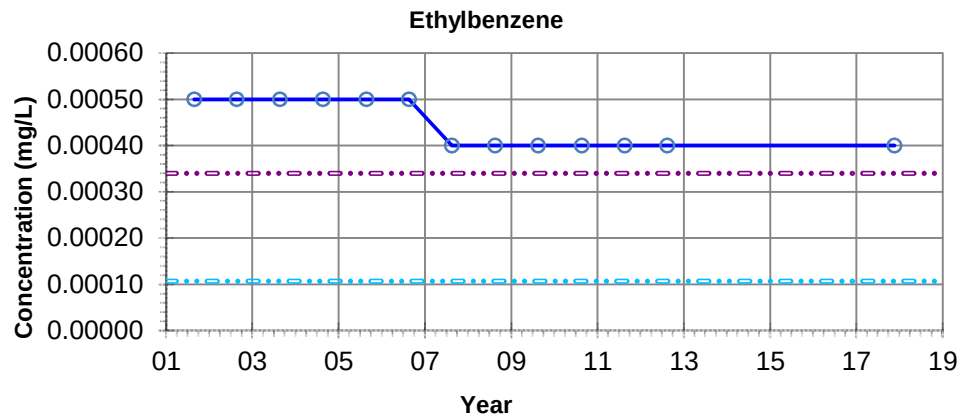
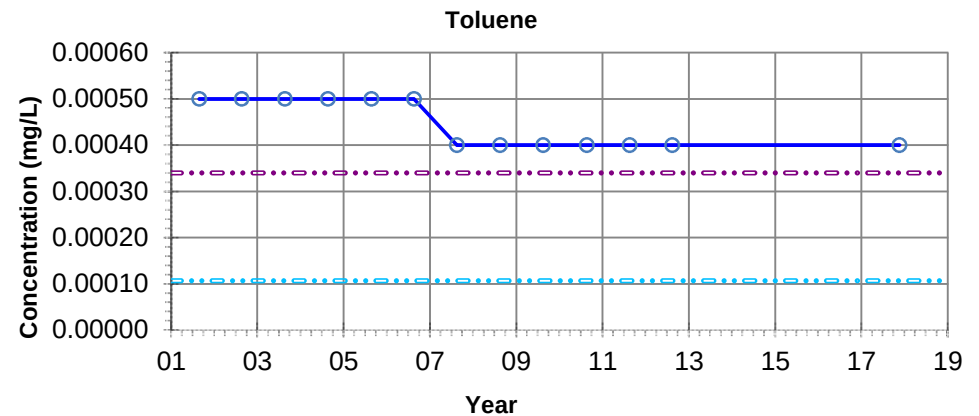
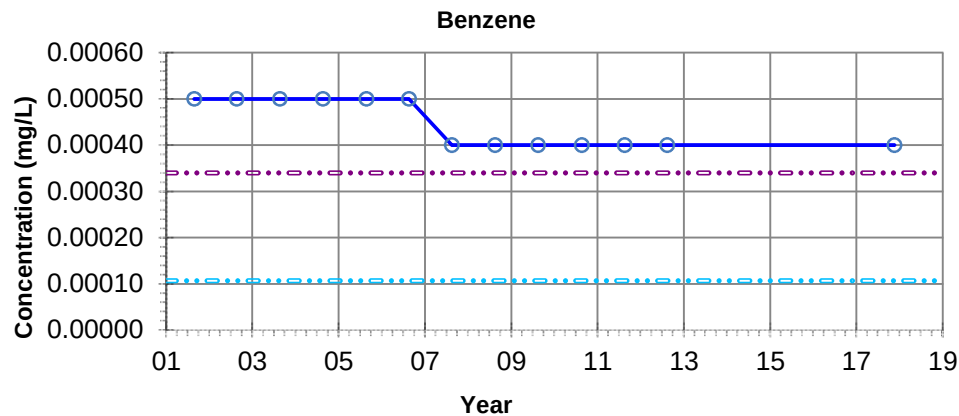
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment							
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: BISS2-09-DP-2					 Advisian WorleyParsons Group		
12-Dec-2017	date	NA	edited by	JC	drawn by	NA	app by
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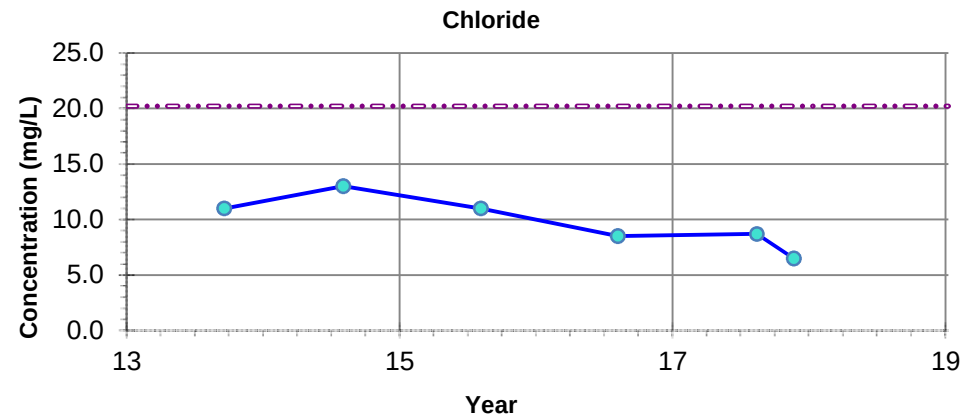
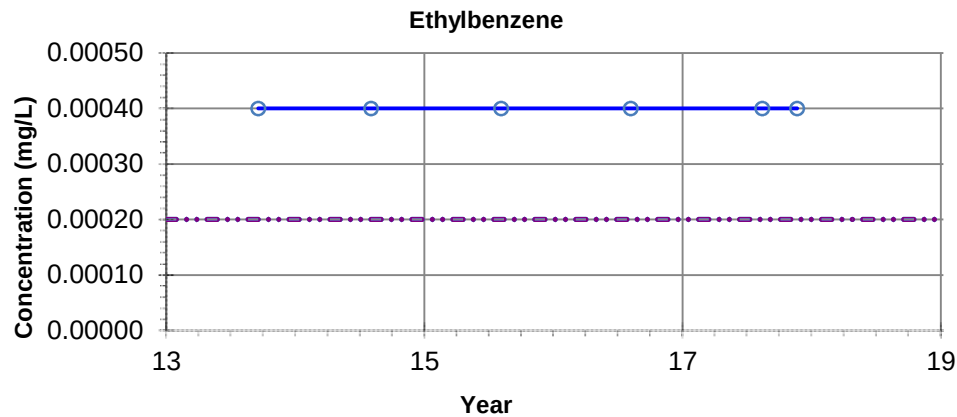
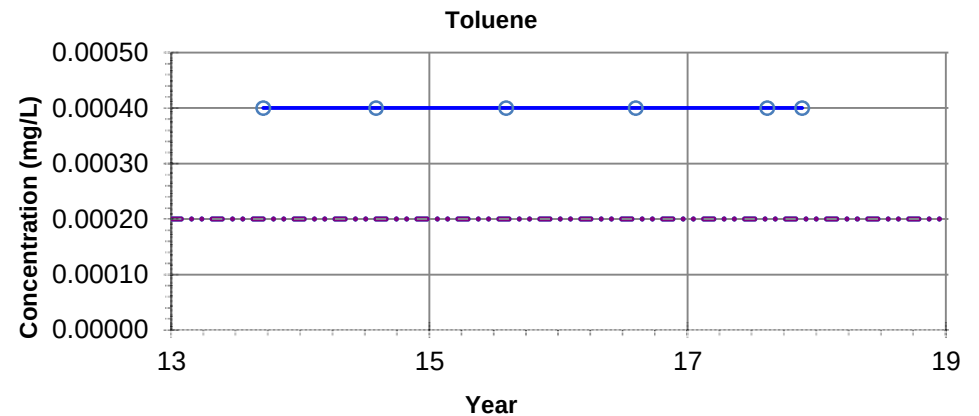
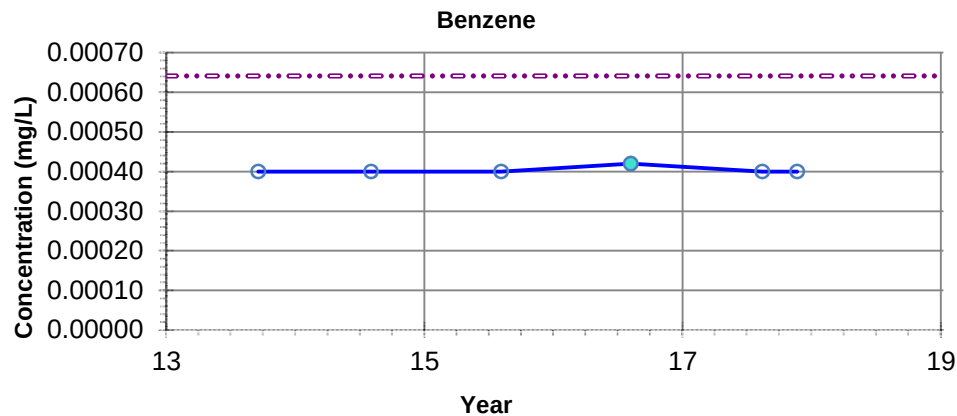
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

----- Upper Control Limit
 ----- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: BIS 97-1-3			PROJECT NUMBER: 407074-00828.400		
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.					
				Figure E-11	



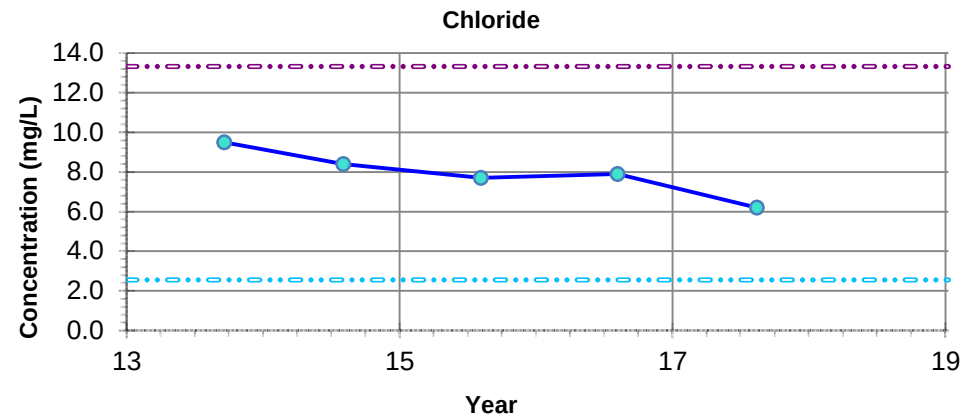
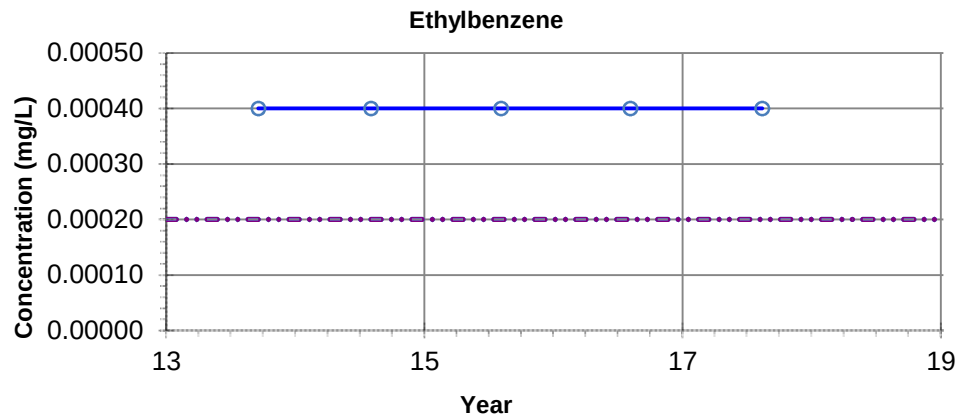
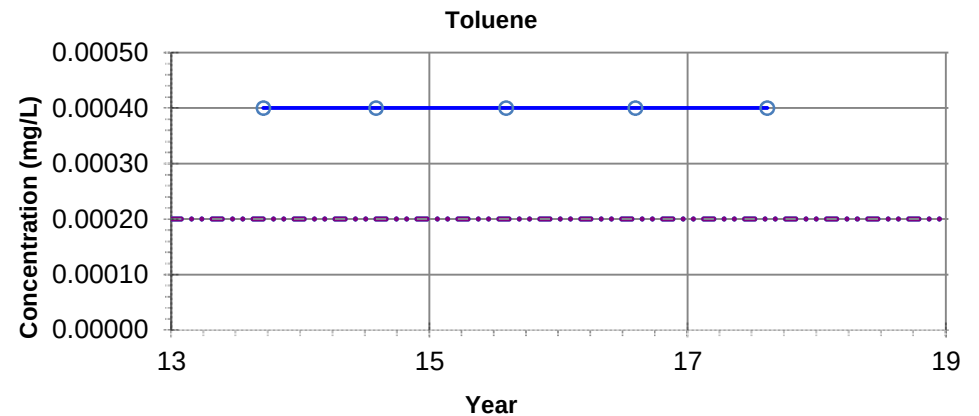
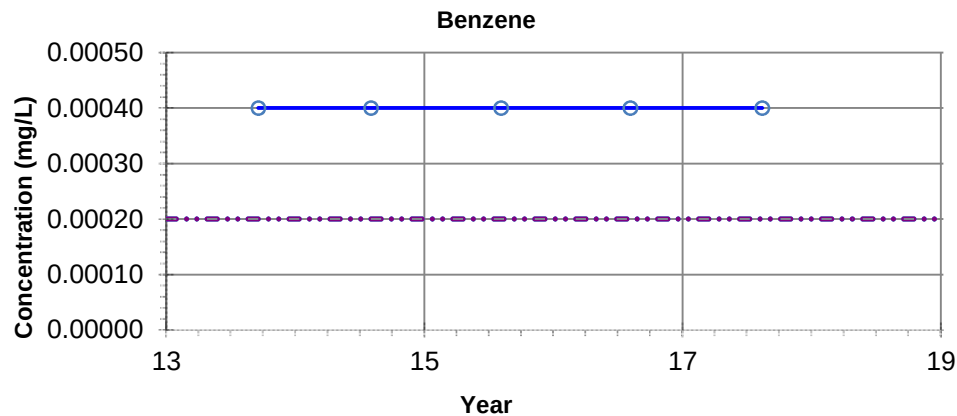
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment							
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: BI-13-3-4.5					 Advisian WorleyParsons Group		
12-Dec-2017	date	NA	edited by	JC	drawn by	NA	app by
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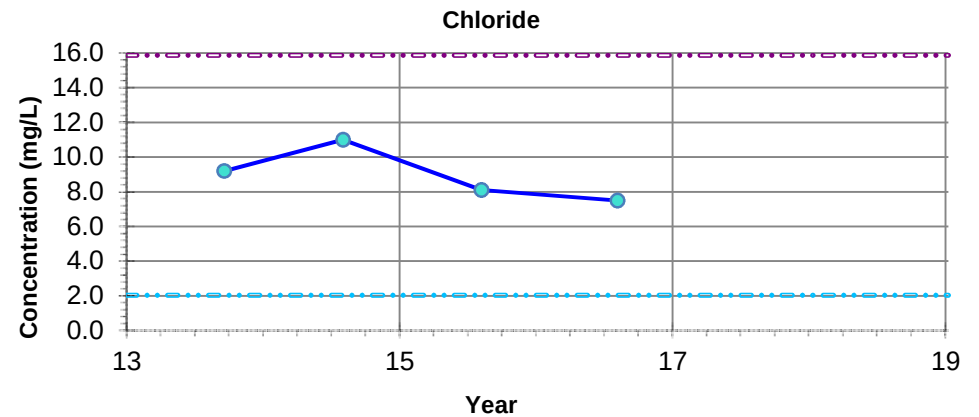
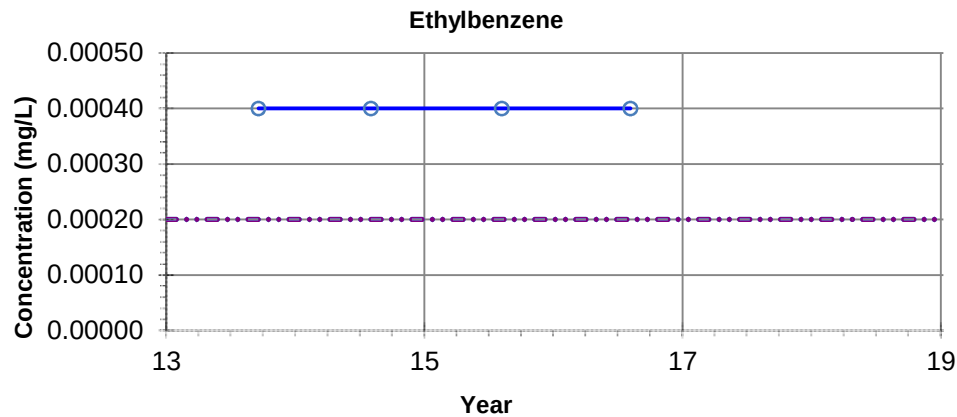
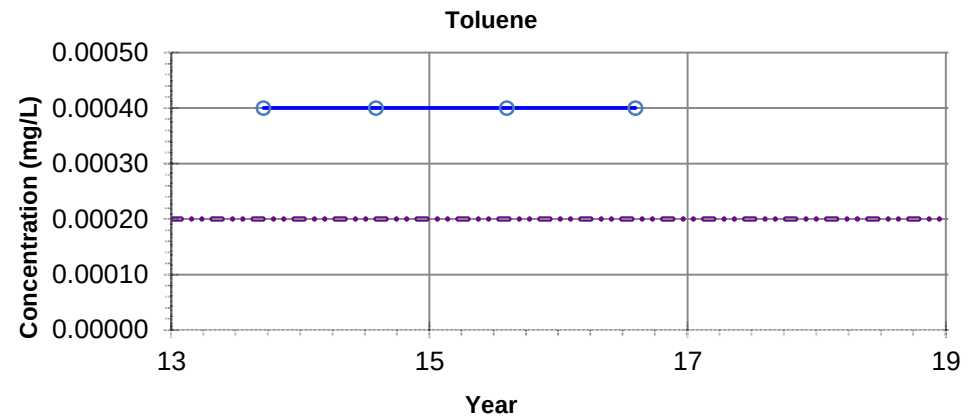
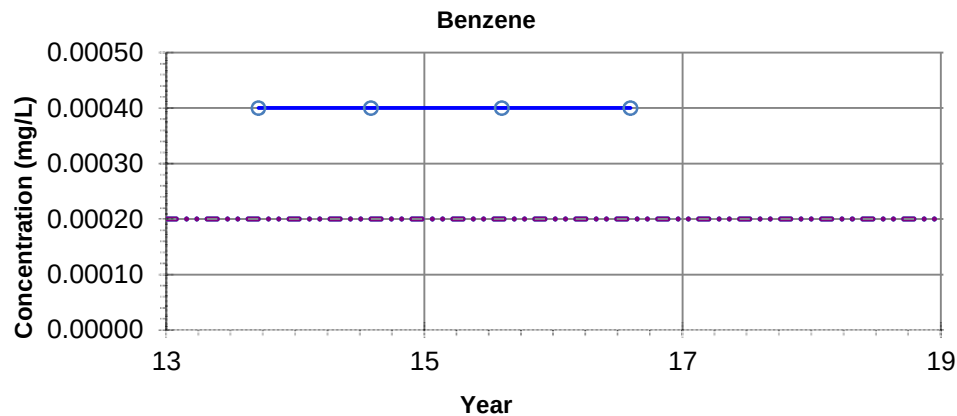
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program			 Advisian WorleyParsons Group		
Concentrations Monitoring Well: BI-13-1-4					
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
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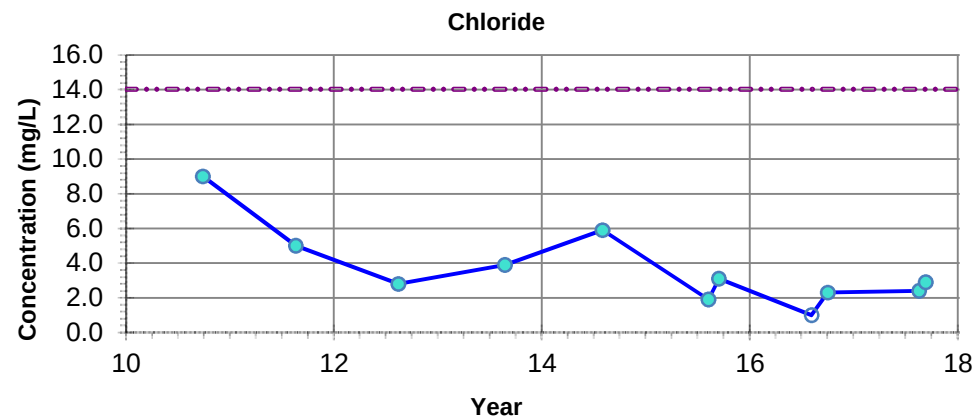
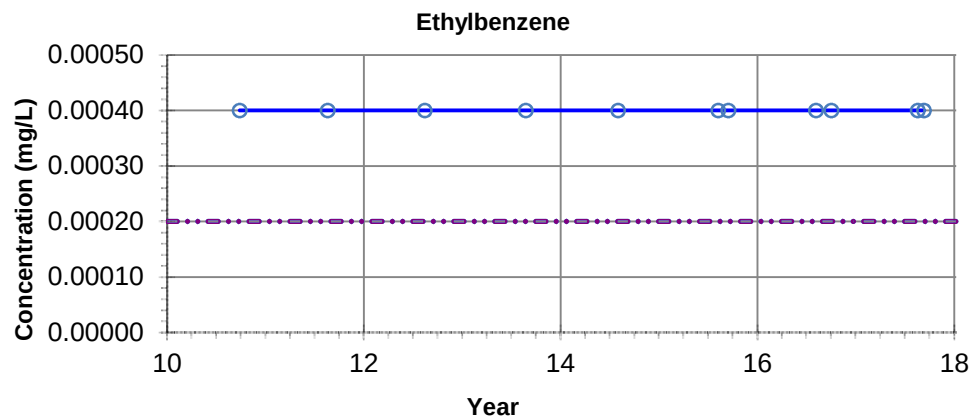
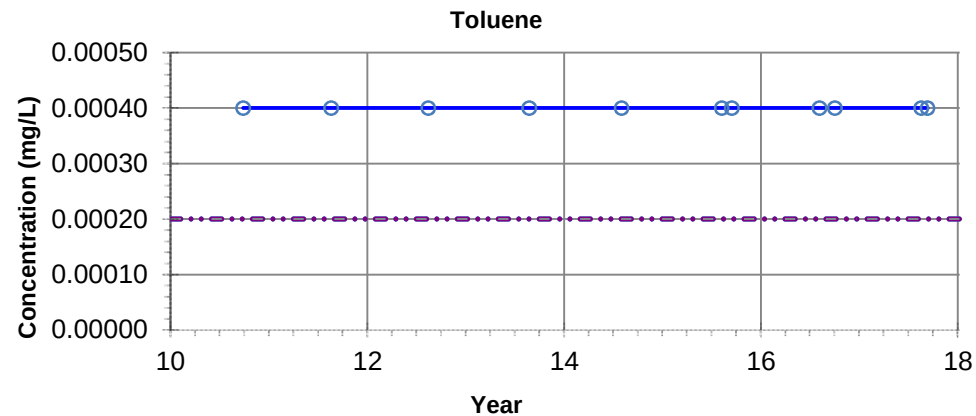
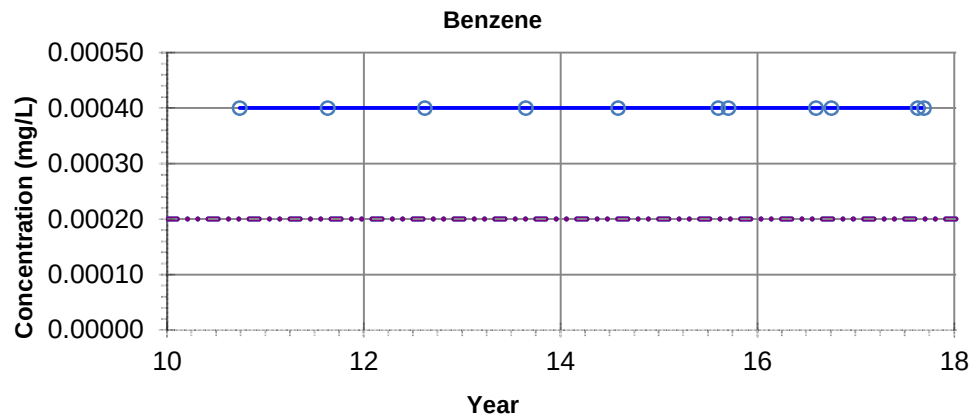
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

----- Upper Control Limit
 ----- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment							
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program Concentrations Monitoring Well: BIBG-12-1-7					 Advisian WorleyParsons Group		
12-Dec-2017	date	NA	edited by	JC	drawn by	NA	app by
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.					PROJECT NUMBER: 407074-00828.400		Figure E-14



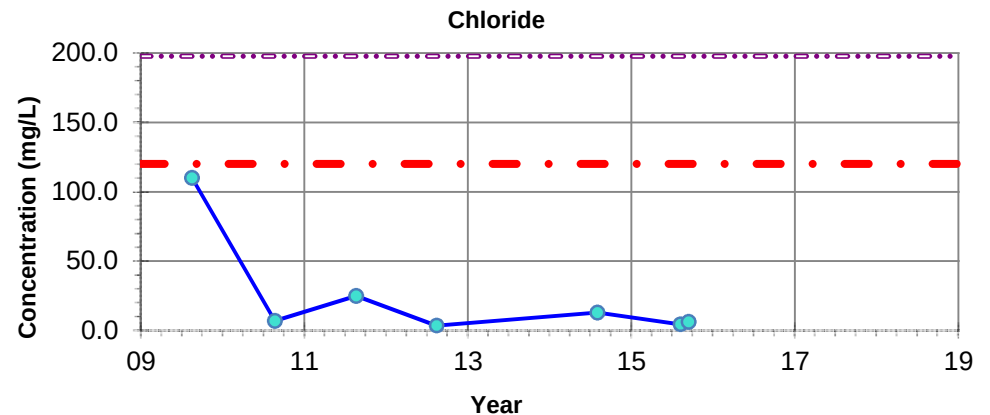
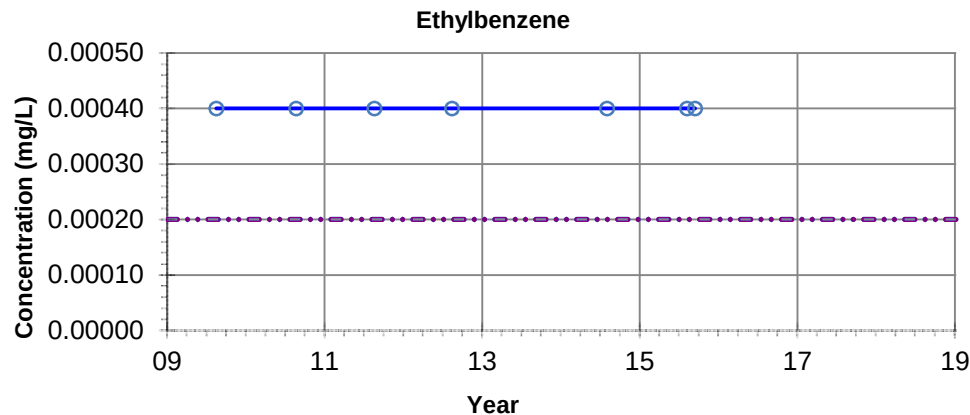
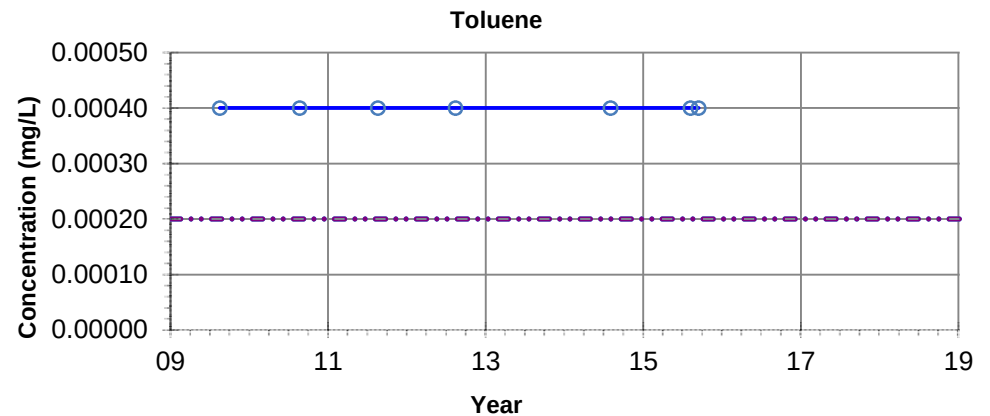
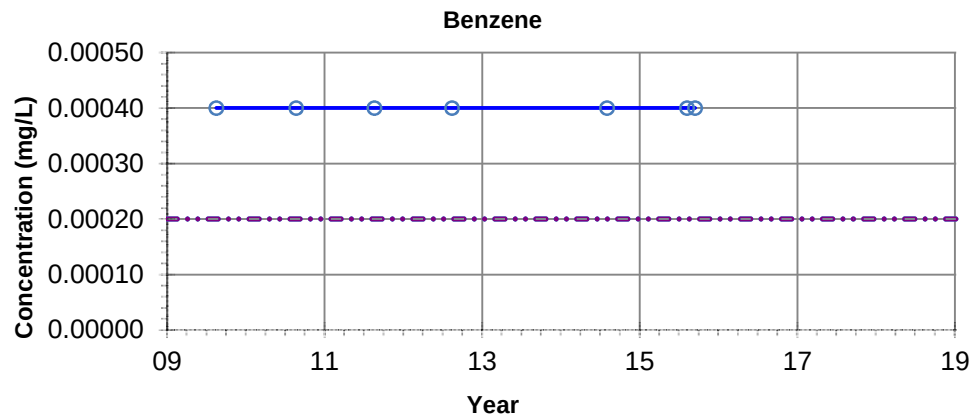
NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program					
Concentrations Monitoring Well: GIBG-10-2-3			PROJECT NUMBER: 407074-00828.400		
12-Dec-2017	date	NA	edited by	JC	drawn by
				NA	app by
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.					
				Figure E-15	

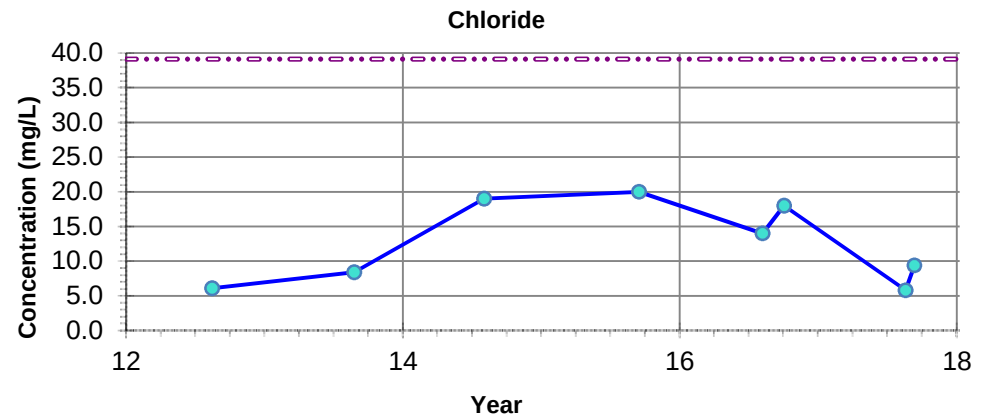
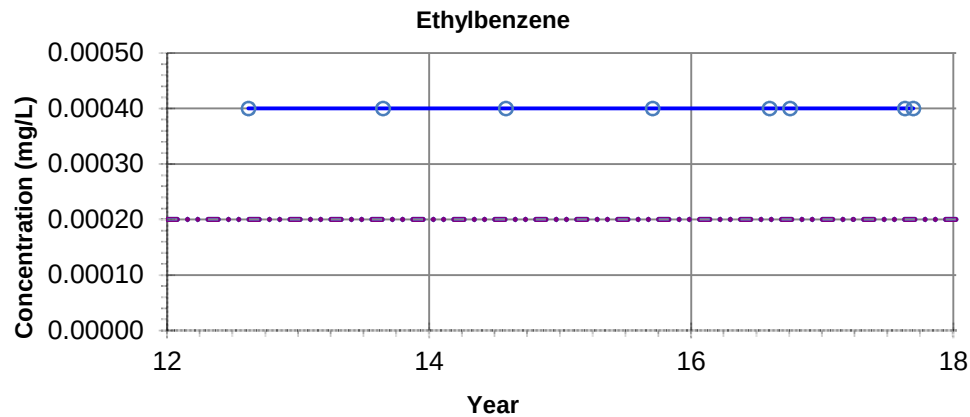
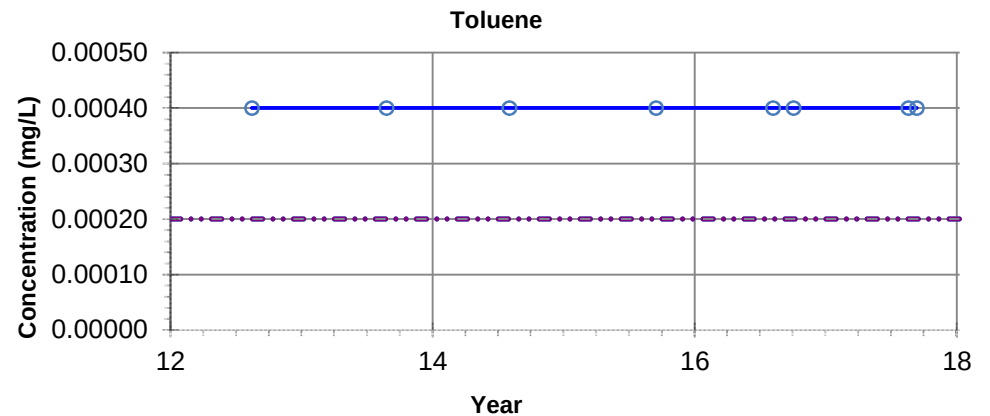
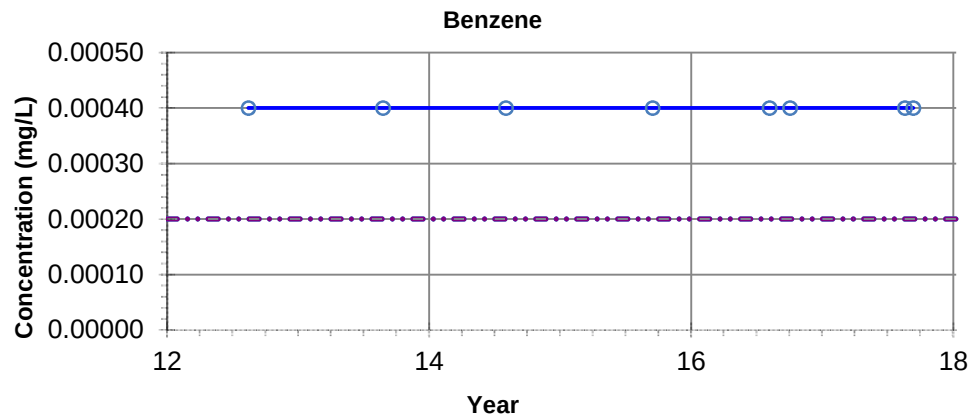


NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program					
Concentrations Monitoring Well: GIP11 09-1-4			PROJECT NUMBER: 407074-00828.400		
12-Dec-2017	date	NA	edited by	JC	drawn by
				NA	app by
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			Figure E-16		



NOTES: - Filled symbols denote Sample Values
 - Unfilled symbols denote Values < Detection Limit(s)

--- Upper Control Limit
 --- Lower Control Limit

--- **GUIDELINE:**
CCME CEQG Freshwater
Aquatic Life

Benzene - 0.37 mg/L
Toluene - 0.002 mg/L
Ethylbenzene - 0.09 mg/L
Chloride - 120 mg/L

Infrastructure & Environment					
SNP Wells - Norman Wells, NT 2017 Groundwater Quality Monitoring Program					
Concentrations Monitoring Well: GIQ8-10-2-4					
12-Dec-2017	date	NA	edited by	JC	drawn by
		NA	app by		
PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH WORLEYPARSONS HAS NOT ENTERED INTO A CONTRACT.			PROJECT NUMBER: 407074-00828.400		Figure E-17



Advisian
WorleyParsons Group

Imperial
2017 Surveillance Network Program
Norman Wells, NT



Appendix F Background Geochemistry



DETERMINATION OF GROUNDWATER GEOCHEMICAL BACKGROUND

In order to effectively evaluate the origin of groundwater parameters which may exceed regulatory guidelines (in this case, freshwater aquatic life criteria [FWAL; CCME 2015]), it is important to defensibly determine naturally occurring background concentrations for the parameters of interest.

Background monitoring wells would ideally be installed in an undisturbed, up-gradient area, isolated from any potential sources of anthropogenic impact. However, these locations tend to be heavily influenced by permafrost in the vicinity of Norman Wells. Previous attempts to install background wells in up-gradient areas of the lease, removed from the Imperial facilities and in areas of natural vegetation, have resulted in rapidly frozen groundwater monitoring wells that consistently remain frozen. As such, the use of the term “background” in this report does not necessarily mean the groundwater monitoring well is installed in an undisturbed, up-gradient area. Rather, the term is used for locations inferred to be removed from site facilities and free of facility-related impacts.

In an effort to improve characterization of background soil and groundwater conditions, the 2010 (WorleyParsons 2011) and 2012 Phase 2 ESA (WorleyParsons 2013) programs focused on installation of new potential background wells in surficial sediments. This included six new wells on the Natural Islands and five wells distributed throughout Mainland East, Central, and West areas over the past three years.

These new wells, supplemented by annual groundwater sampling from 1997 to 2012, provided a sufficient database to determine statistical background values for key geochemical parameters from a range of hydrogeological units of interest. As summarized in Table F-2, 24 wells within the monitoring network have been identified as background locations. These wells are separated into four groups, based on the hydrogeological zone where the well screen is completed, as follows:

- surficial sediments on Mainland (10 wells, nine producing water, total of 28 samples);
- surficial sediments on Natural Islands (seven wells, all producing water, total of 20 samples);
- shallow bedrock on Mainland (three wells, all producing water, total of 21 samples); and
- deeper bedrock on Mainland (four wells).

Data from the first three hydrogeological units is of primary interest for analysis of the environmental monitoring results collected to date. As such the statistical background analyses concentrated on these categories. The deep bedrock category is not characterized to the same extent, and considering that groundwater quality in the deeper bedrock is less important for comparison to the environmental monitoring program, deeper bedrock data will not be considered further in this discussion.

A geometric mean, minimum, maximum, and 95th percentile value for each parameter listed below was determined for each of the three hydrogeological units of interest.

Indicator Parameters

pH	DOC	Hardness	Sulphate	Nitrite as N	Phenols
Chloride	Fluoride	Iron	TDS	Nitrate as N	

Dissolved Metals and Trace Elements

Aluminum	Beryllium	Copper	Nickel	Titanium
Antimony	Boron	Lead	Selenium	Uranium
Arsenic	Cadmium	Mercury	Silver	Zinc
Barium	Chromium	Molybdenum	Thallium	

One of the key aspects of the statistical calculations is the method of dealing with results reported below the laboratory method detection limit (MDL), which is a frequent occurrence with some of the dissolved trace metals in particular. In order to calculate the 95th percentile value, a real number is required rather than a "less than" result. The approach used was as follows:

- in cases where the MDL is the normal precision reported for that particular parameter, then a real number value of $\frac{1}{2}$ the MDL is used in the calculation (U.S. EPA 2009). For example, if the dissolved copper result was reported as <0.001 mg/L, then a real number value of 0.0005 mg/L is assumed for the statistical calculations; and
- in cases where matrix interferences increase the MDL, this method cannot be used and the data point is typically discarded for the purpose of the 95th percentile calculation. Note that although this method is acceptable for 95th percentile calculations, it is much more problematic in the calculation of geometric means.

Key Findings

Results of the statistical analyses are provided in Table F-1. The following results are of particular note in the interpretation of data in the attached report:

- a) The FWAL water quality guidelines (CCME 2015) for a number of trace metals vary depending on the pH and total hardness of the water (see footnotes of dissolved metals table). For the purpose of selecting appropriate guidelines for comparison to Norman Wells water samples, the pH value is considered greater than 6.5, and the total hardness as CaCO₃ is greater than 180 mg/L (very hard water). The 95th percentile value for groundwater samples from background locations was as follows:
 - i) surficial sediments on mainland, pH of 7.1 and hardness of 1,345 mg/L;
 - ii) surficial sediments on islands, pH of 7.2 and hardness of 1,681 mg/L; and
 - iii) shallow bedrock, pH of 7.8 and hardness of 254 mg/L.
- b) The attached analysis of background geochemistry in local groundwater has intentionally avoided using chloride values derived from a background well which is located within a historically documented natural seepage zone on the Mackenzie River shore, directly south of the Former Refinery. Well NWR 03-38-3 represents a natural crude oil and saline formation water seepage zone, where shallow bedrock subcrops within a few metres of ground surface under sediments along the shoreline. Chloride readings from this well, on the order of 250 mg/L, have been discounted in the determination of the 95th percentile chloride value for surficial sediments on the Mainland.

- c) The 95th percentile analyses indicate that the following parameters may naturally exceed the applied FWAL criteria (CCME 2015) in groundwater at this site:
- i) groundwater from surficial sediments on Mainland sites - iron, phenols, arsenic, cadmium, copper, selenium, uranium, and zinc. Chloride and petroleum hydrocarbons can also occur above the applied guideline in natural seepage zones;
 - ii) groundwater from surficial sediments on Natural Islands sites - iron, phenols, cadmium, copper, selenium, uranium, and zinc; and
 - iii) groundwater from shallow bedrock – chloride, iron, phenols, aluminum, arsenic, copper, and selenium. As noted previously, petroleum hydrocarbons would also be expected within areas of natural seepage in the upper bedrock.

References

CCME (Canadian Council of Ministers of the Environment), 2015. Canadian Environmental Quality Guidelines – Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

U.S. EPA (United States Environmental Protection Agency), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009. EPA 530/R-09-007. United States Environmental Protection Agency, Office of Resource Conservation and Recovery. March 2009.

WorleyParsons (WorleyParsons Canada Services Ltd.), 2011. 2010 Phase II Environmental Site Assessment, Norman Wells, NT. Mainland Area, Bear, Frenchy's and Goose Islands. Report prepared for Imperial Oil Resources. File No. C53761050-54. 20 April 2011.

WorleyParsons (WorleyParsons Canada Services Ltd.), 2013. 2012 Phase II Environmental Site Assessment, Mainland Sumps – Norman Wells, NT. Report prepared for Imperial Oil Resources. File No. 307074-01333.100. 4 November 2013.



Table F-1

Groundwater Background Wells Geochemical Statistical Summary

Background Geochemical Statistics for Groundwater: Indicators and Phenols

	Field pH (ph units)	Chloride (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Fluoride (mg/L)	Hardness (as CaCO ₃) (mg/L)	Iron (mg/L)	Sulphate (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Phenols (mg/L)
CCME Freshwater Aquatic Life, 2015	(6.5 - 9)	120	---	---	---	0.3	---	---	0.06	3	0.004
Federal Interim Groundwater Quality Guidelines, Res/Parkland, 2010 ¹	(6.5 - 9)	230	---	0.12	---	0.3	100	---	0.06	3	0.004
95th Percentile Background - Surficial Sediments - Mainland	7.1	15	44	0.4	1345	1.7	720	1945	0.031	0.17	0.021
95th Percentile Background - Surficial Sediments - Islands	7.2	13	no data	no data	1681	3.2	1125	2490	0.025	0.42	0.006
95th Percentile Background - Shallow Bedrock	7.8	332	33	0.3	254	0.8	65	1936	<0.005	<0.02	0.022

Background Geochemical Statistics for Groundwater: Dissolved Metals and Trace Elements

	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)
CCME Freshwater Aquatic Life, 2015	0.1	---	0.005	---	---	1.5	0.00009	0.0089	0.004	0.007
Federal Interim Groundwater Quality Guidelines, Res/Parkland, 2010 ¹	0.1	1.6	0.005	2.3	0.0053	---	0.00031	0.0089	0.004	0.007
95th Percentile Background - Surficial Sediments - Mainland	0.048	0.0160	0.0090	0.79	< 0.001	0.708	0.00046	0.0040	0.014	0.0029
95th Percentile Background - Surficial Sediments - Islands	0.011	0.0005	0.0020	0.22	< 0.001	0.040	0.00042	<0.001	0.012	<0.0002
95th Percentile Background - Shallow Bedrock	0.176	0.006	0.054	6.15	< 0.001	1.36	<0.0001	<0.002	0.016	0.0023

	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Zinc (mg/L)
CCME Freshwater Aquatic Life, 2015	0.000026	0.073	0.15	0.001	0.00025	0.0008	---	0.015	0.03
Federal Interim Groundwater Quality Guidelines, Res/Parkland, 2010 ¹	0.000026	0.073	0.15	0.001	0.0001	0.0008	0.1	0.3	0.03
95th Percentile Background - Surficial Sediments - Mainland	< 0.00005	0.0030	0.028	0.0020	< 0.0001	< 0.0002	< 0.001	0.025	0.036
95th Percentile Background - Surficial Sediments - Islands	< 0.00005	0.0025	0.025	0.0009	< 0.0001	< 0.0002	< 0.001	0.024	0.030
95th Percentile Background - Shallow Bedrock	< 0.00005	<0.005	<0.008	0.0032	<0.0001	<0.0001	< 0.003	0.0019	0.018

Superscript 1 - Guidelines shown for Federal Interim Groundwater Quality Guidelines for Residential/Parkland Land Use are Tier 2, with the Marine Life pathway eliminated.

Table F-2**Background Wells and Hydrogeologic Unit**

PROJECT NO. 407074-00828-400		Lithology Within Screened Interval			Comments
Monitoring Station	Depth Interval of Sandpack (m bgs)	Dominant Hydrogeologic Unit for Well screen			
Background Locators With Groundwater from Surficial Sediment					
Mainland Locations					
NWR 03-38-3	0.50 - 3.00	Surficial sediment	Sand and clay	Former refinery area, known seepage zone, shale fill present	
B38 93-2-4	less than 4 m	Surficial sediment	no borehole log	Mainland east area, shale fill present	
MEBG-10-1-3	1.00 - 3.00	Surficial sediment	Silty Sand / Clayey Silt	Mainland east area, shale wellpad 3 m away	
MLS 09-6-2	0.80 - 2.20	Surficial sediment	Silty clay and bedrock	Mainland sumps area, shale roadbed 3 m away	
BT3 97-2-5	1.10 - 4.60	Surficial sediment	Silt	Mainland central area, shale roadbed 3 m away	
MCBG-10-1-3	0.80 - 2.50	Surficial sediment	Clayey Silt / Peat / Silty Clay	Mainland central area, shale helipad 10 m away	
MCBG-12-1-2	0.50 - 3.00	Surficial sediment		Mainland central area, shale roadbed 3 m away	
MWBG-10-1-3	0.80 - 2.70	Surficial sediment	Silt / Clay	Mainland west area, shale roadbed 3 m away	
MWBG-12-1-3	1.20 - 3.00	Surficial sediment		Mainland west area, shale roadbed 3 m away	
WBIO-08-1-2	0.60 - 2.40	Surficial sediment	Sandy clay / Silty sand	Mainland west area, shale roadbed 20 m away	
Island Locations					
BI 08-1-4	0.60 - 2.40	Surficial sediment	Silty clay	Bear Island	
BIBG-10-1-4	0.78 - 4.10	Surficial sediment	Silty Clay / Sand	Bear Island, shale fill present	
BIBG-10-2-4	0.50 - 3.77	Surficial sediment	Sand	Bear Island	
BIBG-12-2-4	0.70 - 4.20	Surficial sediment		Bear Island	
FIBG-10-1-4	0.69 - 3.97	Surficial sediment	Silty Clay / Sand	Frenchies Island	
GIBG-10-1-5	1.20 - 4.50	Surficial sediment	Sandy Silt	Goose Island	
GIBG-10-2-3	1.30 - 3.00	Surficial sediment	Sand	Goose Island	
Background Locators With Groundwater from Shallow Bedrock					
NWR 98-18-15	11.00 - 14.70	Shallow bedrock	Siltstone	Upgradient of former refinery area	
NWR 99-16-17	12.60 - 17.00	Shallow bedrock	Siltstone	Upgradient of former refinery area	
RB 02-3-2	0.60 - 3.30	Shallow bedrock	Siltstone / Shale	Former refinery area, known seepage zone, screen intercepts shale	
Background Locators Not Used in Statistics (all deeper bedrock)					
B38 00-32-44	37.30 - 43.40	Deep bedrock	Sandstone and shale	delete from list - too deep for our study	
BT3 00-28-44	39.50 - 43.30	Deep bedrock	Shale	delete from list - too deep for our study	
NWR 00-25-36	30.90 - 36.30	Deep bedrock	Siltstone and shale	delete from list - too deep for our study	
NWR 00-26-40	33.30 - 39.60	Deep bedrock	Siltstone	delete from list - too deep for our study	



Table F-3

Background Wells Groundwater Statistics: Indicators and Phenols

PROJECT NO.: 407074-00828-400		Indicators								Nitrogen Parameters		Phenols
Monitoring Station	Date (d-m-y)	pH - Field (ph units)	Chloride (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Fluoride (mg/L)	Hardness (as CaCO3) (mg/L)	Iron (mg/L)	Sulphate (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Phenols (mg/L)
CCME Freshwater Aquatic Life, 2015		(6.5 - 9)	120	---	---	---	0.3	---	---	0.06	3	0.004
Federal Interim Groundwater Quality Guidelines, Res/Parkland, 2010 ¹		(6.5 - 9)	230	---	0.12	---	0.3	100	---	0.06	3	0.004
95th Percentile Background - Surficial Sediments - Mainland Locations		7.1	15	44	0.4	1345	1.7	720	1945	0.031	0.17	0.021
95th Percentile Background - Surficial Sediments - Island Locations		7.2	13	no data	no data	1681	3.2	1125	2490	0.025	0.42	0.006
95th Percentile Background - Shallow Bedrock Locations		7.8	332	33	0.3	254	0.8	65	1936	<0.005	<0.02	0.022
Background - Surficial Sediments - Mainland Locations												
B38 93-2-4	07-Sep-1997	6.41	15.5	14	---	668	0.053	16.5	828	0.022	0.11	---
B38 93-2-4	09-Sep-1998	6.64	14.7	12.9	---	649	0.017	17	726	0.0025	0.16	0.003
B38 93-2-4	15-Sep-1999	6.75	11	12.8	---	710	0.588	12.3	780	0.014	0.04	---
B38 93-2-4	18-Oct-1999	---	---	---	---	---	---	---	---	---	---	0.003
B38 93-2-4	17-Sep-2000	6.77	7.7	9.4	---	716	0.009	19	796	0.008	0.1	0.006
B38 93-2-4 (duplicate)	17-Sep-2000	---	8	11.7	---	669	0.02	19.1	796	0.012	0.08	0.005
B38 93-2-4	26-Aug-2001	6.53	6.8	13.4	---	788	0.006	22.5	834	0.0025	0.08	0.003
B38 93-2-4	20-Aug-2002	6.71	9.9	---	---	821	0.055	18.6	872	0.0025	0.06	---
B38 93-2-4	25-Aug-2003	6.68	7	---	0.1	752	0.044	23	786	0.03	0.1	---
BT3 97-2-5	07-Sep-1997	6.55	2.5	38.1	---	1250	0.657	470	1580	0.006	0.01	---
BT3 97-2-5	10-Sep-1998	6.92	3.3	41.3	---	792	0.29	237	986	0.0025	0.01	0.02
BT3 97-2-5	16-Sep-1999	6.83	2.8	46.9	---	1230	---	465	1640	0.0025	0.05	0.008
BT3 97-2-5	18-Sep-1999	---	2.8	35.3	---	---	---	501	1600	0.0025	0.04	---
BT3 97-2-5	19-Sep-2000	---	---	---	---	---	---	---	---	---	---	0.021
BT3 97-2-5	20-Aug-2002	6.72	3	---	---	1100	0.865	286	1340	---	0.3	0.008
BT3 97-2-5	24-Aug-2003	---	2	---	0.4	945	0.135	254	1070	0.03	0.1	---
NWR 03-38-3	26-Aug-2003	7.07	see note 4	---	0.2	301	---	14	1500	0.03	0.1	---
NWR 03-38-3	23-Aug-2004	7.1	see note 4	---	0.2	368	0.099	31	1200	0.03	0.1	---
NWR 03-38-3	25-Aug-2005	6.77	see note 4	---	---	540	1.17	93.5	---	0.03	0.1	0.023
NWR 03-38-3	20-Aug-2006	6.86	see note 4	---	0.1	490	2.15	49	1330	0.03	0.1	0.012
MCBG-10-1-3	29-Sep-2010	6.45	2	---	---	738	0.03	58	810	0.011	0.07	0.001
MCBG-10-1-3	19-Aug-2011	6.71	3	---	---	650	0.03	100	830	0.025	0.18	0.001
MCBG-10-1-3	16-Aug-2012	6.69	3.5	---	---	640	0.03	86	840	0.0015	0.016	0.001
MEBG-10-1-3	29-Sep-2010	6.51	5	---	---	609	0.1	99	650	0.0015	0.021	0.001
MEBG-10-1-3	18-Aug-2011	6.96	4	---	---	510	0.12	93	720	0.0015	0.0015	0.003
MEBG-10-1-3	19-Aug-2012	6.79	3.8	---	---	560	0.16	85	720	0.0015	0.026	0.001
MWBG-10-1-3	30-Sep-2010	6.94	15	---	---	580	0.46	130	760	0.0015	0.015	0.001
MWBG-10-1-3	18-Aug-2011	6.79	16	---	---	500	1.5	150	860	0.0015	0.0015	0.001
MWBG-10-1-3	17-Aug-2012	6.26	8.3	---	---	680	0.03	260	1400	0.0015	0.0015	0.001
MWBG-12-1-3	17-Aug-2012	6.75	14	---	---	430	0.03	160	580	0.0015	0.0015	---
MCBG-12-1-2	20-Aug-2012	6.49	2.9	---	---	1400	1.9	750	1900	0.052	0.0015	0.0052
WBIO-08-1-2	20-Aug-2009	6.91	7	---	---	1600	0.08	820	2200	0.033	---	0.002
WBIO-08-1-2	18-Aug-2011	---	6	---	---	1300	0.1	700	2000	0.005	---	0.001
MLS-09-6-2	19-Aug-2009	7.11	5	---	---	590	0.03	210	730	0.003	0.046	0.003
MLS-09-6-2	19-Aug-2011	---	9	---	---	380	0.03	98	460	0.0015	0.091	---
geometric mean		done	done	done	done	done	done	done	done	done	done	done
95th percentile		6.74	6	19.7	0.2	693	0.10	94	988	0.006	0.03	0.0031
maximum value		7.09	15	44.4	0.4	1345	1.72	720	1945	0.031	0.17	0.021
previous inferred background		7.11	16	46.9	0.4	1600	2.15	820	2200	0.052	0.3	0.023
			15				0.5					0.006



Table F-3

Background Wells Groundwater Statistics: Indicators and Phenols

PROJECT NO.: 407074-00828-400		Indicators								Nitrogen Parameters		Phenols
Monitoring Station	Date (d-m-y)	pH - Field (ph units)	Chloride (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Fluoride (mg/L)	Hardness (as CaCO3) (mg/L)	Iron (mg/L)	Sulphate (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Phenols (mg/L)
Background - Surficial Sediments - Islands Locations												
BI 08-1-4	21-Aug-2008	6.55	9.7	---	---	1500	0.2	760	2200	0.009	0.025	0.005
BI 08-1-4	18-Aug-2009	6.55	9	---	---	1800	3.6	1000	2400	0.01	0.093	0.003
BI 08-1-4 (duplicate)	18-Aug-2009	---	---	---	---	---	3	---	---	---	---	0.007
BI 08-1-4	23-Aug-2010	6.76	9	---	---	1630	0.22	820	1900	0.015	0.19	0.001
BI 08-1-4 (duplicate)	23-Aug-2010	---	---	---	---	---	0.33	---	---	---	---	0.006
BI 08-1-4	21-Aug-2011	6.71	9	---	---	---	---	800	---	0.018	0.096	0.001
BI 08-1-4 (duplicate)	21-Aug-2011	---	---	---	---	---	---	---	---	---	---	0.001
BI 08-1-4	15-Aug-2012	6.90	11	---	---	1300	0.15	900	1900	0.0015	0.28	0.001
BIBG-10-1-4	29-Sep-2010	6.94	9	---	---	1420	0.32	650	1900	0.006	0.026	0.005
BIBG-10-1-4	21-Aug-2011	6.64	5	---	---	1200	0.07	620	1700	0.013	0.11	0.003
BIBG-10-1-4	15-Aug-2012	6.65	4.6	---	---	1300	0.03	610	1700	0.047	---	0.0049
BIBG-10-2-4	29-Sep-2010	7.19	7	---	---	906	3.1	300	1100	0.013	0.73	0.001
FIBG-10-1-4	29-Sep-2010	7.19	9	---	---	621	0.03	310	720	0.004	0.015	0.003
FIBG-10-1-4 (duplicate)	29-Sep-2010	---	---	---	---	---	0.03	---	---	---	---	0.002
GIBG-10-1-5	21-Aug-2011	---	4	---	---	1600	0.15	1200	2700	0.011	0.022	---
GIBG-10-1-5	15-Aug-2012	6.36	3.3	---	---	1500	3.0	1100	2300	0.0015	0.0015	---
GIBG-10-2-3	28-Sep-2010	6.48	9	---	---	577	2.5	77	630	0.0015	0.007	0.001
GIBG-10-2-3 (duplicate)	28-Sep-2010	---	---	---	---	---	2.5	---	---	---	---	0.001
GIBG-10-2-3	21-Aug-2011	6.51	5	---	---	390	0.91	40	510	0.0015	0.009	0.001
GIBG-10-2-3	15-Aug-2012	7.15	2.8	---	---	370	1.0	110	480	0.0058	0.013	0.001
BIBG-12-2-4	15-Aug-2012	6.70	18	---	---	590	0.03	110	790	0.0015	0.11	0.001
geometric mean		done	done	done	done	done	done	done	done	done	done	done
95th percentile		6.75	7	no data	no data	988	0.4	404	1318	0.006	0.04	0.0019
maximum value		7.19	13	no data	no data	1681	3.2	1125	2490	0.025	0.42	0.0061
previous inferred background		7.19	18	0	0	1800	3.6	1200	2700	0.047	0.73	0.0070
			15				0.5					0.006
Background - Shallow Bedrock												
RB 02-3-2	22-Aug-2002	7.99	212	---	---	55.1	0.093	2.2	1560	< 0.005	< 0.02	0.007
RB 02-3-2 (Duplicate)	22-Aug-2002	---	220	---	---	52.4	0.019	2.5	1580	< 0.005	< 0.02	0.004
RB 02-3-2	26-Aug-2003	7.66	163	---	0.3	47.9	0.032	13	1580	< 0.06	< 0.2	---
RB 02-3-2	23-Aug-2004	7.64	147	---	0.3	60.9	0.044	44	1590	< 0.06	< 0.2	---
RB 02-3-2 (Duplicate)	23-Aug-2004	---	---	---	---	60.1	0.026	---	---	---	---	---
RB 02-3-2	25-Aug-2005	7.45	164	---	---	71	0.508	8	---	< 0.06	< 0.2	0.019
RB 02-3-2 (Duplicate)	25-Aug-2005	---	---	---	---	---	0.813	---	---	---	---	0.021
RB 02-3-2	20-Aug-2006	7.11	158	---	0.2	86	0.112	185	1830	< 0.06	< 0.2	0.01
RB 02-3-2 (Duplicate)	20-Aug-2006	---	---	---	---	---	0.133	---	---	---	---	0.011
NWR 99-16-17	17-Sep-2000	7.66	260	26.4	---	47.5	0.047	24.7	1960	0.006	0.04	0.025
NWR 99-16-17	27-Aug-2001	---	257	23	---	50.3	0.147	18	1730	0.007	< 0.02	0.004
NWR 99-16-17	21-Aug-2002	---	240	---	---	62.8	---	10.6	1930	< 0.005	< 0.02	0.01
NWR 99-16-17	26-Aug-2003	7.49	318	---	0.3	48.8	0.115	7	1440	< 0.06	< 0.2	---
NWR 98-18-15	09-Sep-1998	7.31	330	32.2	---	327	0.101	7.1	1740	< 0.005	< 0.02	0.016
NWR 98-18-15	15-Sep-1999	7.38	230	32.8	---	168	0.197	3.7	1740	< 0.005	< 0.02	0.014
NWR 98-18-15	17-Sep-2000	7.23	290	20.4	---	163	0.0025	11.2	1700	< 0.005	0.06	0.016
NWR 98-18-15 (Duplicate)	17-Sep-2000	---	280	25.8	---	150	0.0025	7.6	1650	< 0.005	< 0.02	0.016
NWR 98-18-15	27-Aug-2001	---	230	17.6	---	167	0.322	5.2	1720	< 0.005	< 0.02	0.0005
NWR 98-18-15	22-Aug-2002	7.27	216	---	---	172	0.717	12.4	1850	< 0.005	< 0.02	0.003
NWR 98-18-15 (Duplicate)	22-Aug-2002	---	206	---	---	149	1.42	8.7	1810	< 0.005	< 0.02	0.007
NWR 98-18-15	26-Aug-2003	7.09	346	---	0.2	246	0.344	4	1820	< 0.06	< 0.2	0.007
geometric mean		7.44	230	25	0.3	94	0.10	10	1714	< 0.005	< 0.02	0.0084
95th percentile		7.81	332	33	0.3	254	0.84	65	1936	< 0.005	< 0.02	0.022
maximum value		7.99	346	33	0.3	327	1.42	185	1960	0	0	0.025
previous inferred background			250				2					0.025



Table F-3

Background Wells Groundwater Statistics: Indicators and Phenols

PROJECT NO.: 407074-00828-400		Indicators								Nitrogen Parameters		Phenols
Monitoring Station	Date (d-m-y)	pH - Field (ph units)	Chloride (mg/L)	Dissolved Organic Carbon (DOC) (mg/L)	Fluoride (mg/L)	Hardness (as CaCO3) (mg/L)	Iron (mg/L)	Sulphate (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Nitrite as N (mg/L)	Nitrate as N (mg/L)	Phenols (mg/L)

- Statistical Analysis Notes:**

 - 1. For non-detect data where the method detection limit (MDL) was raised due to matrix interference, the data point was not used to calculate statistics.
 - 2. For non-detect data where the MDL was at the normal precision (no matrix interference), a value equal to half the MDL was used to calculate statistics.
 - 3. Data point removed for statistical calculations as an extreme outlier.
 - 4. Note that background chloride can be on the order of 250 mg/L in the vicinity of natural seepage zones (i.e., well NWR 03-38-3). This well has not been included in site-wide stats for chloride.
- Other Notes**

 - 5. --- in guideline row(s) denotes no criteria for that parameter.
 - 6. --- in detail data row(s) denotes parameter not analyzed.
 - 7. Highlighting indicates detection limit exceeds applicable guideline value.
 - 8. Highlighting indicates result at guideline value.
 - 9. Yellow highlighting denotes values exceeding CCME (2015) Canadian Environmental Quality Guidelines Summary Table - Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

Nitrate as N:
Standard is for NO3 as N, equivalent standard for NO3 is 13 mg/L.

Nitrite as N:
Standard is for NO2 as N, equivalent standard for NO2 is 0.197 mg/L.

- 10. Superscript 1 - Guidelines shown for Federal Interim Groundwater Quality Guidelines for Residential/Parkland Land Use are Tier 2, with the Marine Life pathway eliminated.



Table F-4

Background Wells Groundwater Statistics: Dissolved Metals and Trace Elements

PROJECT NO.: 407074-00828-400		DISSOLVED METALS AND TRACE ELEMENTS																		
Monitoring Station	Date (d-m-y)	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium ² (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Zinc (mg/L)
CCME Freshwater Aquatic Life, 2015		0.1	---	0.005	---	---	1.5	0.00009	0.0089	0.004	0.007	0.000026	0.073	0.15	0.001	0.00025	0.0008	---	0.015	0.03
Federal Interim Groundwater Quality Guidelines, Res/Parkland, 2010 ¹		0.1	1.6	0.005	2.3	0.0053	---	0.00031	0.0089	0.004	0.007	0.000026	0.073	0.15	0.001	0.0001	0.0008	0.1	0.3	0.03
95th Percentile Background - Surficial Sediments - Mainland Locations		0.048	0.0160	0.0090	0.79	< 0.001	0.708	0.00046	0.0040	0.014	0.0029	< 0.00005	0.0030	0.028	0.0020	< 0.0001	< 0.0002	< 0.001	0.025	0.036
95th Percentile Background - Surficial Sediments - Island Locations		0.011	0.0005	0.0020	0.22	< 0.001	0.040	0.00042	<0.001	0.012	<0.0002	< 0.00005	0.0025	0.025	0.0009	< 0.0001	< 0.0002	< 0.001	0.024	0.030
95th Percentile Background - Shallow Bedrock Locations		0.176	0.006	0.054	6.15	< 0.001	1.36	<0.0001	<0.002	0.016	0.0023	< 0.00005	<0.005	<0.008	0.0032	<0.0001	<0.0001	< 0.003	0.0019	0.018
Background - Surficial Sediments - Mainland Locations																				
B38 93-2-4	07-Sep-1997	0.08	0.03	0.00025	0.88	< 0.0010	0.076		0.004	0.003	0.001	< 0.00005	0.002	0.014	0.00025			< 0.003	---	0.012
B38 93-2-4	09-Sep-1998	0.01	0.016	0.07	0.593	< 0.0010	0.055		0.001	0.0005		---	0.002	0.009				< 0.003	---	0.001
B38 93-2-4	15-Sep-1999	0.02	0.0005	0.002	0.656	< 0.0010	0.062	0.0002	0.004	0.0005	0.002	< 0.00005	0.002	0.013	0.002	< 0.0001		< 0.003	---	0.003
B38 93-2-4	17-Sep-2000	0.01	0.0005	0.001	0.503	< 0.0002	0.051	0.0002	0.0025		0.0005	< 0.00005	0.0025	0.004	0.0005	< 0.0001		< 0.003	---	0.008
B38 93-2-4 (duplicate)	17-Sep-2000	0.01	0.0005	0.001	0.478	< 0.0002	0.047	0.0001	0.0025		0.002	< 0.00005	0.0025	0.004	0.002	< 0.0001		< 0.003	---	0.006
B38 93-2-4	26-Aug-2001	0.01	< 0.05		0.555	< 0.0002	0.059		0.0025			---	0.0025	0.004				< 0.003	---	0.008
B38 93-2-4	20-Aug-2002	0.018	0.0005	0.0005	0.505	< 0.0002	0.048	0.00021	0.0005	0.0047	0.00025	< 0.00005	0.0025	0.004	0.0005	< 0.0001	< 0.0001	< 0.003	0.00692	0.042
B38 93-2-4	25-Aug-2003		0.0005	0.0025	0.521	---	0.025		0.0035			< 0.00005	---	---	0.0005	---	---	---		0.011
BT3 97-2-5	07-Sep-1997	0.04	0.016	0.0019	0.093	< 0.0010	0.095		0.001	0.004	0.0005	0.00007	0.002	0.017	0.0012			< 0.003	---	0.001
BT3 97-2-5	10-Sep-1998	0.05	0.016		0.29	< 0.0010	0.092		0.001	0.0005		---	0.002	0.01				< 0.003	---	0.001
BT3 97-2-5	16-Sep-1999	0.01	0.0005	0.006	0.115	< 0.0010	0.129	0.0001	0.002	0.0005	0.0005	< 0.00005	0.002	0.019	0.002	< 0.0001		< 0.003	---	0.003
BT3 97-2-5	20-Aug-2002	0.008	0.0005	0.003	0.269	< 0.0002	0.134	0.00046	0.0005	0.0056	0.0011	0.00094	0.0025	0.031	0.001	< 0.0001	< 0.0001	< 0.003	0.0152	0.042
BT3 97-2-5	24-Aug-2003		0.0005	0.0025	0.121	---	0.164		0.0035			< 0.00005	---	---	0.0005	---	---	---		0.0025
MCBG-10-1-3	29-Sep-2010	0.003	0.0004	0.001	0.27	< 0.001	0.34	0.00012	0.0005	0.0031	0.0001	---	0.0014	0.0095	0.0003	< 0.0001	< 0.0002	< 0.001	0.015	0.008
MCBG-10-1-3	19-Aug-2011	0.005	0.0005	0.001	0.21	< 0.01	0.21	0.00023		0.006	0.001	---	0.001	0.011				< 0.01	0.016	0.015
MCBG-10-1-3	16-Aug-2012	0.004	0.0005	0.00047	0.17	< 0.0010	0.13	0.00019	0.0005	0.0037	0.0001	---	0.0024	0.0069	0.00023	< 0.0001	< 0.0002	< 0.0010	0.018	0.0076
MEBG-10-1-3	29-Sep-2010	0.0005	0.0005	0.0008	0.4	< 0.001	0.05	0.000015	0.0005	0.0019	0.0001	---	0.0005	0.0063	0.0004	< 0.0001	< 0.0002	< 0.001	0.0047	0.005
MEBG-10-1-3	18-Aug-2011	0.005	0.0005	0.001	0.39	< 0.01	0.04	0.00009		0.001	0.001	---	0.001	0.006				< 0.01	0.005	0.015
MEBG-10-1-3	19-Aug-2012	0.0005	0.0005	0.00076	0.41	< 0.0010	0.045	0.00014	0.0005	0.0023	0.0001	---	0.00068	0.0071	0.00025	< 0.0001	< 0.0002	< 0.0010	0.0049	0.0068
MWBG-10-1-3	30-Sep-2010	0.0005	0.0008	0.0008	0.09	< 0.001	0.24	0.000015	0.005	0.0017	0.0001	---	0.0001	0.0089	0.0005	< 0.0001	< 0.0002	< 0.001	0.005	0.003
MWBG-10-1-3	18-Aug-2011	0.003	0.0005	0.0013	0.08	< 0.001	0.25	0.000038	0.0005	0.0012	0.0001	---	0.001	0.0048	0.0005	< 0.0001	< 0.0002	< 0.001	0.0057	0.012
MWBG-10-1-3	17-Aug-2012	0.0044	0.0005	0.00086	0.082	< 0.0010	0.25	0.00019	0.0005	0.0045	0.0001	---	0.0028	0.01	0.0012	< 0.0001	< 0.0002	< 0.0010	0.015	0.015
NWR 03-38-3	26-Aug-2003		0.003	0.01	2.011	---	0.943		0.0035			< 0.00005	---	---	0.0005	---	---	---		0.005
NWR 03-38-3	23-Aug-2004	0.005	0.0005		0.506	< 0.0002	0.786	0.000049	0.0025	0.011	0.003	< 0.00005	0.0025	0.011				< 0.003	0.003	0.0025
NWR 03-38-3	25-Aug-2005	0.0025	0.0005	0.0025	0.262	< 0.001	0.55	0.00019	0.0035	0.006	0.003	< 0.00005	0.003	0.017	0.001	< 0.0001	< 0.0008	< 0.006	0.003	0.016
NWR 03-38-3	20-Aug-2006	0.0025	0.0005	0.0025	0.568	< 0.001	0.59	0.000005	0.0035	0.014	0.001	< 0.00005	0.003	0.012	0.0005	< 0.0001	< 0.0008	< 0.006	0.004	0.009
MCBG-12-1-2	20-Aug-2012	0.01	0.0005	0.0061	0.075	< 0.0010	0.34	0.00047	0.0005	0.0077	0.0001	---	0.0024	0.033	0.00072	< 0.0001	< 0.0002	< 0.0010	0.022	0.026
WBIO-08-1-2	20-Aug-2009	0.004	0.0008	0.0009	0.15	< 0.001	0.08	0.00042	0.0005	0.016	0.0001	---	0.0013	0.018	0.0029	< 0.0001	< 0.0002	< 0.001	0.038	0.016
MLS-09-6-2	19-Aug-2009	0.0005	0.0003	0.0007	0.11	< 0.001	0.11	0.000069	0.0005	0.003	0.0001	---	0.0004	0.004	0.0002	< 0.0001	< 0.0002	< 0.001	0.002	0.008
geometric mean		0.0055	0.0009	0.0016	0.28	< 0.001	0.127	0.00010	0.0013	0.0028	0.0004	< 0.00005	0.0015	0.0094	0.0006	< 0.0001	< 0.0002	< 0.001	0.0078	0.0070
95th percentile		0.048	0.0160	0.0090	0.79	< 0.001	0.708	0.00046	0.0040	0.014	0.0029	< 0.00005	0.0030	0.028	0.0020	< 0.0001	< 0.0002	< 0.001	0.025	0.036
maximum value		0.08	0.03	0.07	2.01	0	0.943	0.00047	0.005	0.016	0.003	0.00094	0.003	0.033	0.0029	0	0	0	0.038	0.042
previous inferred background		0.1		0.06				0.00020		0.005	0.002	0.0009		0.02	0.002					0.01



Table F-4

Background Wells Groundwater Statistics: Dissolved Metals and Trace Elements

PROJECT NO.: 407074-00828-400		DISSOLVED METALS AND TRACE ELEMENTS																		
Monitoring Station	Date (d-m-y)	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium ² (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Zinc (mg/L)
Background - Surficial Sediments - Islands Locations																				
BI 08-1-4	21-Aug-2008	0.0005	0.0005	0.0005	0.08	< 0.001	0.01	0.00041	< 0.001	0.014	< 0.0002	---	0.0023	0.039	0.0005	< 0.0001	< 0.0002	< 0.001	0.02	0.03
BI 08-1-4	18-Aug-2009	0.006	0.0005	0.0009	0.03	< 0.001	0.02	0.00026	< 0.001	0.0093	< 0.0002	---	0.0014	0.02	0.0009	< 0.0001	< 0.0002	< 0.001	0.016	0.019
BI 08-1-4 (duplicate)	18-Aug-2009	0.005	0.0004	0.0009	0.03	< 0.001	0.01	0.00028	< 0.001	0.0086	< 0.0002	---	0.0013	0.021	0.0009	< 0.0001	< 0.0002	< 0.001	0.016	0.017
BI 08-1-4	23-Aug-2010	0.009	0.0005	0.0015	0.03	< 0.001	0.02	0.00024	< 0.001	0.012	< 0.0002	---	0.0008	0.023	0.0006	< 0.0001	< 0.0002	< 0.001	0.013	0.009
BI 08-1-4 (duplicate)	23-Aug-2010	0.01	0.0005	0.0015	0.03	< 0.001	0.01	0.00023	< 0.001	0.011	< 0.0002	---	0.0008	0.02	0.0006	< 0.0001	< 0.0002	< 0.001	0.013	0.01
BI 08-1-4	21-Aug-2011	0.01	0.0005	0.001	0.07	< 0.01	0.01	0.00016		0.002	< 0.002	---	0.002	0.014				< 0.01	0.004	0.015
BI 08-1-4 (duplicate)	21-Aug-2011	0.01	0.0005	0.001	0.06	< 0.01	0.01	0.00015		0.001	< 0.002	---	0.001	0.014				< 0.01	0.004	0.015
BI 08-1-4	15-Aug-2012	0.0065	0.0006	0.00067	0.038	< 0.0010	0.02	0.000098	< 0.001	0.0054	< 0.0002	---	0.0069	0.0081	0.00037	< 0.0001	< 0.0002	< 0.0010	0.023	0.0046
BIBG-10-1-4	29-Sep-2010	0.0005	0.0005	0.0007	0.06	< 0.001	0.03	0.00021	< 0.001	0.0044	< 0.0002	---	0.0013	0.024	0.0004	< 0.0001	< 0.0002	< 0.001	0.02	0.019
BIBG-10-1-4	21-Aug-2011	0.005	0.0005	0.0003	0.04	< 0.001	0.04	0.00051	< 0.001	0.0055	< 0.0002	---	0.0022	0.015	0.0004	< 0.0001	< 0.0002	0.001	0.012	0.03
BIBG-10-1-4	15-Aug-2012	0.0074	0.0005	0.00044	0.035	< 0.0010	0.035	0.00029	< 0.001	0.0044	< 0.0002	---	0.0023	0.0078	0.00028	< 0.0001	< 0.0002	< 0.0010	0.0054	0.012
BIBG-10-2-4	29-Sep-2010	0.002	0.0005	0.002	0.13	< 0.001	0.02	0.00005	< 0.001	0.0007	< 0.0002	---	0.0008	0.013	0.0003	< 0.0001	< 0.0002	< 0.001	0.0099	0.016
FIBG-10-1-4	29-Sep-2010	0.002	0.0005	0.0008	0.05	< 0.001	0.02	0.0001	< 0.001	0.001	< 0.0002	---	0.0004	0.0067	0.0001	< 0.0001	< 0.0002	< 0.001	0.0023	0.005
FIBG-10-1-4 (duplicate)	29-Sep-2010	0.002	0.0005	0.0006	0.05	< 0.001	0.02	0.00009	< 0.001	0.0007	< 0.0002	---	0.0005	0.0054	0.0001	< 0.0001	< 0.0002	< 0.001	0.0022	0.003
GIBG-10-2-3	28-Sep-2010	0.002	0.0005	0.0019	0.18	< 0.001	0.03	0.00016	< 0.001	0.0006	< 0.0002	---	0.0014	0.0098	0.0001	< 0.0001	< 0.0002	< 0.001	0.0023	0.011
GIBG-10-2-3 (duplicate)	28-Sep-2010	0.0005	0.0005	0.0018	0.18	< 0.001	0.03	0.00009	< 0.001	0.0003	< 0.0002	---	0.0015	0.008	0.0001	< 0.0001	< 0.0002	< 0.001	0.0023	0.009
GIBG-10-2-3	21-Aug-2011	0.007	0.0005	0.0021	0.23	< 0.001	0.03	0.00015	< 0.001	0.0017	< 0.0002	---	0.0008	0.017	0.0002	< 0.0001	< 0.0002	< 0.001	0.002	0.024
GIBG-10-2-3	15-Aug-2012	0.0059	0.0005	0.0014	0.19	< 0.0010	0.024	0.00012	< 0.001	0.0015	< 0.0002	---	0.0018	0.0083	0.0001	< 0.0001	< 0.0002	< 0.0010	0.0024	0.0077
GIBG-10-1-5	15-Aug-2012	0.01	0.0005	0.0017	0.22	< 0.0010	0.049	0.00016	< 0.001	0.0017	< 0.0002	---	0.0021	0.022	0.0001	< 0.0001	< 0.0002	< 0.0010	0.037	0.034
BIBG-12-2-4	15-Aug-2012	0.039	0.0005	0.00086	0.13	< 0.0010	0.026	0.00016	< 0.001	0.0056	< 0.0002	---	0.0014	0.014	0.00048	< 0.0001	< 0.0002	< 0.0010	0.0071	0.0062
geometric mean		0.0041	0.0005	0.0010	0.07	< 0.001	0.021	0.00017	<0.001	0.003	<0.0002	< 0.00005	0.0013	0.014	0.00027	< 0.0001	< 0.0002	< 0.001	0.007	0.012
95th percentile		0.011	0.0005	0.0020	0.22	< 0.001	0.040	0.00042	<0.001	0.012	<0.0002	< 0.00005	0.0025	0.025	0.0009	< 0.0001	< 0.0002	< 0.001	0.024	0.030
maximum value		0.039	0.0006	0.0021	0.23	0	0.049	0.00051	0	0.014	0	0	0.0069	0.039	0.0009	0	0	0.001	0.037	0.034
previous inferred background		0.1		0.06				0.00020		0.005	0.002	0.0009		0.02	0.002					0.01



Table F-4

Background Wells Groundwater Statistics: Dissolved Metals and Trace Elements

PROJECT NO.: 407074-00828-400		DISSOLVED METALS AND TRACE ELEMENTS																		
Monitoring Station	Date (d-m-y)	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium ² (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Zinc (mg/L)
Background - Shallow Bedrock																				
RB 02-3-2	22-Aug-2002	0.047	0.0005	0.004	0.893	< 0.0002	1.07	< 0.00010	< 0.001	0.0108	0.0005	< 0.00005	< 0.005	< 0.008	0.0005	< 0.0001	< 0.0001	< 0.003	0.00105	0.015
RB 02-3-2 (duplicate)	22-Aug-2002	0.009	0.0005	0.004	0.859	< 0.0002	1.05	< 0.00010	< 0.001	0.0097	0.0007	< 0.00005	< 0.005	< 0.008	0.001	< 0.0001	< 0.0001	< 0.003	0.00099	0.018
RB 02-3-2	26-Aug-2003	---	0.0005	0.0025	1.277	---	1.103		< 0.007			< 0.00005	---	---	0.001	---	---	---		0.0025
RB 02-3-2	23-Aug-2004	0.005	0.0005	0.053	1.34	0.0002	1.287	< 0.000034	< 0.005	0.015	0.001	< 0.00005	< 0.005	< 0.008				< 0.003	0.001	0.0025
RB 02-3-2 (duplicate)	23-Aug-2004	0.005	0.0005	0.066	1.307	0.0003	1.249	< 0.000034	< 0.005	0.013	0.001	< 0.00005	< 0.005	< 0.008				< 0.003	0.001	0.0025
RB 02-3-2	25-Aug-2005	0.0025	0.001	0.0486	1.12	< 0.001	1.17	0.00001	< 0.007	0.004	0.0005	< 0.00005	< 0.006	0.024	0.001	< 0.0001	< 0.0008	< 0.006	0.0005	0.007
RB 02-3-2 (duplicate)	25-Aug-2005	0.0025	0.0005	0.0496	1.19	< 0.001	1.11	0.00001	< 0.007	0.003	0.0005	< 0.00005	< 0.006	< 0.008	0.002	< 0.0001	< 0.0008	< 0.006	0.0005	0.015
RB 02-3-2	20-Aug-2006	0.0025	0.0005	0.015	0.388	< 0.001	1.32	< 0.00001	< 0.007	0.001	0.0005	< 0.00005	< 0.006	< 0.008	0.0005	< 0.0001	< 0.0008	< 0.006	0.0005	0.0025
RB 02-3-2 (duplicate)	20-Aug-2006	---	0.0005	0.018	0.383	< 0.001	1.31	< 0.00001	< 0.007	0.001	0.0005	< 0.00005	< 0.006	< 0.008	0.003	< 0.0001	---	< 0.006	0.0005	0.0025
NWR 99-16-17	17-Sep-2000	0.05	0.006	0.012	0.531	< 0.0002	1.17	0.0001	< 0.005	0.005	0.001	< 0.00005	0.008	0.01	0.004	< 0.0001		< 0.003	---	0.009
NWR 99-16-17	27-Aug-2001	0.1	< 0.05		0.811	< 0.0002	1.23		< 0.005			---	< 0.005	< 0.008				< 0.003	---	0.0025
NWR 99-16-17	21-Aug-2002	---	0.005	0.015	1.4	< 0.0002	1.34	< 0.00010	0.006	0.0185	0.0062	< 0.00005	< 0.005	0.018	0.002	< 0.0001	< 0.0001	0.028	0.00266	0.212
NWR 99-16-17	26-Aug-2003	---	0.005	0.018	1.66	---	1.339		< 0.007			< 0.00005	---	---	0.002	---	---	---		0.012
NWR 98-18-15	09-Sep-1998	0.12	0.0005	0.007	7.51	< 0.0010	1.28	< 0.0001	0.003	0.003	0.001	< 0.00005	< 0.004	0.008	0.0005	< 0.0001		< 0.003	---	0.001
NWR 98-18-15	15-Sep-1999	0.01	0.0005	0.004	4.31	< 0.0010	1.24	< 0.0001	< 0.002	0.0005	0.0005	< 0.00005	0.009	< 0.008	0.001	< 0.0001		< 0.003	---	0.001
NWR 98-18-15	17-Sep-2000	0.01	0.0005	0.003	4.34	< 0.0002	1.25	< 0.0001	< 0.005		0.0005	< 0.00005	< 0.005	< 0.008	0.003	< 0.0001		< 0.003	---	0.0025
NWR 98-18-15 (duplicate)	17-Sep-2000	0.01	0.0005	0.003	3.98	< 0.0002	1.26	< 0.0001	< 0.005		0.0005	< 0.00005	< 0.005	< 0.008	0.002	< 0.0001		< 0.003	---	0.0025
NWR 98-18-15	27-Aug-2001	0.14	< 0.05		4.24	< 0.0002	1.23		< 0.005			---	< 0.005	< 0.008				< 0.003	---	0.0025
NWR 98-18-15	22-Aug-2002	0.034	0.0005	0.001	4.52	< 0.0002	1.36	< 0.00010	< 0.001	0.0101	0.00025	0.00021	< 0.005	< 0.008	0.002	< 0.0001	< 0.0001	< 0.003	0.00005	0.008
NWR 98-18-15 (duplicate)	22-Aug-2002	0.284	0.0005	0.002	4.24	< 0.0002	1.37	< 0.00010	< 0.001	0.0115	0.0005	0.00058	< 0.005	< 0.008	0.0005	< 0.0001	0.0001	< 0.003	0.00005	0.006
NWR 98-18-15	26-Aug-2003	---	0.01	0.0025	6.147	< 0.001	1.335		< 0.007			< 0.00005	---	---	0.003	---	---	0.003		0.0025
geometric mean		0.018	0.0009	0.0084	1.73	< 0.001	1.24	<0.0001	<0.002	0.0048	0.00068	< 0.00005	<0.005	<0.008	0.0014	<0.0001	<0.0001	< 0.003	0.00049	0.0049
95th percentile		0.176	0.006	0.054	6.15	< 0.001	1.36	<0.0001	<0.002	0.016	0.0023	< 0.00005	<0.005	<0.008	0.0032	<0.0001	<0.0001	< 0.003	0.0019	0.018
maximum value		0.284	0.01	0.066	7.51	0.0003	1.37	0	0	0.0185	0.0062	0	0	0	0.004	0	0	0.028	0.00266	0.212
previous inferred background		0.3		0.06				0.00020		0.02	0.003	0.0006		0.02	0.002					0.01

Statistical Analysis Notes:

1. For non-detect data where the method detection limit was raised due to matrix interference, the data point was not used to calculate statistics.
2. For non-detect data where the method detection limit was at the normal precision (no matrix interference), a value equal to half the MDL was used to calculate statistics.
3. Data point removed for statistical calculations as an extreme outlier.

Database Notes:

4. --- in guideline row(s) denotes no criteria for that parameter.
5. --- in detail data row(s) denotes parameter not analyzed.
6. Highlighting indicates detection limit exceeds applicable guideline value.
7. Highlighting indicates result at guideline value.
- Superscript¹ 8. Guidelines shown for Federal Interim Groundwater Quality Guidelines for Residential/Parkland Land Use are Tier 2, with the Marine Life pathway eliminated.
- Superscript² 9. Guideline for cadmium is calculated based on a hardness of 1345 mg/L, the 95th percentile value derived for groundwater in surficial sediments on the mainland.
10. For parameters where guidelines vary according to pH and/or hardness, a pH value > 6.5 and a total hardness as CaCO₃ > 180 mg/L was used. These are verified as suitable values for both surficial sediments and shallow bedrock at the site based on 95th percentile background statistics.



Table F-4

Background Wells Groundwater Statistics: Dissolved Metals and Trace Elements

PROJECT NO.: 407074-00828-400		DISSOLVED METALS AND TRACE ELEMENTS																		
Monitoring Station	Date (d-m-y)	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium ² (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Zinc (mg/L)
11. Yellow highlighting denotes values exceeding CCME (2015) Canadian Environmental Quality Guidelines Summary Table - Water Quality Guidelines for the Protection of Freshwater Aquatic Life.																				
Aluminum: Standard varies with pH. pH < 6.5 = 0.005 mg/L pH >= 6.5 = 0.1 mg/L																				
Lead: Standard varies with Total Hardness as CaCO3 (H): Soft: H 0-60 = 0.001 mg/L Medium: H 60-120 = 0.002 mg/L Hard: H 120-180 = 0.004 mg/L Very Hard: H >= 180 = 0.007 mg/L																				
Mercury: Standard is for inorganic mercury only.																				
Nickel: Standard varies with Total Hardness as CaCO3 (H): Soft: H 0-60 = 0.025 mg/L Medium: H 60-120 = 0.065 mg/L Hard: H 120-180 = 0.11 mg/L Very Hard: H >= 180 = 0.15 mg/L																				
Boron: Short-term: 29 mg/L Long-term: 1.5 mg/L																				
Cadmium: Cadmium guideline = [10^{0.86[log(hardness)]-3.2}]/1000																				
Chromium: Limit is for Chromium(III).																				
Copper: Standard varies with Total Hardness as CaCO3 (H): Soft to Medium: H 0-120 = 0.002 mg/L Hard: H 120-180 = 0.003 mg/L Very Hard: H >= 180 = 0.004 mg/L																				
Uranium: Short-term: 0.033 mg/L Long-term: 0.015 mg/L																				



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Appendix G Physical Site Characteristics



Topography

The Norman Wells site is located on the north shore of the Mackenzie River. Elevations range from approximately 50 to 70 metres above sea level (masl). The river flows in a west-northwesterly direction past the town of Norman Wells. The valley within which this major river flows is bounded on the south by the Mackenzie Mountains and on the north by the Franklin Mountains.

The water levels in the Mackenzie River are quite variable throughout the year. Typical levels are approximately 41 masl during the winter, with short-term peaks of up to 51 masl (Komex 1980). The topography along the northern riverbank rises steeply from the lower flood plain to a relatively flat terrace about 65 masl. The site is dissected by Bosworth Creek, a steep-banked drainage feature that is confined to a relatively narrow valley. Bosworth Creek flows into the Mackenzie River south of Battery #3.

The Battery #3 site is located approximately 100 m north of the Mackenzie River, and immediately adjacent to Bosworth Creek. The site itself is situated on an upper terrace of the Mackenzie River, approximately 15 m above average water level. The eastern slope of the Bosworth Creek valley is quite steep, having an angle of roughly 35°. In contrast, the former Refinery is located approximately 50 m north of the Mackenzie River, and has a moderate southern-facing slope.

Geology and Soils

Bedrock

Hume (1954) describes the bedrock geology in the vicinity of Norman Wells in detail. The site is located “on a monoclinical structure on the southwest flank of the Discovery Range, and on the northeast limb of the Carcajou basin” (Hume 1954). The general dip of the bedrock strata is 4 to 5° to the southwest. Recent glacial and post-glacial sediments in the Mackenzie River valley are underlain by Cretaceous and Devonian-aged deposits of the Imperial and Canol Formations, respectively (Link 1920; Hume 1954). North of Bear Island, the Cretaceous beds have been eroded away, and the bedrock surface forms an erosional unconformity with the Canol Formation. Depth to bedrock is generally 5 to 10 m at the Norman Wells site, as noted during recent soil and groundwater quality investigations. The presence of small outcrops along the shore of the Mackenzie River and within the Bosworth Creek valley confirm this.

The Imperial Formation thickness beneath the Norman Wells area varies from approximately 80 m at the northern bank of the Mackenzie River, to less than 10 m under the northern edge of the facility (Link 1920). This formation comprises interbedded sandstones, siltstones, and shales. This, in turn, is underlain by the Canol Formation (250 to 370 m thick). These marine shales are highly bituminous, and are the interval within which the original oil discovery was made. Underlying these shales is up to 100 m of oil-saturated reef limestone known as the Kee Scarp Formation. The contact between the surrounding Canol Formation and Devonian-aged limestone reef forms a stratigraphic trap, producing the reservoir currently exploited by Imperial Oil (Williams 1986).

Local folding and fracturing of the shales and siltstones overlying the oil-saturated Kee Scarp limestone has resulted in some “naturally-occurring” oil and gas seepage zones at ground surface. Natural oil seeps have been documented in the Mackenzie Valley dating back to the explorations of Mackenzie in 1789 and 1793 (Hume and Link 1945). Oil seeps are particularly abundant along a stretch of the Mackenzie River between



Fort Norman and Norman Wells. This area is referred to as the “long straight”. At these locations, seepage zones are found along the contact between the dark oil-rich Canol Formation shale and the overlying Imperial Formation siltstones. This contact lies close to the edge of the Mackenzie River along most of the “long straight”. A particularly productive seep was discovered by T. O. Bosworth in 1914, at the entrance of a creek now known as “Bosworth Creek”. It was on the basis of this seep that the first well (the discovery well) was drilled at Norman Wells in 1921 (Link 1920).

Quaternary Sediments

Details of the Mackenzie Valley Quaternary history are described by Mackay and Mathews (1973). The last period of glaciation (the Wisconsin) resulted in the deposition of a till veneer, as well as some pro-glacial lake and spillway deposits in portions of the area.

In the vicinity of Norman Wells, remnants of glacio-lacustrine sediments are present. These sediments may be quite variable in texture, ranging from silt and clay-sized particles, to coarser sand and gravel lenses deposited during more active meltwater drainage episodes.

Soils

The dominant soils identified in the area of Norman Wells include Static and Turbic Cryosols, which have developed on either alluvial or morainal parent materials (Hardy Associates (1978) Ltd. 1980). Localized areas of Organic Cryosols have also been noted overlying lacustrine deposits in depressional areas or around fens and local wetland areas.

The active layer, or seasonally unfrozen layer above the permafrost, is generally between 0.3 and 1.0 m thick. The thickness of this layer is highly dependent on the time of year, aspect to the sun, proximity to buried infrastructure (e.g. underground flowlines), or degree of surface disturbance such as vegetation clearing or presence of open excavations.

Regional Hydrogeology

There are no known regional hydrogeologic studies that have been completed in the Norman Wells area. Therefore, results from the work commissioned to date by Imperial Oil Resources form the basis of understanding the local hydrogeologic setting.

The regional terrain slopes towards the Mackenzie River from the Norman Range of the Franklin Mountains, located north of the site. Given that shallow, unconfined groundwater flow is generally controlled by topography, the inferred direction of shallow groundwater flow on the north side of the Mackenzie River would be to the south, with discharge eventually occurring to that major water body. Smaller creek valleys, such as Bosworth Creek, would also exert some control on local groundwater flow patterns, and serve as discharge areas as well.

The presence of discontinuous permafrost exerts a strong control on local groundwater flow patterns, both lateral and vertical. Ice lenses in the subsurface act as barriers to groundwater movement based on the comparatively low hydraulic conductivity associated with frozen soil. As a result, complex groundwater flow

patterns are expected beneath the area. This complexity may, in some cases, contradict preconceived expectations.

Permafrost, Oil & Gas Seeps

Permafrost

Permafrost is defined exclusively on the basis of temperature, and is independent of material type (e.g. fill, overburden, or bedrock). Permafrost is ground that remains below 0°C continuously for several years (National Research Council of Canada 1988). The Norman Wells area lies in a zone of discontinuous permafrost (Geological Survey of Canada 1969), where typical permafrost thickness ranges from 50 to 65 m. In the vicinity of the Mackenzie River and around some facilities at Norman Wells, permafrost was not encountered while drilling (Komex 1998a). Rapid changes in permafrost depth and thickness do occur at the Norman Wells site, and the distribution of frozen ground likely controls contaminant movement in certain areas (Komex 1998b).

Oil & Gas Seeps

During Link's original field programs (1919; 1920), he identified a large zone of seepage in the Mackenzie River. This was located between the delta of Bosworth creek and the present location of the Crude Loading dock. In 1919, Link dug several test pits east of Bosworth Creek to estimate the volume of oil seeping from the ground. These test pits were reported to collect between 0.3 and 1.3 gallons of oil over a three day period, resulting in an estimated flow of 6.3 barrels/year (Link 1919). Seeps were also mapped at Seepage Lake, and downstream of the Bosworth Creek delta.

During construction of the artificial islands in the 1980s, oil and gas seeps were noted at a depth of 9-12 m below the river base in two bedrock boreholes (Komex 1980). Oil and gas seepage continues to occur at all of these locations today. However, the seeps are most obvious at four specific locations:

- along the Mackenzie shoreline below the former Refinery area;
- Bosworth Delta area;
- along the Mackenzie shoreline below the F-28X well; and
- at Seepage Lake to the north.

There are several possible sources for the concentrations of hydrocarbon presently found in seepage zones on the banks of the Mackenzie River. First, the oil may be seeping naturally from the source rock (Canol shale) or reservoir rock (Kee Scarp limestone). Second, the oil may originate from a spill or leak at an active facility in the Norman Wells field. Third, the oil may be emanating from a historical or recently abandoned facility at the site. The Norman Wells field has a long history; therefore, it is possible that all three situations may occur at a single seep.

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