



Supplemental Phase II Environmental Site Assessment and Human Health and Ecological Risk Assessment

Marystown Shipyard Marystown, NL

Department of Municipal Affairs and Environment



Executive Summary

GHD was retained by the Newfoundland and Labrador Department of Municipal Affairs and Environment (NLDMAE) to carry out a Supplemental Phase II Environmental Site Assessment (ESA) and a Human Health and Ecological Health Risk Assessment (HHERA) at the Marystown Shipyard (Site or Property) located on the west side of Mortier Bay in the Town of Marystown, Newfoundland and Labrador (NL).

The scope of work was based on a Document Review, Data Gap Analyses, and Scope of Work Development previously completed by GHD in August 2018 and updated with the e-mail correspondence dated November 23, 2018. The project objectives were to complete a Supplemental Phase II ESA that included the collection of soil, sediment, groundwater, surface water and benthic invertebrate samples for laboratory analysis. The purpose of the assessment is to re-evaluate the Site conditions, close the data gaps identified where possible and use the new Site data collected to support the completion of a HHERA.

The findings from the October and December 2018 Supplemental Phase II ESA sampling program include:

- Remaining soil impacts from petroleum hydrocarbons (mTPH) on Site were reported above the Atlantic RBCA Tier I RBSLs. These samples were collected from on the north side of the assembly and erection building, north and south ends of the service building and in the fuel pump area.
- Chromium concentrations above the generic CCME screening levels were identified in two soil samples collected from the north side of the assembly and erection building and in the lower laydown area of the Shipyard.
- Elevated metals, PAHs and/or PCBs above the generic CCME sediment quality guidelines were reported in the sediment samples collected from the waterlot of the Shipyard.
- F2 carbon fraction and/or mTPH exceedances of the Atlantic RBCA Tier I RBSL and/or ESL criteria were reported in the groundwater from seven of the on-Site monitor well locations (MSBL-MW2-2018, MSBL-MW6, MFPA-MW1-2018, MAEB-MW2-2018, MGSB-MW15 and MGSB-MW17). The samples exceeding the guidelines were collected in the lower laydown area, fuel pump area, service building area, the south side of the general storage building and the north side if the assembly and erection building.
- Arsenic, Copper, Selenium and Zinc concentrations were reported to be above the Tier 2
 FIGQG for commercial land use marine exposure in the groundwater samples collected from
 five monitor well locations in the lower laydown area, the drum storage area and the north side
 of the assembly and erection building.
- Surface water samples collected from the waterlot had concentrations of chemicals of potential concern (COPCs) below applicable screening levels or were consistent with background conditions in the area.



Anecdotal evidence indicates that shellfish harvesting, specifically scallops, occurs in Mortier
Bay and macroinvertebrates were present throughout the waterlot. Detectable concentrations of
several COPCs were identified in invertebrate tissue samples collected from the waterlot as
well as reference locations. However, highly bioaccumulative COPCs such as mercury and
PCBs were not detected in macroinvertebrates collected.

Based on the findings of the 2018 Supplemental Phase II ESA, GHD completed a HHERA to evaluate potential risks to human and ecological receptors.

HHRA

Based on the HHRA, there are petroleum hydrocarbon concentrations present in the soil above the Human Health Screening Levels (HHSL) for the protection of indoor air at locations near the on-Site commercial buildings that require further assessment.

There are groundwater samples collected at the Site that have arsenic and vanadium concentrations greater than the commercial direct contact/ingestion HHSLs located in the lower laydown area of the Shipyard. There are also groundwater samples that exceeded the mTPH direct contact/ingestion HHSLs collected from monitor well MGSB-MW15, which is located on the south side of the general store building. As the on-Site groundwater is not being consumed, the only receptor with potential groundwater contact would be a construction worker.

The sediment located in the waterlot does not pose an unacceptable risk to the commercial worker receptors through direct contact pathway at the Site.

The HHRA indicated the consumption of shellfish collected from the waterlot are unlikely to pose a risk to human health based on current usage of the waterlot. However, the HHRA indicated that consumption of shellfish harvested from the waterlot, specifically scallops, could pose a risk to toddlers if consumed on subsistence or heavy consumer basis (5 days/week, 26 weeks per year). The shellfish consumption pathway was assessed based on measured concentrations of COPCs (e.g. cadmium) in composite samples of soft tissue and not specific to edible portions of shellfish. Using whole body tissue concentrations likely overstates the potential for risk as COPCs such as cadmium are known to preferentially accumulate in the digestive gland of scallops with substantially less concentrations being present in the edible portions of the shellfish such as abductor muscles. As indicated in literature provided by the Department of Fisheries and Oceans, Research Branch (J.F. Uthe and C.L. Chou, 1986), cadmium concentrations in abductor muscles typically constitute less than 1% of the total cadmium concentrations in the soft tissue of scallops. For the purposes of this risk assessment, it has been conservatively assumed that the abductor muscle is 10% of wholebody which would result in an EPC that is well below the SSTLs developed for both a toddler and adult receptor (subsistence, recreational/commercial consumption). It has also been noted that in the conditions of the DFO recreational/commercial licensing both commercial and recreational harvesters are not to consume any portion, other than the adductor muscle ("meat"), from scallops that are harvested from the shoreline and adjacent waters surrounding the province of NL. As such, it is reasonable to assume that the concentration of cadmium in the edible portion of scallops (abductor muscle) collected from the Site is well below concentrations that are considered to pose a potential risk to human health.



ERA

Based on the results of the ERA, the concentrations of COPCs in sediment of the waterlot are not considered to pose an unacceptable risk to benthic invertebrates, fish, or aquatic wildlife through the direct contact and consumption exposure pathways.

If sediment is required to be excavated/removed to facilitate any future wharf upgrades, leachate analyses on the sediment has confirmed the dredged material is not classified as a toxic hazardous waste. As a result, the excavated dredged material meets the requirements outlined in the Guidance Document entitled "Protocol for the Management of Excavated Soils, Concrete Rubble and Dredged Materials (GD-PPD-045.2)" and can be disposed at an approved landfill facility, pending landfill approval.

Similarly, concentrations of COPCs in surface water of the waterlot were below applicable screening guidelines or reference conditions and considered to pose a low risk to ecological receptors. Based on the surface water analytical results, groundwater at the Site with elevated concentrations of metals and mTPH exceeding guidelines for groundwater discharging to an aquatic receptor are unlikely to pose an unacceptable risk to aquatic ecological receptors.

Recommendations

The following recommendations are provided based on the results of the Supplemental Phase II ESA and HHERA:

- Conduct a groundwater monitoring program for seasonal variation including free product
 gauging in all of the on-Site monitor wells and recovery wells for analyses of petroleum
 hydrocarbons and metals (including mercury). A minimum of two monitoring events should be
 completed in the Spring and Summer months to assess seasonal variation and provide the
 analytical data to determine if a risk management plan is required.
- Due to the locations of the commercial buildings on the Site, it is recommended that the soil
 exceedance areas illustrated on Figures 5A to 5C be further assessed through the installation
 and seasonal sampling of soil vapour probes. A minimum of two monitoring events should be
 completed in the Summer and Winter months to assess seasonal variation and provide the
 analytical data to determine if a risk management plan is required.
- Although the maximum groundwater concentration (447 mg/L in MGSB-MW15, near the Carpenters & Joiners Building) does not exceed the indoor air inhalation HHSL, the groundwater at the Site is shallower than that assumed in the derivation of the HHSLs and therefore the HHSL may not be applicable, which may warrant further assessment. Although no free product was measured in groundwater during the field work, the groundwater concentration measured in MGSB-MW15 is indicative of the possible presence of free product in the area. Therefore it is recommended that consideration be given to further assessing the soil vapour to indoor air pathway in this area through the installation and seasonal sampling of soil vapour probes. Due to the monitor well's proximity to the existing building and the absence of elevated soil concentrations in the adjacent boreholes, sub-slab probes beneath the building may be preferred. As recommended above, a minimum of two groundwater events (to determine the presence/absence of free product) and a minimum of two soil vapour events would be required



to assess seasonal variation. If free phase product is detected, additional assessment would be required that includes installation of monitor wells for delineation purposes.

- It is recommended that a Risk Management Plan including Best Management Practices and a Site specific health and safety plan be developed to address possible contact with groundwater impacts should sub-surface work be required in the lower laydown area and the south side of the general store building, which specifically address arsenic, vanadium, and modified TPH. It is noted that no soil samples collected contained metals or petroleum hydrocarbons above the applicable HHSLs for direct contact; therefore, the sub-surface soil at the Site does not present a risk to construction workers.
- If a remedial program is not completed to address the soil and groundwater impacts at the Site, impacts should be risk managed or a Phase III ESA is recommended to delineate the soil and/or groundwater impacts to meet minimal site assessment requirements. The Phase III ESA program would include delineation of petroleum hydrocarbon and chromium soil impacts south of MAEB-MW2, petroleum hydrocarbon soil impacts east and south of MSBL-MW6/BH5, petroleum hydrocarbons soil impacts west of MFPA-MW1, chromium soil impacts north of MFPA-BH3, petroleum hydrocarbon soil impacts north, south and east of MLLA-MW3, as well as petroleum hydrocarbon impacts in groundwater north of MGSB-MW15. The Phase III ESA can be combined with the groundwater and soil vapour monitoring programs discussed above

Although outside the scope to develop an environmental liability for the Site, the following recommendations are carried forward from previous ESA programs reviewed as part of the data gap analyses:

- Any ASTs remaining on the Site and intended to be used, should be inspected to ensure they
 meet the requirements specified in the Newfoundland and Labrador Gasoline and Associated
 Products (GAP) and/or Heating Oil Storage Tank (HOST) Regulations for their intended
 usages.
- Although no major surface stains were noted in the areas assessed during the Supplemental Phase II ESA, any surface stains noted at the Site should be assessed or remediated as per provincial requirements.
- Any drums, containers or other vessels remaining at the Site should be collected and consolidated in designated Site areas and those no longer required should be disposed of at an approved facility.
- The scrap steel and debris, particularly in the lower laydown area and observed to be present in fill materials around the shoreline and ditching to the southwest of the lower laydown area, should be removed from the Site and disposed of at approved facilities.
- If existing buildings are to remain, an inspection of the existing septic sewer systems should be completed to ensure sewage discharges meet provincial regulations.
- Any ODS containing equipment or PCB containing light ballasts remaining at the Site should be disposed of in accordance with the applicable regulations.



 Although the underground fuel distribution lines on Site were documented to be drained, purged, capped and abandoned in place in 2000 and petroleum hydrocarbon impacts were not found along the pipelines in 2000, regulatory approval for abandonment in place would be required. This should be included in any future submissions for regulatory closure of the Site.

The statements made in this Executive Summary are subject to the same limitations included in Section 10.0 (Closure), and are to be read in conjunction with the remainder of this report.



1.	Introd	luction		1
	1.1	Site Desc	ription	1
	1.2	Scope of	Work	2
		1.2.1 1.2.2	Supplemental Phase II ESAHuman Health and Ecological Risk Assessment (HHERA)	
	1.3	Assessme	ent Standards	2
2.	Sumn	nary of Pre	vious Investigations	3
3.	Site F	Reconnaiss	ance	9
4.	Suppl	lemental P	hase II Environmental Site Assessment (ESA)	10
	4.1			
		4.1.1 4.1.2 4.1.3 4.1.4	Borehole Program Borehole Location Survey Soil Sampling Program Quality Assurance/Quality Control (QA/QC) Sampling Program	11 11
	4.2	Groundwa	ater	12
		4.2.1 4.2.2	Fluid Level Gauging/Surveying Groundwater Sampling	
	4.3	Sediment		13
		4.3.1 4.3.2	Sediment SamplingQuality Assurance/Quality Control (QA/QC) Sampling Program	
	4.4	Biological	Tissue	17
	4.5	Surface W	/ater	19
		4.5.1 4.5.2	Surface Water SamplingQuality Assurance/Quality Control (QA/QC) Sampling Program	
5.	Resul	lts of Field	Investigation	20
	5.1	Soil		20
		5.1.1 5.1.2 5.1.3	Soil Analytical Data – Petroleum Hydrocarbons Soil Analytical Data – Metals Soil QA/QC Sampling Program	22
	5.2	Groundwa	ater	22
		5.2.1 5.2.2 5.2.3 5.2.4	Fluid Level Gauging/Surveying Groundwater Analytical Data – Petroleum Hydrocarbons Groundwater Analytical Data – Metals Groundwater QA/QC Sampling Program	23 23
	5.3	Sediment		24
		5.3.1 5.3.2 5.3.3	Sediment Analytical Data – Petroleum Hydrocarbons	25



		5.3.4 5.3.5 5.3.6	Sediment Analytical Data – FOCs	26
	5.4	Tissue		27
		5.4.1 5.4.2 5.4.3 5.4.4	Tissue Analytical Data – Metals Tissue Analytical Data – PAHs Tissue Analytical Data – PCBs Tissue Analytical Data –Lipids	27 27
	5.5	Surface V	Vater	
		5.5.1 5.5.2 5.5.3 5.5.4 5.5.5	Surface Water Analytical Data – Petroleum Hydrocarbons	28 28 28
6.	Data	Evaluation		29
	6.1	Metals of	Low Concern	29
	6.2	Contamin	ant Distribution	30
	6.3	6.2.1 6.2.1.1 6.2.1.2 6.2.2 6.2.2.1 6.2.2.2 6.2.3 6.2.3.1 6.2.3.2 6.2.3.3 6.2.3.4 6.2.4 Exposure	Soil	3030313131
	6.4	•	ability for Risk Assessment	
	6.5		nd Analysis	
7.	Huma	an Health F	Risk Assessment	33
	7.1		Formulation	
		7.1.1 7.1.1.1 7.1.1.2 7.1.1.3 7.1.1.4 7.1.1.5 7.1.1.6 7.1.2 7.1.3 7.1.4	Human Health Chemicals of Potential Concern (COPC) Screening	34 37 41 44 45 50



	7.2	Exposure .	Assessment	55
		7.2.1 7.2.2	Assessment Tools	
	7.3	Toxicity As	ssessment	56
	7.4	Risk Chara	acterization	57
		7.4.1 7.4.1.1 7.4.1.2	Site Specific Target Level Calculation Results	57
	7.5	Human He	ealth Risk Assessment Results	58
		7.5.1 7.5.2 7.5.3 7.5.4	Commercial Land Use – Indoor Air	59 60
	7.6	Summary	of Uncertainty Analysis	62
8.	Ecolo	gical Risk A	Assessment	63
	8.1	Ecological	Screening	64
		8.1.1 8.1.2 8.1.3 8.1.4	Soil	65 65
	8.2	Problem F	ormulation	74
		8.2.1 8.2.2 8.2.3	Receptor Identification	75
	8.3	Evaluation	of Terrestrial Plants and Invertebrates	77
	8.4	Evaluation	of Benthic Invertebrates	79
		8.4.1 8.4.1.1 8.4.1.2 8.4.1.3 8.4.1.4 8.4.1.5 8.4.1.6 8.4.1.7 8.4.2 8.4.3 8.4.4	Chemical Characterization Spatial Extent of Metals Exceedances Spatial Extent of PAH Exceedances Spatial Extent of PCB Exceedances Magnitude of Exceedances Evaluation of Metals Evaluation of PAHs Evaluation of PCBs Benthic Invertebrate Community Assessment Field Evidence Invertebrate Tissue	80 80 81 81 82 83 84 84 86 87
	8.5	Evaluation	of Fish	88
		8.5.1 8.5.2 8.5.3	Target Constituents for Assessing Fish	89
	8.6	Evaluation	of Aquatic Wildlife	90



		8.6.1	Target Constituents for Assessing Aquatic Wildlife	90
		8.6.2	Receptors of Concern	91
		8.6.3	Exposure of Aquatic Wildlife to COPCs	91
		8.6.4	Effects Levels for Aquatic Wildlife	94
		8.6.5	Hazard Assessment for Aquatic Wildlife	95
		8.6.5.1	Mammals	95
		8.6.5.2	Birds	95
	8.7	Summary	of Ecological Risks	96
	8.8	Uncertain	ty Analysis	99
9.	Conc	lusions and	d Recommendations	100
	9.1	Conclusio	ns	100
	9.2	Recomme	endations	102
10.	Closu	ıre		103
11.	Refer	ences		105



Figure Index

Figure 7.1	Conceptual Site Model for Human Receptors	54
Figure 8.1	Conceptual Site Model for Ecological Receptors	78
Figure In	dex (following text)	
i igaic iii	dex (following text)	
Figure 1	Site Location Map	
Figure 2	Property Plan	
Figure 3	Site Plan with Sample Locations	
Figure 4A	Site Plan with Sample Locations - Waterlot	
Figure 4B	Site Plan with Sample Locations - Reference	
Figure 5	Site Plan with Soil Exceedances	
Figure 5A	Site Plan with Soil Exceedances – MAEB	
Figure 5B	Site Plan with Soil Exceedances – MSBL	
Figure 5C	Site Plan with Soil Exceedances – MLLA/MFPA	
Figure 6	Site Plan with Groundwater Exceedances	
Figure 6A	Site Plan with Groundwater Exceedances - MGSB	
Figure 7A	Contaminant Distribution - Waterlot	
Figure 7B	Contaminant Distribution - Reference	
Table Inc	dex	
Table 4-1	Sediment Sample Location Descriptions and Biota Observed	15
Table 4-2	Invertebrate Tissue Summary	18
Table 7-1	Human Health Screening of Surface Soil	36
Table 7-2	Human Health Screening of Groundwater	38
Table 7-3	Human Health Screening of Sediment	40
Table 7-4	Shellfish Tissue Concentrations for Assessing Human Consumption Exposure	43
Table 7-5	Human Health Screening for Consumption of Shellfish	46
Table 7-6	Human Health Screening for Surface Water	47
Table 7-7	Exposure Definitions	51
Table 7-8	Potential Exposure Scenarios - Human Receptors	51
Table 7-9	Receptor Characteristics – Adult Commercial Worker	55



Table 7-10	Receptor Characteristics – Commercial/Subsistence Fisher	55
Table 7-11	Selected Toxicity Values for Non-Carcinogens	56
Table 7-12	Selected Toxicity Values for Carcinogens	56
Table Ind	lex	
Table 7-13	Human Health Risk Assessment Results – Commercial Worker Exposure to Sediment	57
Table 7-14	Human Health Risk Assessment Results –Commercial or Subsistence Fisher Consumption of Shellfish	58
Table 7-15	Human Health Risk Results – Commercial Indoor Air	58
Table 7-16	Human Health Risk Results – Construction Worker Direct Contact/Incidental Ingestion	59
Table 7-17	Human Health Risk Results – Commercial Direct Contact/Incidental Ingestion	60
Table 7-18	Human Health Risk Results –Shellfish Consumption Pathway	61
Table 8-1	Ecological Screening of Surface Soil	68
Table 8-2	Ecological Screening of Groundwater	69
Table 8-3	Ecological Screening of Sediment	70
Table 8-4	Ecological Screening of Surface Water	71
Table 8-5	Potential Exposure Scenarios - Ecological Receptors	76
Table 8-6	Ecological Risk Results – Plants and Invertebrates	79
Table 8-7	Hazard Quotients for Benthic Invertebrates in Sediment	82
Table 8-8	Benthic Invertebrate Community Results	85
Table 8-9	Invertebrate Tissue Concentration	88
Table 8-10	Hazard Quotients for Mammalian Species	95
Table 8-11	Hazard Quotients for Avian Species	95
Table Ind	lex (following text)	
Table 1	Groundwater Monitoring Results	
Table 2	Petroleum Hydrocarbons in Soil	
Table 3	Metals in Soil	
Table 4	Petroleum Hydrocarbons in Groundwater	
Table 5	Metals in Groundwater	



Table Index (following text)

Table 6 Petroleum Hydrocarbons in Sediments Table 7 Metals in Sediment Table 8 PAHs in Sediment Table 9 FOC in Sediment Table 10 PCBs in Sediment Table 11 Metals in Benthic Invertebrate Tissue Table 12 PAHs in Benthic Invertebrate Tissue Table 13 PCBs in Benthic Invertebrate Tissue Table 14 Petroleum Hydrocarbons in Surface Water Table 15 Metals in Surface Water Table 16 PAHs in Surface Water Table 17 General Chemistry in Surface Water

Appendix Index

Appendix A Photographic Record Appendix B Borehole/Monitor Well Logs Laboratory Certificates of Analysis Appendix C Appendix D Statistical Analyses and Supporting Data Appendix E **HHRA Supporting Information** Appendix F **ERA Supporting Information** Appendix G Potential Species at Risk Supporting Information Appendix H **Divers Report**



1. Introduction

GHD was retained by the Newfoundland and Labrador Department of Municipal Affairs and Environment (NLDMAE) to carry out a Supplemental Phase II Environmental Site Assessment (ESA) and a Human Health and Ecological Health Risk Assessment (HHERA) at the Marystown Shipyard (Site or Property) located on the west side of Mortier Bay in the Town of Marystown, Newfoundland and Labrador (NL). The purpose of this investigation is to re-evaluate the environmental Site conditions with the collection of additional soil, sediment and groundwater data to support the completion of the HHERA. A Site Location Map is included as Figure 1 and a Property Plan is presented on Figure 2.

The scope of work was based on a Document Review, Data Gap Analyses, and Scope of Work Development previously completed by GHD in August 2018 and updated with the e-mail correspondence dated November 23, 2018. The objectives of the Supplemental Phase II ESA were as follows:

- Complete a Supplemental Phase II ESA that included the collection of soil, sediment, groundwater and tissue samples for laboratory analysis. The purpose of the assessment is to re-evaluate the Site conditions and close any gaps identified.
- Use the new Site data collected to complete a HHERA.
- Complete the work within the specified timeframe.

1.1 Site Description

The Marystown Shipyard was established in 1968 and is located in Mortier Bay on the Burin Peninsula of NL. The Site was designed as different clusters of specialty buildings that collectively form the Shipyard and include several fabrication, storage, maintenance, and office buildings. The Site also includes a waterlot, yard areas, and areas for fuel storage and marine facilities with associated infrastructure. Based on information provided to GHD, the Shipyard has a total in-house fabrication area of 9,368 square metres (m²) and a water frontage of approximately 330 metres (m).

The Site is surrounded by a mixture of residential and bulk storage tank farms to the north/northeast, a mixture of Shipyard parking areas and residential areas to the south, the waters of Mortier Bay to the east, and an access road (Ville Marie Drive) to the west. Access to the Shipyard is restricted to an access track leading from the parking area to the south, a coastal road leading to the Federal wharf just beyond the northeast corner of the Site, or by boat traffic to the Shipyard wharf.

The Site was originally created by infilling the former cove of Mortier Bay and is surrounded by steep rocky cliffs to the north, west, and south with elevations of 20 m above the Shipyard. The Site is relatively flat with surface drainage directed towards ditches surrounding the site that ultimately discharge to Mortier Bay. The Shipyard and surrounding properties are connected to the municipal water supply system. A Property Plan is shown on Figure 2.



1.2 Scope of Work

The scope of work for the Supplemental Phase II ESA and HHERA, based on the above objectives, included the following:

1.2.1 Supplemental Phase II ESA

GHD to complete a Supplemental Phase II ESA that will include the re-evaluation/assessment of the current on-Site soil, groundwater and sediment conditions as well as an assessment of the marine habitat and biological tissue within the waterlot associated with the Site. The chemicals of potential concern include petroleum hydrocarbons and metals in the soil and groundwater and petroleum hydrocarbons, metals, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in sediment and marine biological tissue. The chemicals of potential concern were identified based the historical shipyard activities and the results of past investigations.

1.2.2 Human Health and Ecological Risk Assessment (HHERA)

GHD to use the new Site data collected during the completion of the Supplemental Phase II ESA to complete a HHERA for the Site. The HHERA will evaluate the risk to both the human and ecological users of the Site based on the current Site data and aid in the development of environmental liability associated with the Site.

1.3 Assessment Standards

The Site former and current land use of the property is commercial/industrial.

Site soils are considered to be coarse-grained and groundwater resources are not used for human consumption; therefore, the Site is considered to be non-potable.

Regulatory guidance documents used for comparison against current analytical results are:

- Canadian Council of Ministers of the Environment (CCME), Canadian Soil Quality Guidelines (CSQGs) – Accessed online October 2018.
- Atlantic Risk-Based Corrective Action (RBCA) Tier I Risk-Based Screening Levels (RBSLs) for soil and groundwater – 2016.
- Atlantic RBCA Tier I Ecological Screening Levels (ESLs) for soil, sediment, groundwater and surface water, – 2016.
- Canadian Council of Ministers of the Environment (CCME), Interim Sediment Quality Guidelines (ISQGs) - Accessed online October 2018.
- Canadian Council of Ministers of the Environment (CCME), Probable Effects Levels (PELs) Accessed online October 2018.
- Canadian Council of Ministers of the Environment (CCME), Water Quality Guidelines for the Protection of Aquatic Life (WQG), Marine and Freshwater - Accessed online January 2019.
- Federal Contaminated Sites Action Plan (FCSAP), Guidance Document on Federal Interim Groundwater Quality Guidelines (FIGQG) for Federal Contaminated Sites June 2016.



2. Summary of Previous Investigations

Previous investigations were completed at the Site between 1997 and 2018 and are included the following table:

Report Title	Consultant	Date
Phase I Environmental Site Assessment (ESA), Marystown Shipyard and Cow Head Facility	Jacques Whitford Environment Limited (JWEL)	1997
Phase II ESA, Marystown Shipyard and Cow Head Facility	JWEL	1998
Ecological Risk Assessment (ERA), Marystown Shipyard (Draft)	JWEL	1999
Asbestos Operations and Maintenance Program, Marystown Shipyard, Marystown, Newfoundland	JWEL	2000
Human Health Risk Assessment (HHRA) Program, Friede Goldman Newfoundland's Facilities at Marystown	JWEL	2001
Tank Removal and Replacement Program, Marystown Shipyard	JWEL	2001
Asbestos and Lead-Based Paint Abatement Program Friede Goldman Newfoundland Limited's Facilities, Marystown	JWEL	2002
Letter to Department of Industry, Trade and Rural Development (ITRD), Additional Testing and ERA Related to Marine Sediments, Marystown Shipyard	JWEL	2002
Phase I ESA, Marystown Shipyard and Cow Head Facility	JWEL	2002
Paint Assessment, Carpenter and Joiner's Building, Marystown Shipyard	Stantec (Formerly JWEL)	2009
Paint Assessment, Maintenance Building, Marystown Shipyard	Stantec	2010
Lead Paint Abatement, Carpenter and Joiners Building and Maintenance Building, Marystown Shipyard	Stantec	2011
Document Review, Data Gap Analysis, and Scope of Work Development, Marystown Shipyard, Marystown, Newfoundland and Labrador	GHD	2018

GHD completed a detailed review of the documents provided, which are listed in the table above. The following is a summary from the historical Phase I ESAs detailing the yard areas and waterlots.

Yard Areas

The Site was used as a wooden boat building facility complete with a sawmill prior to development as the Marystown Shipyard in the 1960s. The following issues were documented in the 1997 Phase I ESA:

- The presence of six underground storage tanks (USTs), several aboveground storage tanks (ASTs) and waste oil tanks, and underground fuel lines on the Site.
- The presence of several waste oil storage areas and several drum storage areas on the Site.
- The former presence of a foundry at the Murley Building.



- The presence of staining on exterior soil, asphalt and concrete surfaces throughout the Site. Significant surface staining was observed in the vicinities of the six former USTs, to the west of the Main Shed, in the lower laydown area, and in the steel and drum storage area to the north of the Outfit & Stores Building (in the vicinity of the waste oil storage area).
- The use of creosote piles on Site.
- The storage of sandblast grit and other debris at various Site locations.

An extensive subsurface investigation was conducted on Site during a Phase II ESA in 1998 to investigate these issues. Soil and/or groundwater were tested at various Site locations for petroleum hydrocarbons, PCBs, metals, PAHs and volatile organic compounds (VOCs). The results of the Phase II ESA confirmed that petroleum hydrocarbon impacts were present in soil in several areas of the Site (the UST locations, drum storage areas and the lower laydown area) and metals impacts were present in soil in some of the areas (drum storage area and lower laydown area). Free-phase petroleum products were also present at three locations on the Site in the vicinity of the USTs.

A Human Health Risk Assessment (HHRA) completed for the Site in 1999 established Site-specific target levels (SSTLs) for petroleum hydrocarbon impacts and evaluated the acceptability of the detected levels of metals. The results of the HHRA indicated that the detected levels of metals on the Site were acceptable for the Site usage and the detected levels of petroleum hydrocarbons were acceptable except in near-surface soils (less than 1 m deep) in the refuelling area, provided the identified free-phase product was removed from the Site.

Six USTs and two ASTs were removed from the Site in 2000. The underground fuel distribution line was drained, purged, capped and abandoned in place in at that time. A soil remediation program was also conducted in the refuelling area to remove the petroleum hydrocarbon impacted soil within 1 metre from the ground surface. Soil remediation was also conducted in the immediate vicinities of the six former USTs to remove soil that was heavily impacted with petroleum hydrocarbons. No other remediation of the surface stained soils identified on Site in 1997 was conducted in accordance with the results of the HHRA. Recovery wells were installed at three Site areas in 2000. As of February 2002, product recovery had been ongoing, that was complete in two of the areas; some free product remained in the refuelling area.

A lead paint survey was conducted in 1999 for the buildings located at the Shipyard. The lead survey indicated the presence of lead in paint in the Main Shed Building, the Outfit & Stores Building (now referred to as the Carpenters and Joiners Building); the Services Building (now referred to as the Maintenance Building) and the Parts Building. Most of the painted surfaces in the Services Building, Parts Building and Outfit & Stores Building were in good condition. Some of the paint in the Main Shed Building and Outfit & Stores Building was in poor condition with extensive scaling and peeling paint. Leachability testing indicated that paints in the Main Shed Building, the Outfit & Stores Building and the Parts Building contained leachable lead and; therefore, were considered to be a hazardous material for disposal purposes. A lead-based paint abatement program was conducted in 2001 and included the complete removal of accessible paints in areas where the existing paints were extensively damaged (i.e., Main Shed Building and portions of the Outfit & Stores Building). In other areas of the Site, the abatement program was limited to the removal of damaged paints only. Paint assessments of the Carpenter and Joiners Building and



Maintenance Building were conducted in 2009/2010 when excessive amounts of interior paints had fallen off inside the buildings within a one year period. A lead-based paint abatement program was performed at the Site in 2011 and included the removal and disposal of all loose, scaling or easily removed paints on the interior walls, floors and ceilings of the Carpenter and Joiners Building and Maintenance Building with the exception of painted interior galvanized roof and wall panels where all paints were removed.

An Asbestos Operations and Maintenance program was developed by JWEL in 2000 to assist Site personnel to safely perform their job function when working near asbestos-containing materials (ACMs). An asbestos abatement program was then conducted at the Shipyard in 2001 and included the removal and disposal of all known friable ACMs from the Main Shed Building, the Syncrolift Building, the Services Building and the Administration Building, with the exception of short sections of friable pipe insulation which was left in concealed wall spaces in eight locations in the Administration Building. The abatement program also included the removal and disposal of friable ACMs from pipelines above ceilings in offices and washrooms in the lower floor of the Outfit & Stores Building as necessary.

Waterlots

The property at the Marystown Shipyard includes two nearshore waterlots near the wharf areas. A dive survey, as part of the 1998 Phase II ESA, indicated the presence of various debris, including old lead-acid batteries and paint cans in the waterlots around the Site.

Analysis in 1998 and 1999 indicated that sediments in the area were impacted by heavy metals and PAHs and would not be suitable for ocean dumping; the sediments would be considered as hazardous waste if disposed of at onshore facilities. A draft screening level ERA was completed for the impacted sediments; however, as of 2002 the report had not been finalized. Environment Canada indicated that additional samples would be required in the marine area near the Site (including sampling of control sites) before remedial options could be evaluated for the impacted sediments.

GHD completed a document review to identify any data gaps that may need to be addressed to document the current liability estimate at the Site in 2018. Based on GHD's review of the historical environmental reports, the following summary of outstanding issues were noted:

- The presence and/or absence of free-phase product in the recovery wells located on the south side of the Main Administration and Security Office (MASO) and the south side of the General Stores Building (MGSB) is to be confirmed.
- The soil and groundwater for petroleum hydrocarbons in the vicinity of the previous soil remediation areas at MGSB, MASO, Assembly and Erection Building (MAEB), Service Building (MSBL) and Fuel Pump Area (MFPA), as well as the previously identified petroleum hydrocarbon impacted areas at Lower Laydown Area (MLLA), MAEB, and Drum Storage Area (MDSA) require re-assessment.
- Soil and groundwater in the vicinity of the areas previously identified metal impacts at MLLA, MDSA, and MAEB require re-assessment.



- Sediment in the waterlot is to be re-assessed to confirm the presence or absence of petroleum hydrocarbons, metals, PAHs and PCBs.
- Previously debris was previously identified in the waterlot, debris in the nearshore waterlots should be collected and be disposed of at approved facilities.
- Aboveground storage tanks (ASTs) were present on the property during the previous ESA
 programs. The ASTs were noted in the previous studies to not be properly dyked, and
 therefore do not comply with the Newfoundland and Labrador Gasoline and Associated
 Products (GAP) Regulations for their intended usages. The installation of suitable secondary
 containment or removed the tanks from the Site is recommended.
- Various drums and containers of petroleum products (some full and some partly used) were
 observed at various locations throughout the Site during previous studies. Petroleum products
 should be collected and consolidated in designated Site areas and those no longer required
 should be disposed of at an approved facility.
- Various steel and other debris was noted to be stored on Site during previous assessments,
 particularly in the lower laydown area, the northern part of the Site and along the shoreline.
 Various debris was observed to be present in fill materials around the shoreline and in the lower
 laydown area. The scrap steel and debris should be removed from the Site and disposed of at
 approved facilities. Future infilling on Site should be completed with clean debris-free fill
 materials.
- Waste oil and liquid hazardous waste (i.e. waste paint thinners and degreasers) were noted to be stored in tanks and 200 L capacity drums in various locations on the Site. These waste liquids were reported to be collected from the Site regularly by an approved waste disposal contractor. All containers of liquid wastes on Site should be collected, identified by sampling if necessary and sent to an approved disposal facility. During normal operation, all containers of liquid waste should be stored on the designated storage pad. Proper workplace hazardous materials information system (WHMIS) labelling should be present on all containers used to store liquid wastes. All containers used to store liquid wastes should be properly sealed.
- The Site (exterior and interior) is to be inspected for evidence of spills and stains, based on past observations. If spills or stains are identified, they should be cleaned or removed.
- If the refueling pumps are no longer required, the surface stained soils in the vicinities of the
 dispensing pumps should be remediated to meet the applicable screening criteria. If still in
 operation, a spill containment system (e.g., spill containment trays and hydrophobic absorbent
 pads) should be installed at the dispensing pumps to prevent future spillage onto the ground.
- Past oil staining was observed in the lower laydown area, in an area of stored waste oil drums
 to the west of the Syncrolift Building and in the vehicle parking areas. It is also possible that oil
 stains were present in other areas on the Site. If required, remediation of surface stained areas,
 through removal of the stained soil, should be conducted.
- The previous assessments revealed the septic system discharged to a drainage ditch on Site
 which does not comply with provincial regulations. A design and specifications had been
 completed to extend the sewer line from the tank with an outfall in Mortier Bay. Based on
 information provided to GHD, the installation of the sewer line and outfall has not been



completed to date. Make the required modifications at the septic tank to comply with provincial regulations (i.e., install a new sewer line from the on-Site septic tank, with an off-shore outfall in Mortier Bay).

- Based on previous studies, the lower floor of the Parts Building contained a sump which
 discharged to Mortier Bay via a floor drain. There was visible oil spilled into the sump and drain
 during the previous field programs. A clean up the spilled oil in the area was recommended. In
 addition, it was recommended to block the drain or otherwise prevent oil entry into Mortier Bay if
 oil products were to continue to be stored in this area.
- No oil/water separator was present in the Side Transfer area. Drainage from the area
 discharges to Mortier Bay and can contain waste oil and/or bilge from vessels under repair in
 the area. It was recommended to consider the installation of an oil/water separator in the Side
 Transfer area to prevent incremental impacts in the nearshore marine area.
- Due to the age of Site buildings, PCBs may be present in ballasts in fluorescent and high-pressure light fixtures. During any light fixture removal or replacement, any ballast identified as containing PCBs should be disposed of by an approved contractor. Suitable precautions and approved contractors should be used for PCB handling.
- A detailed asbestos survey confirmed the presence of friable and non-friable ACMs in various Site buildings. Previous reports recommended following the Asbestos Operations and Maintenance Program when carrying out activities on Site that may disturb known or suspected ACMs. Suitable precautions and approved contractors should be used for asbestos handling.
- A detailed lead survey had confirmed the presence of lead-based paints in various Site buildings. A major remediation of lead-based paints was completed on Site in 2001, and again in 2011 to remove identified lead-based paints that were in poor condition. Lead-based paints are known to remain in the Outfit & Stores Building (now referred to as the Carpenters & Joiners Building), the Parts Building and the Services Building (now referred to as the Maintenance Building). Lead may be present in paints that were not tested during the paint survey (e.g., paints in small sheds and trailers, paints on ceilings and structural steel that were in good condition). A Lead Operations and Maintenance Program had been developed for the Site. Follow the Lead Operations and Maintenance Program when carrying out activities on Site that may disturb known or suspected lead-based paints. Suitable precautions and approved contractors should be used for lead handling. If buildings have been vacant for a period of time, an inspection should be completed of painted surfaces remaining to confirm the paint is still in good condition (i.e. not peeling or flaking).
- The ozone depleting substance (ODS) containing equipment identified on the Site should be removed from any abandoned units and the units should be disposed of properly. Suitable precautions and approved contractors should be used for ODS handling.
- A cylinder of tetra Fluor HF1340 was observed at the compressed gas storage area. If the cylinder remains, it should be removed from the Site if it is no longer required.
- The underground fuel distribution lines on Site were noted to be drained, purged, capped and abandoned in place in 2000. Petroleum hydrocarbon impacts were not found along the pipelines except at the locations of former USTs, which were removed in 2000. Soil removal



was carried out in the former tank areas. Regulatory approval has not yet been received for the pipeline abandonment. Confirm the analytical results in the area of the abandoned fuel pipeline and, if favourable, submit for Regulatory closure.

Based on the results of the document review and recommendations, GHD developed a work plan and scope document to address the data gaps identified that involve environmental liability at the Site. The objectives of the work program are as follows:

- To become familiar with the Site and review the data gap analyses; and/or delineate and quantify previously identified impacts in the soil, groundwater and sediment at the Site.
- To inspect, sample and update the previously completed Hazardous Materials Study completed at the Site this to be completed as a separate report.
- To produce a detailed report outlining methodology used in obtaining the samples, sample
 Quality Assurance/Quality Control (QA/QC); the analytical results of the current sampling
 events and to compare to the current applicable human health and ecological based guidelines.
- To update/complete a revised Human Health and Ecological Risk Assessment (HHERA) for the Site.
- To provide a liability estimate for the Site, under separate cover, based on the results of the new data collected.

Although outside the scope to develop an environmental liability for the Site, the following recommendations are to be carried forward from the data gap analyses:

- Any ASTs remaining on the Site and intended to be used, should be inspected to ensure they
 meet the requirements specified in the Newfoundland and Labrador GAP and/or Heating Oil
 Storage Tank (HOST) Regulations for their intended usages.
- Although no major stains were noted in the areas assessed during the Supplemental Phase II ESA, any stains noted at the Site should be assessed or remediated.
- Any drums, containers or other vessels remaining at the Site should be collected and consolidated in designated Site areas and those no longer required should be disposed of at an approved facility.
- The scrap steel and debris, particularly in the lower laydown area and observed to be present in fill materials around the shoreline and ditching to the southwest of the lower laydown area, should be removed from the Site and disposed of at approved facilities.
- If existing buildings are to remain, an inspection of the existing septic sewer systems should be completed to ensure discharges meet provincial regulations.
- Any ozone depleting substance (ODS) containing equipment or PCB containing light ballasts remaining at the Site should be disposed of in accordance with the applicable regulations.
- Although the underground fuel distribution lines on Site were documented to be drained, purged, capped and abandoned in place in 2000 and petroleum hydrocarbon impacts were not found along the pipelines in 2000, regulatory approval is required. This should be included in any future submissions for regulatory closure of the Site.



3. Site Reconnaissance

On September 28, 2018, GHD conducted a Site walkthrough to locate and identify previously installed monitor wells at the Site prior to the drilling program. Based on information provided to GHD, there were 14 monitor wells and five recovery wells previously installed on the Site. Following the Site inspection, GHD personnel located four of the 14 previously installed monitor wells (MW-7, MDSA-MW9, MGSB-MW15 and MGSB-MW17) and two recovery wells (RW1 and RW2) located near the main administration and security office building. All monitor wells and recovery wells appeared to be in good condition. The surrounding areas adjacent to RW1 and RW2 were found to be overgrown with vegetation; however, a visual inspection revealed the recovery wells were sealed with metal covers and contained groundwater. Based on the observations and depths to groundwater, the recovery wells appeared to be functioning in an active capacity. Site photographs are included in Appendix A.

In addition to an inspection of the previous monitor wells, GHD also completed a safety inspection to determine the location of underground services, most notably underground services in areas of the proposed drilling program as well as document any signs of underground storage tanks (USTs), surface staining and/or general debris discussed in the previous ESA reports. Based on the Site inspection, it was determined that a number of proposed locations would require the use of a private locating subcontractor to clear areas prior to completing the subsurface drilling program. No surface soil staining or observations of fill/vent pipes associated with USTs were noted. Various steel and other debris was stored on Site, particularly in the lower laydown area as well as observed to be present in fill materials around the shoreline and ditching located along the southwest edge of the lower laydown area.

Following the initial Site walkthrough, a GHD representatives completed a secondary Site reconnaissance on December 12 and 13, 2018, to obtain information on the local community utilization of the waterlot portion of the Site and to collect biological tissue and surface water samples from the waterlot. At this time, several interviews were conducted with municipal representatives as well as local fishermen and residents that utilize the waterlot and were present at the Site during the December 2018 Site investigation. A summary of the major findings from the interview are presented below.

- There are no beaches located within the waterlot and swimming does not occur within the waterlot.
- A scallop bed is reportedly located within the Mortier Bay and commercial shellfish (scallops)
 harvesting does occur within the bay in the vicinity of the Site waterlot.
- Fishing generally does not occur within the Site waterlot but residents reported that fishing from the Transport Canada wharf located directly north of the Site does occur occasionally. Fish harvested from the Transport Canada wharf was reported to generally be limited to migratory sea trout.
- Approximately 250 metres northeast of the waterlot, a small quantity of lobster is commercially harvested within Mortier Bay and pot lines continue to extend northeast following the shoreline.
- Small recreational boats traverse the waterlot during the summer months.



• There are no municipal storm sewer or sanitary discharges located within the waterlot. However, Site related sanitary discharges as well as other effluents may discharge to the waterlot.

4. Supplemental Phase II Environmental Site Assessment (ESA)

The field work associated with the Supplemental Phase II ESA program was completed between October and December 2018, and involved the following:

- The advancement of 41 boreholes, of which 12 were installed as monitor wells, using a
 geotechnical drill rig.
- Continuous sampling of soil from the boreholes and submission of select samples for chemical analyses.
- A Site survey completed by Gary Templeton Surveys Ltd which included the collection of GPS coordinates of the new borehole/monitor well locations, existing monitor wells, existing recovery wells and selected Site features.
- Gauging for the presence of free phase product and sampling of groundwater from each monitoring well (new and pre-existing) as well as all recovery wells located on Site.
- Collection of 18 sediment samples in the area of the wharf structures referred to as the waterlot (including 3 step-out samples) and three reference sediment samples collected outside the Marystown Shipyard property boundary in Mortier Bay.
- Collection of seven sediment samples from the waterlot and one sample from a reference area for benthic invertebrate taxonomic evaluation. The benthic invertebrate sample locations were co-located with the bulk sediment samples collected for chemical characterization.
- Collection of 12 benthic invertebrate samples from the waterlot and three samples from the
 reference area for chemical analysis of invertebrate tissue. The intended scope of work for the
 project also included the collection of fish from the waterlot and reference areas for tissue
 analysis but fish were not observed to be present in the waterlot at the time of sampling.
- Collection of five surface water samples from the waterlot and two samples from the reference area for selected chemical analysis.

It is noted that due to time constrictions, physical impairments (i.e. rock cliffs, Site buildings, shorelines, etc.), surface covering at the Site (i.e. asphalt and/or concrete) and the shallow soil conditions encountered during the drilling program, it was decided to complete boreholes in place of the delineation test pits proposed for the Site. If visual or olfactory observations revealed soil and/or groundwater impacts, additional boreholes were completed to delineate impacts, were applicable.

A photographic log of the 2018 Supplemental Phase II ESA activities is presented in Appendix A. A Site plan with the soil and groundwater sample locations is shown as Figure 3. Site plans showing the sediment sample locations from the waterlot and the reference area are shown on Figures 4A and 4B; respectively. The surface water sample locations as well as the benthic invertebrate community samples are also included on Figures 4A and 4B.



4.1 Soil

4.1.1 Borehole Program

During the period of October 2 to 10, 2018, a total of 41 boreholes with 12 completed as monitor wells were advanced using a geotechnical drill rig. The borehole/monitor well locations are identified on Figure 3. It is noted that GHD personnel located four existing monitor wells (MW7, MDSA-MW9, MGSB-MW15 and MGSB-MW17) during the Site reconnaissance program. As a result, the monitor wells proposed in these locations were changed to boreholes to allow for collection of soil samples in these areas.

The boreholes were constructed to further characterize and delineate the areas of petroleum hydrocarbon and/or metal impacted soil historically identified on the Site. The boreholes were advanced to depths ranging from 1.8 metres to 5.1 metres below ground surface. The borehole logs are included in Appendix B.

4.1.2 Borehole Location Survey

As part of the Supplemental Phase II ESA, the borehole locations were surveyed by Gary Templeton Surveys Ltd. The GPS coordinates for the newly constructed and existing monitor wells are provided in Table 1 and/or in the borehole logs included in Appendix B.

4.1.3 Soil Sampling Program

The following acronyms were used to describe the sample locations:

- MSBL = Marystown Shipyard Service Building
- MLLA = Marystown Shipyard Lower Laydown Area
- MASO = Marystown Shipyard Main Administration and Security Office
- MAEB = Marystown Shipyard Assembly and Erection Building
- MGSB = Marystown Shipyard General Stores Building
- MDSA = Marystown Shipyard Drum Storage Area
- MFPA = Marystown Shipyard Fuel Pump Area
- MNMA = Marystown Shipyard Nearshore Marine Area
- 2018 = 2018 (year of sampling)
- MW = monitor well
- BH = borehole
- SS = soil sample

Hence, the sample designation MSBL-MW1-2018-SS1 refers to the first soil sample collected from monitor well 1 location at the Marystown Shipyard Service Building (MSBL) in 2018.

Soil samples were collected from each borehole on a continuous basis (0.6 m intervals) where possible. Select soil samples submitted for benzene, toluene, ethyl benzene, xylenes (BTEX) and total petroleum hydrocarbon (TPH) fraction (C_6 - C_{10}) analysis were measured using a 10 mL Terra CoreTM Sampler to collect an approximate 10 gram soil core. The soil core was immediately field preserved by placing it into a 40 mL clear glass vial containing 10 mL of purge and trap grade



methanol. Samples collected for modified (m) TPH ($>C_{10}-C_{32}$) and metal analysis were collected with zero headspace in glass jars with Teflon lined lids. All sample containers were supplied by the laboratory.

The sample containers intended for laboratory analysis were maintained in cool dark storage for shipment to the laboratory. Samples not submitted for laboratory analysis were archived for potential future analysis.

To minimize the potential for cross-contamination, all sampling equipment was thoroughly rinsed between each sampling event. Disposable nitrile gloves were worn during all sampling work.

The soil analytical results are discussed below.

4.1.4 Quality Assurance/Quality Control (QA/QC) Sampling Program

The Quality Assurance/Quality Control (QA/QC) Program consisted of the collection of duplicate samples, cleaning of sampling equipment between each sampling event location, and the use of new nitrile gloves for each sample.

All soil samples collected during the sampling program were assigned a unique sample identification, logged onto a chain-of-custody form, placed inside a cooler on ice and transported to AGAT Laboratories (AGAT) for analysis. AGAT is certified by Canadian Association of Laboratory Accreditation (CALA).

Duplicate samples were collected where possible during the soil sampling program for the Site. One blind field duplicate (MAEB-MW2-2018-DUP01) of MAEB-MW2-2018-SS4 was collected during the field program that was analyzed for petroleum hydrocarbons. It is noted that field duplicates were limited based on low recoveries encountered in the split spoon sampler during the borehole drilling program.

4.2 Groundwater

As noted above, GHD conducted a Site walkthrough to locate and identify previously installed monitor wells and/or recovery wells at the Site prior to the drilling program. GHD personnel located four existing monitor wells (MW7, MDSA-MW9, MGSB-MW15 and MGSB-MW17) and two recovery wells (RW1 and RW2) located near the main administration and security office building prior to the 2018 drilling program. All monitor wells and recovery wells appeared to be in good condition and were functioning in an active capacity at the time of the field program.

4.2.1 Fluid Level Gauging/Surveying

Water level measurements, including direct measurement of any existing light non-aqueous phase liquids (LNAPLs, or free product, if present) were conducted prior to sampling, this information is presented in Table 1. Groundwater level measurements were carried out using an oil/water interface probe (Solinst Model 122). Gauging was conducted on October 11, 2018 and October 26, 2018 by lowering the clean probe down into each monitor well and/or recovery well until a tone was obtained indicating a liquid had been contacted. The depth at which a tone was first sounded was then carefully noted to the nearest millimeter (mm). Each newly installed monitor well was surveyed



in relation to an assumed elevation benchmark by Gary Templeton Surveys Ltd. Using this information, the groundwater elevations relative to the Site were determined. Free phase product was not identified in any of the gauged monitor wells during the field program.

4.2.2 Groundwater Sampling

The newly constructed wells and the pre-existing wells were monitored on October 11, 2018 and sampled on October 12, 2018. The two previously installed recovery wells were also monitored and sampled on October 26, 2018. The monitoring included measurements of water levels, and the presence or absence of free phase product.

The depth to the water table and presence or absence of free product in the wells were determined with a Solinst electronic interface probe that was cleaned with a non-toxic, biodegradable cleaner/degreaser, then rinsed with clean tap water, between monitoring wells.

If measurable free product is observed in any well, a groundwater sample is not collected from that well. However, groundwater samples are collected from wells if petroleum hydrocarbon sheen is observed.

The monitor wells were then developed by removing three well volume equivalents of groundwater prior to sample collection. The monitor wells were allowed to recover and sampled using dedicated, disposable bailers. The groundwater samples were collected in laboratory supplied bottles and placed in coolers with ice immediately after they were collected and forwarded to AGAT for analyses of BTEX/TPH and/or metals.

4.3 Sediment

October 19, 2018, a total of 15 sediment samples were collected adjacent to the shoreline and wharf area located near the Marystown Shipyard, referred to as the waterlot. Three reference samples were also collected approximately 1,000 and 1,200 metres to the east of the Shipyard waterlot in Mortier Bay. Between December 12 and 13, 2018, additional sediment samples were collected at three locations immediately adjacent to the waterlot boundary and referred to as "step-out" samples. In addition to the step-out sediment samples for chemical characterization, selected sediment sample locations were also resampled from the waterlot and reference area for benthic invertebrate taxonomic evaluation. The sediment samples collected for benthic community characterization were co-located with bulk sediment samples collected for chemical characterization during the October sampling event. Site plans showing all sediment sample locations and GPS coordinates are presented on Figure 4A (Waterlot) and Figure 4B (Reference).

Professional divers, Sparkes Subsea Construction (Sparkes) from Corner Brook, NL were hired by GHD to collect the sediment samples at predetermined locations. In addition to collection sediment samples, Sparkes also recorded descriptions, videos and photos of the sediment samples being collected, bottom substrate and general aquatic habitat for each sample location.

A summary of the substrate, macrofauna and macroflora observed at each sample location in the Harbour and reference locations is provided in Table 4-1. Biota listed in the referenced table includes biota reportedly observed by diver, biota observed by GHD staff during sediment sample processing as well as biota observed during the review of the diver video. Identification was



dependent on quality of video and prominence of identifying characteristics. Sedentary and mobile fauna were enumerated where possible and estimated for abundancy as follows:

- Abundant Numerous observations of individuals made throughout the entire section.
- Common Numerous observations of individuals made intermittently along the section.
- Occasional Quantifiable observations of individuals made intermittently along the section.
- Uncommon Quantifiable observations of individuals made infrequently along the section.

Based on Simkanin et al. (2005) Abundant, Common, Frequent, Occasional and Rare (ACFOR) scale.

Photos and video footage were collected and utilized to describe flora/fauna and substrate conditions at each sample location (refer to Table 4-1 and Diver's Reports in Appendix H).

4.3.1 Sediment Sampling

Chemical Analysis

Fifteen sediment samples (18-MNMA-SS1 to 18-MNMA-SS15), three step-out samples (18-MNMA-STEP1 to 18-MNMA-STEP3) and three reference sediment samples (18-MNMA-REF1 to 18-MNMA-REF3) were collected from the top 0.10 metres of the sediment encountered at the pre-selected sample locations.

All sediment samples collected including the reference samples were analyzed for petroleum hydrocarbons, PAHs, metals, PCBs, and fraction of organic carbon (FOC). Several of the sediment samples collected were also submitted for metals leachate analysis. All samples were submitted to AGAT in St. John's, NL for analysis.

All sediment samples collected during the sampling program were logged onto a chain-of-custody form, placed inside a cooler on ice and transported to the laboratory for analysis. As required, standard equipment decontamination procedures were followed to prevent or minimize cross-contamination.

Benthic Invertebrate Taxonomic Evaluation

A total of 7 sediment samples were collected from the waterlot for benthic invertebrate taxonomic evaluation (18-MNMA-BMI1, 18-MNMA-BMI3, 18-MNMA-BMI5, 18-MNMA-BMI6, 18-MNMA-BMI11, 18-MNMA-BMI12, and 18-MNMA-BMI14). One sediment from the reference area (18-MNMA-BMI-REF2) was also collected for benthic invertebrate taxonomic evaluation. The samples collected for benthic invertebrate evaluation were co-located with the bulk sediment samples collected for chemical characterization. Samples were collected by certified divers in 10 litre (L) plastic pails with sealable lids and brought to surface. GHD washed the samples in the field using a 0.5 millimetre (mm) sieve screen to remove fines and reduce the volume of sediment requiring preservation and subsequent sorting by the taxonomist. The washed sediment was transferred to 1 L glass mason jars and preserved in the field using a 10% buffered formalin solution. The preserved samples were then submitted to Dr. Mike Dadswell in Chester, NS, for taxonomic identification and enumeration.



4.3.2 Quality Assurance/Quality Control (QA/QC) Sampling Program

The QA/QC Program consisted of the collection of duplicate samples, cleaning of sampling equipment between each sampling event/location, and the use of new nitrile gloves for each sample.

All sediment samples collected during the sampling program were assigned a unique sample identification, logged onto a chain-of-custody form, placed inside a cooler on ice, and transported to the laboratory for analysis.

Duplicate samples were collected at a 10% frequency for the entire sediment sampling program for the Site. Three blind field duplicate (18-MNMA-DUP1, 18-MNMA-DUP2 and 18-MNMA-DUP3) of 18-MNMA-S6, 18-MNMA-S11 and 18-MNMA-STEP3; respectively, were collected during the field program that were analyzed for petroleum hydrocarbons, PAHs, metals, PCBs, and FOC.

Table 4-1 Sediment Sample Location Descriptions and Biota Observed

Comple ID	Water Depth	or o occidinates		Description	Biota Observed
Sample ID	(metres)	Latitude	Longitude	(sediment substrate)	Biota Observed
			Waterlot		
18-MNMA-S1	14	47° 9' 49.22"	55° 8' 58.71"	Brown Silt with Gravel over Black Mud, , Shell Debris, Plastic Bag, Glass Bottle	Periwinkles (occ.), Rock Crab, Scallops (r.), Sea Star (r.), Eel Grass (com.), Tubed Weed (com.), Kelp (com.), Coraline Algae (occ.)
18-MNMA-S2	14	47° 9' 50.39"	55° 8' 57.95"	Brown Silt with Gravel over Black Mud, Shell Debris	Periwinkles (r.), Rock Crab, Scallops (r.), Sea Star (r.), Eel Grass (occ.), Tubed Weed (com.), Kelp (com.), Coraline Algae (com.)
18-MNMA-S3	25	47° 9' 51.42"	55° 8' 57.38"	Brown Silt over Black Mud, Shell Debris	Periwinkles (occ.), Scallops (r.), Sea Star (r.), Eel Grass (r.), Tubed Weed (com.), Kelp (com.)
18-MNMA-S4	31	47° 9' 51.77"	55° 8' 55.90"	Brown Silt over Black Mud	Periwinkles (r.), Rock Crab, Sea Star (r.), Scallops (r.), Eel Grass (r.), Tubed Weed (occ.), Kelp (com.), Coralline Algae (occ.)
18-MNMA-S5	23	47° 9' 50.82"	55° 8' 54.92"	Brown Silt with Minor Gravel over Black Mud, Aluminum Can, Shell Debris	Periwinkles (r.), Rock Crab, Scallops (r.), Sea Star (r.), Eel Grass (r.), Tubed Weed (r.), Kelp (com.), Coraline Algae (com.)
18-MNMA-S6	32	47° 9' 51.27"	55° 8' 53.71"	Brown Silt with minor Gravel over Black Mud, Old Metal Grate, Shell Debris, Old Plastic Fish Tote	Periwinkles (r.), Rock Crab, Scallops (r.), Sea Star (r.), Sea Cucumber (r.), Eel Grass, Tubed Weed (r.), Kelp (com.), Coral (r.), Coraline Algae (occ.)
18-MNMA-S7	30	47° 9' 50.29"	55° 8' 52.52"	Brown Silt with gravel over Black Mud, Shell Debris	Periwinkles (occ.), Sea Star (r.), Rock Crab (r.), Scallops (r.), Tubed Weed (r.), Kelp (occ.), Coraline Algae (com.)



Table 4-1 Sediment Sample Location Descriptions and Biota Observed

0 1 10	Water	Ci C Coolainateo		Description		
Sample ID	Depth (metres)	Latitude	Longitude	(sediment substrate)	Biota Observed	
18-MNMA-S8	30	47° 9' 50.86"	55° 8' 51.26"	Sand/Gravel, Shell Debris	Periwinkles (occ.), Rock Crab, Jellyfish (occ.), Mussels, Knotted Wrack (com.), Tubed Weed (r.), Coraline Algae (occ.)	
18-MNMA-S9	28	47° 9' 49.88"	55° 8' 50.59"	Sand/Gravel, Shell Debris	Hermit Crab (r.), Periwinkles (r.), Sea Star (r.), Mussels, Jellyfish (occ.), Rock Crab, Kelp (r.), Knotted Wrack (r.)	
18-MNMA-S10	36	47° 9' 51.81"	55° 8' 52.22"	Black Mud, Shell Debris, Glass Bottle, Aluminum Can	Scallops (r.), Sea Star (occ.), Rock Crab, Kelp (com.), Sea Colander (occ.), Coraline Algae (occ.)	
18-MNMA-S11	22	47° 9' 51.57"	55° 8' 50.38"	Black Mud, Shell Debris	Mussels, Scallops, Sea Star (r.), Kelp (r.), Sea Colander (occ.), Coraline Algae (occ.), Coral (r.)	
18-MNMA-S12	32	47° 9' 52.60"	55° 8' 49.32"	Black Mud, Shell Debris	Mussels, Sea Star (r.), Scallops, Rock Crab, Kelp (r.), Sea Colander (r.), Coral (r.), Coraline Algae (com.)	
18-MNMA-S13	33	47° 9' 53.17"	55° 8' 51.40"	Black Mud, Shell Debris, Aluminum Cans, Building Material Debris	Scallops, Sea Star (com.), Rock Crab (r.), Kelp (com.), Edible Kelp (occ.), Tubed Weed (occ.), Coraline Algae (occ.), Coral (occ.)	
18-MNMA-S14	32	47° 9' 53.61"	55° 8' 53.53"	Black Mud, Shell Debris, Metal Debris, Macro Algal Debris	Scallops, Rock Crab, Sea Star (occ.), Rockweed (r.), Kelp (occ.), Coraline Algae (occ.), Coral (r.), Sea Anemone (r.)	
18-MNMA-S15	32	47° 9' 54.03"	55° 8' 55.23"	Black Mud, Glass Bottle	Rock Crab (r.), Periwinkle, Sea Urchin (r.), Sea Star (occ.), Scallops, Eel Grass (r.), Brown Seaweed occ.), Tube Weed (r.), Kelp (occ.), Coral (r.), Coraline Algae (r.)	
Step-Out						
18-MNMA-STEP1	25	47° 9' 49.81"	55° 8' 54.01"	Grey Sand/Gravel, Shell Debris	Scallops (r.), Mussels (occ.), Sea Star (r.), Periwinkles (occ.), Tubed Weed (occ.), Rock Weed (occ.), Coral (r.), Coraline Algae (com.)	
18-MNMA-STEP2	25	47° 9' 51.02"	55° 8' 48.70"	Black Mud/Sand, Shell Debris	Mussels, Scallops, Hermit Crab (r.) Periwinkles (occ.), Sea Star (r.), Rock Weed (r.), Kelp (r.), Coraline Algae (com.), Coral (r.)	



Table 4-1 Sediment Sample Location Descriptions and Biota Observed

O-mala ID	Water Depth	GPS Coordinates		Description	Dieta Observed
Sample ID	(metres)	Latitude	Longitude	(sediment substrate)	Biota Observed
18-MNMA-STEP3	35	47° 9' 53.94"	55° 8' 50.93"	Black Mud/Sand, Macro Algal Debris, Aluminum Can	Scallops (occ.), Periwinkles (occ.), Mussels, Hermit Crab (r.), Rock Weed (r.), Kelp (occ.), Coraline Algae (occ.), Sea Colander (r.)
		В	ackground/Ref	erence	
18-MNMA-REF1	25	47° 10' 06.80"	55° 7' 40.10"	Grey Sand/Gravel, shell debris, glass bottle	Periwinkle (occ.), Scallops (r.), Common Sea Star (r.), Rock Crab (r.), Brown Seaweed (r.), Eel Grass (com.), Knotted Wrack (r.), Tubed Weed (occ.), Kelp (r.), Coralline algae (com.)
18-MNMA-REF2	10	47° 10' 06.50"	55° 7' 46.60"	Grey Sand/Gravel	Periwinkles (occ.), Scallops (r.), Eel Grass (abu.), Kelp (occ.), Tubed Weed (com.), Coraline Algae (com.), Sea Star (occ.)
18-MNMA-REF3	30	47° 10' 21.9"	55° 8' 10.40"	Grey Sand, shell debris	Scallops (r.), Mussels (r.), Jellyfish (r.), Tubed Weed (com.), Kelp (r.), Coraline Algae (com.)

abu. – Abundant com. – Common occ. – Occasional r. - Rare

4.4 Biological Tissue

Samples of benthic invertebrates, specifically bivalve mollusks (e.g., mussels and scallops), were also to be collected from each bulk sediment sample location within the waterlot and at each reference location (if present) for potential chemical analysis. Consistent with the information obtained during the Site reconnaissance, scallops were present throughout the waterlot and collected for analysis. Rock crab and mussels were also observed at several waterlot and reference locations and collected for potential chemical analysis. The invertebrate samples were collected by Sparkes and provided to GHD for subsequent processing. Fish were not observed to be present in the waterlot at the time of the sampling program and, therefore, fish tissue samples could not be collected for chemical analysis.

Table 4-2 identifies the tissue samples collected at each bulk sediment sample location. A total of 15 invertebrate tissue samples were selected for chemical analysis and are outlined below:

Crab

- 18-MNMA-TIS-Comp1 - Composite of crab samples collected from sample locations 18-MNMA-S1, 18-MNMA-S2 and 18-MNMA-S4



- 18-MNMA-TIS-Comp2 Composite of crab samples collected from sample locations
 18-MNMA-S5, 18-MNMA-S6, 18MNMA-S7, 18-MNMA-S8, 18-MNMA-S9 and 18-MNMA-S10
- 18-MNMA-TIS-Comp3 Composite of crab samples collected from sample locations 18-MNMA-S12, 18-MNMA-S13, 18-MNMA-S14, and 18-MNMA-S15
- 18-MNMA-TIS-REF1B Composite of crab samples collected from reference location 18-MNMA-REF1

Mussels

- 18-MNMA-TIS-Comp4 Composite of mussel samples collected from sample locations
 18-MNMA-S8 and 18-MNMA-S9
- 18-MNMA-TIS-REF3B Composite of mussel samples collected from Reference Location 18-MNMA-REF3

Scallops

- A total of nine samples submitted for analysis from the following locations:
 - 18-MNMA-TIS1A collected from sediment sample location 18-MNMA-S1
 - 18-MNMA-TIS3 collected from sediment sample location 18-MNMA-S3
 - 18-MNMA-TIS5A collected from sediment sample location 18-MNMA-S
 - 18-MNMA-TIS6A collected from sediment sample location 18-MNMA-S6
 - 18-MNMA-TIS10A collected from sediment sample location 18-MNMA-S10
 - 18-MNMA-TIS11 collected from sediment sample location 18-MNMA-S11
 - 18-MNMA-TIS12A collected from sediment sample location 18-MNMA-S12
 - 18-MNMA-TIS14A collected from sediment sample location 18-MNMA-S14
 - 18-MNMA-REF3A collected from sediment sample location 18-MNMA-REF3

For the scallop and mussel samples, within 48 hours of the collection, the soft tissue from the scallops and mussels were removed and frozen at GHD's St. John's office. Selected frozen tissue samples were subsequently submitted for selected laboratory analysis. The crab samples collected were frozen whole at GHD's office. Crab samples selected for chemical analysis were shipped to the laboratory whole and the soft tissue extracted at the laboratory for chemical analysis. The selected tissue samples were analyzed for PAHs, metals, PCBs and lipids. All samples were submitted to AGAT in St. John's, NL for analysis.

Table 4-2 Invertebrate Tissue Summary

Location	Sample ID	Method	Species	Quantity	Weight (g)	Submitted for Analysis
18-MNMA-S1	18-MNMA-TIS1A	Diver	Sea Scallop	3	Shucked - 343	Yes
10-IVIIVIVIA-31	18-MNMA-TIS1B	Divei	Rock Crab	1	Whole - 164	Composite
18-MNMA-S2	18-MNMA-TIS2A	Diver	Sea Scallop	3	Shucked - 239	No
10-IVIINIVIA-32	18-MNMA-TIS2B	Divei	Rock Crab	1	Whole - 260	Composite
18-MNMA-S3	18-MNMA-TIS3	Diver	Sea Scallop	3	Shucked - 270	Yes



Table 4-2 Invertebrate Tissue Summary

Location	Sample ID	Method	Species	Quantity	Weight (g)	Submitted for Analysis
18-MNMA-S4	18-MNMA-TIS4A	Diver	Sea Scallop	2	Shucked - 138	No
10-IVIINIVIA-34	18-MNMA-TIS4B	Divei	Rock Crab	1	Whole - 249	Composite
18-MNMA-S5	18-MNMA-TIS5A	Diver	Sea Scallop	3	Shucked - 402	Yes
10-IVIIVIVIA-33	18-MNMA-TIS5B	Divei	Rock Crab	1	Whole - 98	Composite
18-MNMA-S6	18-MNMA-TIS6A	Diver	Sea Scallop	2	Shucked - 136	Yes
10-IVIIVIVIA-30	18-MNMA-TIS6B	DIVE	Rock Crab	1	Whole - 218	Composite
18-MNMA-S7	18-MNMA-TIS7A	Diver	Sea Scallop	2	Shucked - 325	No
10-IVIINIVIA-37	18-MNMA-TIS7B	Divei	Rock Crab	1	Whole - 212	Composite
	18-MNMA-TIS8A		Sea Scallop	2	Shucked - 33	No
18-MNMA-S8	18-MNMA-TIS8B	Diver	Horse Mussel	4	Shucked - 115	Composite
	18-MNMA-TIS8C		Rock Crab	1	Whole - 201	Composite
18-MNMA-S9	18-MNMA-TIS9A	Diver	Horse Mussel	1	Shucked - 40	Composite
	18-MNMA-TIS9B		Rock Crab	1	Whole - 101	Composite
10 MNIMA C10	18-MNMA-TIS10A	Diver	Sea Scallop	3	Shucked - 351	No
18-MNMA-S10	18-MNMA-TIS10B	Divei	Rock Crab	1	Whole - 286	Composite
18-MNMA-S11	18-MNMA-TIS11	Diver	Sea Scallop	3	Shucked - 355	Yes
18-MNMA-S12	18-MNMA-TIS12A	Divor	Sea Scallop	3	Shucked - 435	Yes
10-IVIINIVIA-3 12	18-MNMA-TIS12B	Diver	Rock Crab	1	Whole - 126	Composite
18-MNMA-S13	18-MNMA-TIS13A	Diver	Sea Scallop	2	Shucked - 350	No
10-IVIINIVIA-3 13	18-MNMA-TIS13B	Divei	Rock Crab	1	Whole - 178	Composite
18-MNMA-S14	18-MNMA-TIS14A	Diver	Sea Scallop	3	Shucked - 384	Yes
10-IVIINIVIA-3 14	18-MNMA-TIS14B	DIVE	Rock Crab	1	Whole - 228	Composite
	18-MNMA-TIS15A		Sea Scallop	3	Shucked - 141	No
18-MNMA-S15	18-MNMA-TIS15B	Diver	Horse Mussel	4	Shucked - 57	No
	18-MNMA-TIS15C		Rock Crab	1	Whole - 98	Composite
10 MAIMA DEE4	18-MNMA-TIS-REF1A	Divor	Sea Scallop	3	Shucked - 333	No
18-MNMA-REF1	18-MNMA-TIS-REF1B	Diver	Rock Crab	1	Whole - 98	Yes
18-MNMA-REF2	18-MNMA-TIS-REF2	Diver	Sea Scallop	2	Shucked - 210	No
	18-MNMA-TIS-REF3A		Sea Scallop	2	Shucked - 204	Yes
18-MNMA-REF3	18-MNMA-TIS-REF3B	Diver	Horse Mussel	3	Shucked - 105	Yes

4.5 Surface Water

Surface water samples were collected from various locations within the waterlot as well as the reference area in Mortier Bay. The surface water sample locations were spatial distributed across the waterlot in an effort to determine if storm water, groundwater or other discharges are adversely



affecting water quality within the waterlot. The surface water sample locations are shown on Figures 4A and 4B.

4.5.1 Surface Water Sampling

A total of five surface water samples (18-MNMA-W2, 18-MNMA-W6, 18-MNMA-W9, 18-MNMA-W12 and 18-MNMA-W14) plus a field duplicate sample (18-MNMA-W-DUP1) were collected from the waterlot as part of the sampling program completed at the Site between December 13 and 14, 2018. A total of two surface water samples were also collected from the reference area (18-MNMA-W-REF2 and 18-MNMA-W-REF3) for chemical analysis.

Surface water samples were collected in a dedicated polyethylene sampling container and transferred to laboratory supplied bottles for analysis of general chemistry, metals, PAHs and petroleum hydrocarbons. The surface water samples were collected using a boat supplied by Sparkes Subsea Construction and at a depth of approximately 0.5 metres below the water surface. All surface water samples were submitted to AGAT in St. John's, NL.

All surface water samples collected during the sampling program were logged onto a chain-of-custody form, placed inside a cooler on ice and transported to the laboratory for analysis. As required, standard equipment decontamination procedures were followed to prevent or minimize cross-contamination.

4.5.2 Quality Assurance/Quality Control (QA/QC) Sampling Program

The QA/QC Program consisted of the collection of duplicate samples, cleaning of sampling equipment between each sampling event/location, and the use of new nitrile gloves for each sample.

All surface water samples collected during the sampling program were assigned a unique sample identification, logged onto a chain-of-custody form, placed inside a cooler on ice, and transported to the laboratory for analysis.

Duplicate samples were collected at a 10% frequency for the entire surface water sampling program for the Site. One blind field duplicate (18-MNMA-DUP1) of 18-MNMA-W6, was collected during the field program and analyzed for petroleum hydrocarbons, PAHs, general chemistry and metals including mercury.

Results of Field Investigation

5.1 Soil

Soil samples were collected from the Shipyard Site in seven areas. The soil samples were analyzed for petroleum hydrocarbons and/or metals including mercury depending on past chemicals of concern identified in the sample areas. The soil samples were submitted to AGAT in St. John's, NL for analysis.

The soil sample locations are shown on Figure 3 and the Laboratory Certificates of Analysis are included as Appendix C.



5.1.1 Soil Analytical Data - Petroleum Hydrocarbons

Marystown Shipyard Service Building (MSBL)

Fourteen soil samples collected in the MSBL area from six boreholes (5 boreholes and 1 monitor well) reported non-detectable BTEX concentrations. Modified TPH concentrations ranged from non-detectable to 6,810 mg/kg (see Table 2). With the exception of one sample collected from MSBL-BH5-2018-SS6, the analytical results were below the Atlantic RBCA Tier I RBSL for a commercial property with non-potable groundwater and coarse-grained soil. All samples were below applicable Tier I ESLs.

Marystown Shipyard Lower Laydown Area (MLLA)

Eight soil samples collected in the MLLA from four boreholes (1 borehole and 3 monitor wells) reported non-detectable BTEX concentrations. Modified TPH concentrations ranged from non-detectable to 4,690 mg/kg (see Table 2). With the exception of one sample collected from MLLA-MW3-2018-SS7, the analytical results were below the Atlantic RBCA Tier I RBSL for a commercial property with non-potable groundwater and coarse-grained soil. All samples were below applicable Tier I ESLs.

Marystown Shipyard Fuel Pump Area (MFPA)

Nine soil samples collected in the MFPA from five boreholes (4 boreholes and 1 monitor well) reported non-detectable BTEX concentrations. Modified TPH concentrations ranged from non-detectable to 7640 mg/kg (see Table 2). With the exception of one sample collected from MFPA-MW1-2018-SS1, the analytical results were below the Atlantic RBCA Tier I RBSL for a commercial property with non-potable groundwater and coarse-grained soil. All samples were below applicable Tier I ESLs.

Marystown Shipyard Main Administration and Security Office (MASO)

Nine soil samples collected in the MASO area from four boreholes (3 boreholes and 1 monitor well) reported non-detectable BTEX concentrations and mTPH concentrations below the Atlantic RBCA Tier I RBSL and/or Tier I ESLs for a commercial property with non-potable groundwater and coarse-grained soil. See Table 2.

Marystown Shipyard Assembly and Erection Building (MAEB)

Six soil samples collected in the MAEB area from three boreholes reported non-detectable BTEX concentrations. Modified TPH concentrations ranged from non-detectable to 5230 mg/kg (see Table 2). With the exception of one sample collected from MEAB-MW2-2018-SS4, the analytical results were below the Atlantic RBCA Tier I RBSL for a commercial property with non-potable groundwater and coarse-grained soil. All samples were below applicable Tier I ESLs.

Marystown Shipyard Drum Storage Area (MDSA)

Fourteen soil samples collected in the MDSA from seven boreholes (5 boreholes and 2 monitor wells) reported non-detectable BTEX concentrations and mTPH concentrations below the Atlantic RBCA Tier I RBSL and/or Tier I ESLs for a commercial property with non-potable groundwater and coarse-grained soil. See Table 2.



Marystown Shipyard General Stores Building (MGSB)

Seven soil samples collected in the MGSB area from four boreholes reported non-detectable BTEX concentrations and mTPH concentrations below the Atlantic RBCA Tier I RBSL and/or Tier I ESLs for a commercial property with non-potable groundwater and coarse-grained soil.

The soil analytical data for all soil samples analyzed for petroleum hydrocarbons is included in Table 2. The Laboratory Certificates of Analysis are included as Appendix C.

5.1.2 Soil Analytical Data - Metals

Five areas of the Shipyard Site were assessed for metals including mercury. A total of 32 soil samples from 17 boreholes/monitor wells were analyzed for metals including mercury. The samples submitted for analyses from the MSBL area, MDSA, and MLLA were within the CCME SQGs for commercial land use. However, two soil samples; MFPA-BH3-2018-SS1 and MAEB-MW2-2018-SS2 collected from fuel pump area and the north side of the assembly and erection building reported chromium concentrations exceeding the CCME SQGs for commercial land use.

The soil analytical data for all soil samples analyzed for metals including mercury are included in Table 3. The Laboratory Certificates of Analysis are included as Appendix C.

5.1.3 Soil QA/QC Sampling Program

One field duplicate soil sample (DUP01) was collected from the same sample location of MAEB-MW2-2018-SS4, which was submitted for analysis of petroleum hydrocarbons. The field duplicate soil sample (DUP01) reported non-detectable concentrations of BTEX all of which were consistent with the parent sample. The field duplicate soil sample (DUP01) reported detectable concentrations of total petroleum hydrocarbons, with a calculated relative percent difference (RPD) between the two samples ranging from non-calculable due to low levels detected to 149%.

There are no firm guidelines for the degree of correlation expected between field duplicates and parent samples due to natural heterogeneity in soil type (e.g., grain size, clay fraction); however, the results are considered to be an acceptable duplicable correlation and therefore meet the objectives for this sampling program.

5.2 Groundwater

Groundwater samples were collected from the 12 newly installed monitoring wells, three existing monitoring wells and two recovery wells located in the assessed areas of the Shipyard Site. Groundwater samples were collected on October 12 and October 26, 2018 and submitted for BTEX/mTPH and/or metals analyses. All samples were submitted to AGAT in St. John's, NL for the specified analysis.

The groundwater sample locations are shown on Figure 3 and the Laboratory Certificates of Analysis are included as Appendix C.



5.2.1 Fluid Level Gauging/Surveying

Water level measurements were conducted on October 11 and October 26, 2018 prior to sampling. Free product was not identified in any of the gauged monitor wells during the field program. Measured groundwater depths ranged from 0.82 metres below top of riser (mbtr) at MASO-MW1-2018 to 2.62 mbtr at MSBL-MW6.

The interpreted groundwater elevations confirm the overall direction of groundwater flow for the Site is in the northeastern direction toward Mortier Bay.

5.2.2 Groundwater Analytical Data - Petroleum Hydrocarbons

Sixteen groundwater samples (MBSL-MW2-2018, MW-0 – field duplicate of MBSL-MW2-2018, MLLA-MW1- 2018, MFPA-MW1-2018, MASO-MW1, RW1, RW2, MAEB-MW1-2018, MAEB-MW2-2018, MDSA-MW3-2018, MDSA-MW9, MGSB-MW15, MW00-field duplicate of MGSB-MW15, and MGSB-17) were collected from the seven assessed areas of the Site.

The groundwater samples analyzed for petroleum hydrocarbons reported no detectable BTEX concentrations and therefore were within the Atlantic RBCA Tier I RBSLs for commercial land use, non-potable water and coarse-grained soil. Modified TPH concentrations were within the Atlantic RBCA Tier I RBSLs with the exception of the sample collected from MGSB-MW15 and its field duplicate.

The groundwater samples were also compared to the Atlantic RBCA Tier I Groundwater ESLs for Plants and Soil Invertebrate Direct Contact with Shallow Groundwater and Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type. The reported results were within these guidelines with the exception of two samples (MGSB-MW15 and MAEB-MW2-2018) that contained F2 hydrocarbon fractions exceeding the Tier I ESLs for Plant and Soil Invertebrates Direct Contact with Shallow Groundwater. Three groundwater samples (MW0 (field duplicate of MSBL-MW2-2018), MGSB-MW17, and MFPA-MW1-2018) contained mTPH concentrations exceeding the Tier I ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for a distance of 10 and 20 metres to the closest receiving body (i.e., Mortier Bay).

The groundwater analytical data for petroleum hydrocarbons is summarized in Table 4.

5.2.3 Groundwater Analytical Data - Metals

Six groundwater samples (MAEB-MW2-2018, MDSA-MW1-2018, MW000 – field duplicate of MDSA-MW1-2018, MLLA-MW2-2018, MLLA-MW3-2018 and MLLA-MW4-2018) including one field duplicate were collected from three areas of the Site: the assembly and erection building area, the drum storage area, and the lower laydown area. All five groundwater samples reported detectable metals concentrations for most analytes.

As there are no provincial guidelines for metals in groundwater in NL, the groundwater results were screening using the FIGQG Tier 2 for Marine Life Exposure Pathway. Exceedances of arsenic and copper were identified in all of the samples collected for analyses. Selenium exceeded in all but one sample (MAEB-MW2-2018) submitted for analyses. Zinc concentrations above the FIGQG were



present in all but two of the samples (MAEB-MW2-2018 and MLLA-MW3-2018) submitted for analyses.

The groundwater analytical data for metals is summarized in Table 5.

5.2.4 Groundwater QA/QC Sampling Program

Three field duplicate groundwater samples (MW0, MW00, and MW000) were collected from the sample locations MSBL-MW2-2018, MGSB-MW15, and MDSA-MW1-2018, which were submitted for analysis of BTEX/mTPH and/or metals.

The field duplicate groundwater samples reported detectable concentrations of mTPH, and metals with calculated RPDs ranging from non-calculable to 91% for the mTPH, and RPDs ranging from non-calculable to 29% for the metal parameters.

There are no firm guidelines for the degree of correlation expected between field duplicates and parent samples; however, the results are considered to be an acceptable duplicable correlation and therefore meet the objectives for this sampling program.

5.3 Sediment

Fifteen sediment samples (18-MNMA-S1 to 18-MNMA-S15) were collected from the waterlot of the Marystown Shipyard Site, three step-out samples were collected directly adjacent to the waterlot boundary (18-MNMA-STEP1 to 18-MNMA-STEP3) and three reference samples (18-MNMA-REF1 to 18-MNMA-REF3) were collected from Mortier Bay. The sediment samples were collected at a depth of zero to 0.10 metres.

The sediment samples were analyzed for petroleum hydrocarbons, metals including mercury, PAHs, PCBs and FOC. Several samples were also analyzed for metals leachate to provide data to support disposal options, if required. All samples were submitted to AGAT in St. John's, NL for chemical analysis.

In addition to chemical analysis, a total of seven samples collected from within the waterlot (18-MNMA-BMI1, 18-MNMA-BMI3, 18-MNMA-BMI5, 18-MNMA-BMI6, 18-MNMA-BMI11, 18-MNMA-BMI12, and 18-MNMA-BMI14) and one reference sample (18-MNMA-BMI-REF2) were also submitted to Dr. Mike Dadswell in Cheter, NS for benthic invertebrate taxonomic evaluation.

The sediment sample locations are shown on Figures 4A and 4B and the Laboratory Certificates of Analysis are included as Appendix C.

5.3.1 Sediment Analytical Data - Petroleum Hydrocarbons

The sediment samples analyzed for petroleum hydrocarbons were within the Atlantic RBCA Tier I Sediment ESL for Other Sediment Type. It is noted that the FOC values were used to calculate the applicable mTPH value for the Site up to a maximum level of 500 mg/kg. BTEX concentrations were not detected in the any of the sediment samples analyzed.

The sediment analytical data for petroleum hydrocarbons is summarized in Table 6.



5.3.2 Sediment Analytical Data - Metals

The sediment samples analyzed for metals including mercury were within the CCME ISQGs and PELs, with the exception of the following metals parameters:

- Arsenic CCME ISQGs exceeded in all of the sediment samples collected from the waterlot, step-out and reference areas. The CCME PELs were exceeded at sediment sample locations 18-MNMA-S12 and 18-MNMA-S13, located on the northeast corner of the waterlot but the step-out samples had concentrations of arsenic below CCME PELs.
- Cadmium CCME ISQGs exceeded at sample location 18-MNMA-DUP2, a field duplicate of 18-MNMA-S11 collected on the eastern side of the waterlot. The step-out samples had concentrations of cadmium below CCME ISQGs.
- **Chromium** CCME ISQGs exceeded at sample location 18-MNMA-S1 from southern corner of the waterlot. The step-out samples had concentrations of chromium below CCME ISQGs.
- Copper CCME ISQGs exceeded in all the sediment samples collected from the waterlot. One step-out sample (18-MNMA-STEP3 and the corresponding field duplicate) also had a concentration of copper exceeding CCME ISQG. The CCME PELs were exceeded in all of the waterlot sediment sample locations except 18-MNMA-S2, 18-MNMA-DUP1 (field duplicate of 18-MNMA-S6), 18-MNMA-S7, 18-MNMA-S8 and 18-MNMA-S10. The step-out samples had concentrations of copper below CCME PELs.
- Lead CCME ISQGs exceeded in all the sediment samples collected from the waterlot. One step-out sample (18-MNMA-STEP3 and the corresponding field duplicate) also had a concentration of lead exceeding CCME ISQG. The CCME PELs were also exceeded in all of the sediment sample locations with the exception of 18-MNMA-S10, and 18-MNMA-DUP2 (field duplicate of 18-MNMA-S11). The step-out samples had concentrations of lead below CCME PELs.
- Mercury CCME ISQGs exceeded at sample locations 18-MNMA-S1, 18-MNMA-S4 and 18-MNMA-S14 collected from the waterlot. The field duplicate of step-out sample 18-MNMA-STEP3 (18-MNMA-DUP3) also had a concentration of mercury exceeding CCME ISQG.
- Zinc CCME ISQGs exceeded in all the sediment samples collected from the waterlot. One step-out sample (18-MNMA-STEP3 and the corresponding field duplicate) also had a concentration of zinc exceeding CCME ISQG. The CCME PELs were also exceeded in all of the sediment sample locations with the exception of 18-MNMA-S2. The step-out samples had concentrations of zinc below CCME PELs.

The sediment analytical data for metals are summarized in Table 7.

5.3.3 Sediment Analytical Data - PAHs

The sediment samples analyzed for PAHs from the waterlot exceeded the CCME ISQGs in all of the samples analyzed for nine or more of the 13 PAH parameters having established guidelines. The CCME PELS were also exceeded in one or more of the PAH parameters having established guidelines in all of the samples analyzed from the waterlot with the exception of two samples (18-MNMA-S7 and 18-MNMA-S11).



Two of the three step-out samples collected had concentrations of PAHs below CCME ISQGs and PELs. Step-out sample location 18-MNMA-STEP3 (and the corresponding field duplicate) had concentrations of ten PAH parameters exceeding applicable CCME ISQGs. However, concentrations of PAHs in step-out sample 18-MNMA-STEP3 were below CCME PELs excluding a minor exceedance of phenanthrene.

The samples collected from the reference area were within the CCME ISQGs and PELs.

The sediment analytical data for PAHs are summarized in Table 8.

5.3.4 Sediment Analytical Data - FOCs

The sediment samples were analyzed for FOC, the average FOC for the sediment samples collected from the waterlot is 0.1074. The FOC data was used for the interpretation of the hydrocarbon data as noted above. The average FOC for the samples collected from the reference area is 0.038. The sediment analytical data for FOC is summarized in Table 9.

5.3.5 Sediment Analytical Data - PCBs

The sediment samples reported detectable PCB concentrations above the CCME ISQGs for a marine receptor in all but five of the 15 sediment samples analyzed from the waterlot. The CCME PELs were exceeded in three of the sediment samples (18-MNMA-S3, 18-MNMA-S6 and 18-MNMA-S12) analyzed from the waterlot.

The step-out and reference area samples collected and analyzed did not contain detectable PCB concentrations.

The sediment analytical data for PCBs is summarized in Table 10.

5.3.6 Sediment QA/QC Sampling Program

Three field duplicate sediment samples (18-MNMA-DUP1, 18-MNMA-DUP2 and 18-MNMA-DUP3) were collected from the sample locations 18-MNMA-S6, 18-MNMA-S11 and 18-MNMA-STEP3; respectively, which were submitted for analysis of BTEX/mTPH, metals including mercury, PCBs and PAHs. Two field duplicates were also submitted for FOC analysis. The field duplicate sediment samples reported non-detectable concentrations of BTEX, and PCBs, all of which were consistent with the parent samples with the exception of PCBs that were detected at 18-MNMA-S6.

The field duplicate sediment samples reported detectable concentrations of mTPH, metals, FOC and PAHs, with calculated RPDs of non-calculable to 90% for the mTPH, RPD ranging from non-calculable to 116% for the metal parameters, RPD ranging from 0% to 39% for the FOC and RPD ranging from non-calculable to 145% for the PAH parameters.

There are no firm guidelines for the degree of correlation expected between field duplicates and parent samples due to natural heterogeneity in sediment type (e.g., grain size, clay fraction); however, the results are considered to be an acceptable duplicable correlation and therefore meet the objectives for this sampling program.



5.4 Tissue

A total of three composite crab tissue samples (18-MNMA-TIS-Comp1, 18-MNMA-TIS-Comp2 and 18-MNMA-TIS-Comp3), one composite mussel tissue sample (18-MNMA-Comp4) and eight scallop tissue samples (18-MNMA-TIS1A, 18-MNMA-TIS3, 18-MNMA-TIS5A, 18-MNMA-TIS6A, 18-MNMA-TIS10A, 18-MNMA-TIS11, 18-MNMA-TIS12A, and 18-MNMA-TIS14A) were submitted for chemical analysis as part of the sampling program. A total of three invertebrate tissue samples collected from the reference area were also submitted for chemical analysis (18-MNMA-TIS-REF1B (composite crab sample), 18-MNMA-TIS-REF3B (composite mussel sample) and 18-MNMA-REF3A (scallop sample).

The tissue samples were analyzed for metals, PAHs, PCBs and lipids. All samples were submitted to AGAT in St. John's, NL for chemical analysis.

The Laboratory Certificates of Analysis are included as Appendix C.

5.4.1 Tissue Analytical Data - Metals

The tissue samples collected from the waterlot and reference area did not have detectable concentrations of mercury as well as several other parameters. Detectable concentrations of metals in the waterlot and reference tissue samples were generally limited to aluminum, arsenic, boron, cadmium, copper, iron, lead, manganese, selenium, strontium, vanadium and zinc.

The tissue analytical data for selected metals are summarized in Table 11.

5.4.2 Tissue Analytical Data - PAHs

The tissue samples collected from the waterlot and reference area had detectable concentrations of several individual PAH parameters. However, the concentrations of PAHs detected in the tissue samples collected from the waterlot were generally equal to or below the concentrations of PAHs observed in the reference area samples.

The tissue analytical data for PAHs is summarized in Table 12.

5.4.3 Tissue Analytical Data - PCBs

The tissue samples collected from the waterlot and reference area had concentrations of PCBs below laboratory detection limits.

The tissue analytical data for PCBs is summarized in Table 13.

5.4.4 Tissue Analytical Data - Lipids

The tissue samples collected from the waterlot and reference area had lipid contents ranging from 0.22 to 1.97%. The tissue analytical data for lipids is included in the Laboratory Certificates of Analysis of Appendix C.

5.5 Surface Water

A total of five surface water samples (18-MNMA-W2, 18-MNMA-W6, 18-MNMA-W9, 18-MNMA-W12 and 18-MNMA-W14) plus a field duplicate sample (18-MNMA-W-DUP1) were



collected from the waterlot as part of the sampling program. A total of two surface water samples were also collected from the reference area (18-MNMA-W-REF2 and 18-MNMA-W-REF3) for chemical analysis.

The surface water samples were analyzed for petroleum hydrocarbons, PAHs, general chemistry and metals including mercury. All samples were submitted to AGAT in St. John's, NL for chemical analysis.

The surface water sample locations are shown on Figures 4A and 4B and the Laboratory Certificates of Analysis are included as Appendix C.

5.5.1 Surface Water Analytical Data - Petroleum Hydrocarbons

Petroleum hydrocarbons (BTEX/mTPH) were not detected in the surface water samples collected from the waterlot and reference area and the laboratory detection limits are below the Atlantic RBCA Tier I ESL for surface water.

The surface water analytical data for petroleum hydrocarbons is summarized in Table 14.

5.5.2 Surface Water Analytical Data - Metals

The surface water samples analyzed for metals including mercury were within the CCME WQGs, with the exception of the following metals parameters:

- Copper CCME WQG exceeded in all the surface water samples collected from the waterlot.
 However, the reference samples also had concentrations of copper exceeding the CCME WQG
 and the maximum concentration of copper identified in the waterlot samples was less than the
 reference sample 18-MNMA-W-REF3. The CCME WQG for copper used for comparison to Site
 data is based on protection of freshwater aquatic life as a marine specific guideline was not
 available from CCME.
- Selenium CCME WQG marginally exceeded at sample location 18-MNMA-W14 collected from the waterlot. All other surface water samples collected from the waterlot and reference area had concentrations of selenium below CCME WQGs (if detected).

The surface water analytical data for metals are summarized in Table 15.

5.5.3 Surface Water Analytical Data - PAHs

The surface water samples collected from the waterlot and reference area did not contain detectable concentrations of PAHs and the laboratory detection limits are below CCME WQGs.

The surface water analytical data for PAHs are summarized in Table 16.

5.5.4 Surface Water Analytical Data - General Chemistry

The surface water samples were analyzed for general chemistry parameters such as pH, hardness, turbidity, nitrates, ammonia, etc. General chemistry parameters for the surface water samples collected from the waterlot and reference area were within CCME WQGs.

The surface water analytical data for general chemistry parameters is summarized in Table 17.



5.5.5 Surface Water QA/QC Sampling Program

One field duplicate surface water sample (18-MNMA-W-DUP1) was collected from sample location 18-MNMA-6 and submitted for analysis of BTEX/mTPH, PAHs, general chemistry and metals including mercury. The field duplicate surface water sample reported non-detectable concentrations of BTEX/mTPH, and PAHs all of which were consistent with the parent samples.

The field duplicate surface water sample reported detectable concentrations of some metals with calculated RPDs ranging from non-calculable to 67% for the metal parameters. RPDs for general chemistry parameters ranged from non-calculable to 73%.

There are no firm guidelines for the degree of correlation expected between field duplicates and parent samples due to natural heterogeneity in water; however, the results are considered to be an acceptable duplicable correlation and therefore meet the objectives for this sampling program.

6. Data Evaluation

For the purposes of the assessment of human health and ecological risk, where multiple samples were collected at one location (i.e., at varying depths), only one sample (the maximum measured concentration) was chosen to represent the concentration at that location. Similarly, where duplicate samples were collected (or laboratory duplicate samples were analyzed), the sample with the highest concentration (on an analyte by analyte basis) was considered representative of the sample location. These steps were taken to ensure conservativeness in the assessment.

6.1 Metals of Low Concern

It is important to determine whether all parameters analyzed and/or detected are present as a result of Site activities and if they are generally considered hazardous or toxic to humans or wildlife. Several elements can be classified as major mineral forming elements or essential nutrients, each of low inherent toxicity. Government agencies often do not develop regulatory criteria for these and other innocuous substances. The following elements are generally ubiquitous in the environment and are generally not considered hazardous to humans or wildlife, although they are commonly analyzed within standard analytical chemistry or trace metal packages: aluminum, ammonia, bismuth, bromide, calcium, fluoride, iron, lithium, magnesium, manganese, nitrate, nitrite, phosphorous, potassium, rubidium, titanium, sodium and sulphide.

Elevated concentrations of iron and manganese can be associated with discharge areas of chemical plumes in groundwater, particularly plumes of organic substances that can degrade in the environment and consume oxygen. Surface deposits of iron and manganese in wetlands or streambeds are typically readily identified by iron staining. These deposits are typically not hazardous to wildlife receptors by themselves, although substances associated with the groundwater plume may be. However, such areas are typically identified in the field and sampled as areas of potential contamination. Therefore, for the purpose of the HHRA and ERA, iron and manganese are considered non-hazardous, and it is assumed that any associated contaminants will be identified and assessed on a substance specific basis.



Also, the following elements, for which limited toxicity information exists, are typically associated with seawater spray and could be expected to be present at the site due to its proximity to the ocean, and not as a result of historical site activities.

• Boron, bismuth, lithium, phosphorus, rubidium and strontium.

Thus, some metals that have a low inherent toxicity, that are associated with sea spray or that were only identified at concentrations near their detection limits were excluded from evaluation and were not carried forward in the human health or ecological risk assessments

6.2 Contaminant Distribution

6.2.1 Soil

6.2.1.1 Petroleum Hydrocarbons in Soil

Based on the analytical soil BTEX/mTPH data obtained to date (shown in Table 2), concentrations of mTPH have been identified exceeding the applicable Atlantic RBCA Tier I RBSL for commercial land use with non-potable water and coarse-grained soil (Diesel/#2 Fuel Oil). The distribution of mTPH concentrations is shown on Figure 5, with individual sample locations highlighted in Figure 5A (MAEB), Figure 5B (MSBL) and Figure 5C (MLLA/MFPA).

6.2.1.2 Metals in Soil

Based on the analytical soil metals data obtained to date (shown in Table 3), chromium concentrations have been identified exceeding the applicable CCME commercial SQGs. The distribution of trace metal (chromium) concentrations is shown on Figure 5, with individual sample locations highlighted in Figure 5A (MAEB) and Figure 5C (MLLA/MFPA).

6.2.2 Groundwater

6.2.2.1 Petroleum Hydrocarbons in Groundwater

Based on the analytical groundwater BTEX/mTPH data obtained to date (shown in Table 4), concentrations of mTPH have been identified exceeding the applicable Atlantic RBCA Tier I RBSL for commercial land use with non-potable water and coarse-grained soil (Diesel/#2 Fuel Oil). The distribution of mTPH concentrations in groundwater is shown on Figure 6, with the individual sample location of MGSB highlighted in Figure 6A.

6.2.2.2 Metals in Groundwater

Based on the analytical groundwater metals data obtained to date (shown in Table 5), arsenic, copper, selenium and zinc concentrations have been identified exceeding the applicable Federal Interim Groundwater Quality Guidelines Generic Guidelines for Commercial and Industrial Land Uses – Tier 2 for Marine Life Exposure Pathway. The distribution of trace metal concentrations in groundwater is shown on Figure 6.



6.2.3 Sediment

6.2.3.1 Petroleum Hydrocarbons in Sediment

Based on the analytical sediment BTEX/mTPH data obtained to date (shown in Table 6), concentrations are within the applicable Atlantic RBCA Tier I Sediment ESLs for the Protection of Freshwater and Marine Aquatic Life.

6.2.3.2 Metals in Sediment

Based on the analytical sediment metals data obtained to date (shown in Table 7), arsenic, cadmium, chromium, copper, lead, mercury and zinc concentrations have been identified exceeding the applicable CCME sediment ISQG and/or PELs. However, the concentrations of these specific metals in the three step-out samples collected directly adjacent to the waterlot boundary were below CCME ISQGs or PELs. The distribution of trace metal concentrations in sediment is shown on Figures 7A and 7B.

6.2.3.3 PAHs in Sediment

Based on the analytical sediment PAH data obtained to date (shown in Table 8), 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene fluorine, naphthalene, phenanthrene, and pyrene concentrations have been identified exceeding the applicable CCME sediment ISQG and/or PELs. However, the concentrations of these specific PAH parameters in the three step-out samples collected directly adjacent to the waterlot boundary were below CCME ISQGs or PELs excluding a minor exceedance of phenanthrene in the field duplicate of sample 18-MNMA-STEP3. The distribution of PAH concentrations in sediment is shown on Figures 7A and 7B.

6.2.3.4 PCBs in Sediment

Based on the analytical sediment PCBs data obtained to date (shown in Table 10), PCB concentrations have been identified exceeding the applicable CCME sediment ISQG and/or PELs. However, the three step-out samples did not contain detectable concentrations of PCBs.

6.2.4 Surface Water

Although concentrations of mTPH and selected metals in groundwater at the Site exceeded applicable screening guidelines for protection of aquatic life (groundwater discharge to surface water pathway), concentrations of mTPH and metals in surface water samples collected from the waterlot were either not detectable or below applicable CCME WQGs. The exceptions would be boron, chromium and copper which had elevated concentrations in surface water samples collected from the waterlot but the concentration of these parameters were also elevated in the reference samples. The concentration of selenium also marginally exceeded CCME WQG in one waterlot sample collected but the remainder of the samples were below laboratory detection limits.



6.3 Exposure Point Concentrations

As impacts have been identified at concentrations exceeding the applicable criteria, human and ecological receptors at the site could be exposed to the identified metals impacts in surface soil. Further risk assessment and possibly risk management is required. Subsequent risk assessments use maxima or exposure point concentrations (EPCs) to represent contaminant concentrations. The EPC is an estimate of a reasonable upper limit value for the average chemical concentration in the medium, determined for each exposure unit (USEPA, 1989; USEPA, 2010). EPCs are represented by upper confidence limits on the mean (UCLM) (95% or above) (or maxima, where data are not suitable or sufficient for EPC calculations) calculated from ProUCL, Version 5.1, using data from the dataset discussed above. The results of the statistical analyses are provided in Appendix D. In the case of laboratory duplicates, field duplicates, or samples from multiple depths, the sample with the highest concentration at each location was used in the calculation of the EPC. ProUCL, Version 5.1 recommends that at least 10 data points be available for conducting statistical calculations; therefore, UCLM concentrations were not calculated for parameters having less than 10 data points. EPC concentrations are also included, where applicable in the human health and ecological specific screening tables referenced in Sections 7 and 8, below.

6.4 Data Suitability for Risk Assessment

Decisions about whether to include or exclude outliers in the data set to be used to compute the UCLs should be made by the project team familiar with the site based on an interpretation of the physical meaning and significance of the identified outliers. Questions considered in evaluating whether to include or exclude outliers from the statistical calculations included:

- Is there a clear visual separation of the outlier from the remaining data on a graphical display of the data, such as a Q-Q plot?
- Is the outlier sample spatially related to a known source (e.g., dripline of a building)?
- Is the COPC known to be associated with a suspected source (e.g., lead is associated with paint whereas cadmium is not)?
- Is the outlier sample location sufficiently delineated to have confidence that it represents a small area in comparison to human or ecological exposure areas?

If the suspected outlier is clearly separate from the remaining data, is not spatially related to a source or is not known to be associated with that source, and is accurately delineated to a small area, then the outlier was removed from the data for calculation of an EPC. If the suspected outliers did not meet these criteria, they were generally included in the data set for calculation of the EPCs.

There were no outliers removed from the calculation of the EPCs.

6.5 Background Analysis

To account for the potential presence of chemical of potential concerns (COPCs) in sediment of the Shipyard waterlot that are naturally elevated in the area or from sources not associated with the Shipyard activities, the sediment sampling program included the collection and analyses of



background sediment samples from three locations in Mortier Bay, between 1,000 and 1,200 metres to the east of the waterlot (18-MNMA-REF1 to 18-MNMA-REF3).

Selected sediment data from the waterlot were compared to background sediment using the two sample Wilcoxon Mann Whitney test available in ProUCL. This is a non-parametric (i.e., independent of the underlying distributions) test in which values (i.e., concentrations) are assigned a rank and the ranks for the two sample populations (waterlot and background) compared. This test also takes into account non-detected values, provided the detection limits are identified. Comparisons were made using two sided tests under the null hypotheses that concentrations in the populations of samples from waterlot and the samples from background locations are equal. If a statistically significant difference was identified using a two sided test, then a one sided test (also available in ProUCL) was conducted to determine if concentration in the waterlot were greater than the background samples.

The ProUCL output sheets for the background evaluation are provided in Appendix D

7. Human Health Risk Assessment

This HHRA has been conducted in accordance with current guidance documents, including:

- Atlantic RBCA (2015). Atlantic RBCA (Risk Based Corrective Action) for Petroleum Impacted Sites in Atlantic Canada, Version 3, User Guidance, July 2012 (revised January 2015).
- Health Canada (2017). Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathway, March 2017.
- Health Canada (2010a). Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0, September 2010 (revised 2012).
- Health Canada (2010b). Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0, September 2010.
- Health Canada (2010c). Federal Contaminated Site Risk Assessment in Canada, Part III:
 Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0.
- Health Canada (2010d). Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRAchem), September 2010.
- Health Canada (2010e). Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFOODs), October 2010.
- Health Canada (HC), 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption, Bureau of Chemical Safety Food Directorate, Health Products and Food Branch, March 2007.



 CCME Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (CCME, 2006).

7.1 Problem Formulation

The Problem Formulation step is an information gathering and interpretation stage that focuses the assessment on the primary areas of concern for the study area. The Problem Formulation step defines the nature and scope of the risk assessment, permits practical boundaries to be placed on the overall scope of work, and ensures that the HHRA is directed at the key areas and issues of concern related to Site activities.

7.1.1 Human Health Chemicals of Potential Concern (COPC) Screening

The analytical data for soil, sediment and groundwater were compared to human health specific screening levels (HHSLs) developed or recognized by Atlantic RBCA, NSE, CCME, or human health screening values from other jurisdictions if a guideline was not available from these sources. Consistent with Section 1.3, the HHSLs were selected to be protective of commercial land use with non-potable groundwater use. Considering the use of the property as a shipyard, it is considered possible that commercial workers may come into contact with sediment and/or surface water in the waterlot. Although the commercial/industrial property is not used for growing consumable plants or for hunting wild game, the possibility that fishing and/or harvesting of shellfish could occur within or in close proximity to the waterlot is included in the HHRA screening.

A constituent was identified as a COPC if the maximum detected concentration or exposure point concentration is greater than its HHSL and background concentration. Unless a constituent is considered to be highly bioaccumulative, it was eliminated from further consideration if the maximum detected concentration or EPC is less than its HHSL or background concentration. If the constituent was not detected, it was not retained as a COPC.

Available human health screening criteria for soil, groundwater, sediment, and surface water do not account for humans consuming plants, wild game or fish that may accumulate bioaccumulative constituents. Therefore, regardless of screening results, exposure to bioaccumulative COPC, such as PCBs and mercury, is evaluated further in the sections below, where required.

7.1.1.1 Soil

In order of preference, the following HHSLs were used for screening of chemicals in soil for inclusion in the HHRA:

- Atlantic RBCA (2012, revised 2015). Atlantic Risk-Based Corrective Action (RBCA) Tier II
 Pathway Specific Screening Levels (PSSLs) for Commercial, Non-Potable Water Use,
 Coarse-Grained Soil, Soil Ingestion Pathway and Indoor Air Pathway.
- CCME (1999, revised to 2018). Canadian SQGHH Commercial, non-potable, coarse-textured soil. Pathway-specific information from the individual fact sheets was reviewed to confirm human health guidelines for the soil ingestion and indoor air pathways.



- NSE (2014). Nova Scotia Environmental (NSE) Pathway Specific Standards (PSS) NSE PSS for Commercial, Non-Potable Water Use, Coarse-Grained Soil, Soil Ingestion Pathway and indoor air pathway.
- Ontario Ministry of the Environment (OMOE, 2011), Rationale Document, Components for Table 3 - Full Depth, Non-potable Water Scenario, Coarse textured soil, Industrial/Commercial Land Use.
- United States Environmental Protection Agency (USEPA, 2018). Regional Screening Levels (RSL) Generic Tables – Industrial soil.

The Ontario MOECC component values and USEPA RSLs were adjusted (multiplied by 10) to the Health Canada and CCME target incremental cancer risk of 1.0 x 10⁻⁵. The USEPA RSLs for a target HQ of 0.1 were adjusted (multiplied by 2) to the Health Canada and CCME target HQ of 0.2.

As indicated in Table 7-1, Modified TPH – Diesel/#2 Fuel Oil exceeds the HHSLs for soil for the indoor air pathway and; therefore, requires further assessment to evaluate the soil vapour to indoor air pathway. No soil samples collected during the field program contained Modified TPH concentrations above the HHSLs for direct contact; therefore, the petroleum hydrocarbons in the sub-surface soil does not present a risk to construction workers.

Table 7-1 Human Health Screening of Surface Soil for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration Concentration Maximum Concentration Concentration				Human Health Scre (mg	ening Levels (HH ŋ/kg)	SL)	Comment
Chemical	(mg/kg)	(EPC) (mg/kg)	Background (mg/kg)	Direct Contact	Reference	Vapour Inhalation	Reference	Comment
Metals								
Antimony	<1	NC	1	63	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Arsenic	23	NC	17	31	CCME SQG	Not Volatile	=	Maximum meets HHSL
Barium	343	NC	81	10000	CCME SQG	Not Volatile	-	Maximum meets HHSL
Beryllium	<2	NC	1	110	CCME SQG	Not Volatile	-	Maximum meets HHSL
Cadmium	0.7	NC	0.8	49	CCME SQG	Not Volatile	-	Maximum meets HHSL
Chromium	107	NC	52	630	CCME SQG	Not Volatile	=	Maximum meets HHSL
Cobalt	34	20	17	250	NSE PSS (OMOE, 2011)	Not Volatile	-	EPC meets HHSL
Copper	87	NC	57	4000	CCME SQG	Not Volatile	-	Maximum meets HHSL
Lead	96.7	NC	35	260	CCME SQG	Not Volatile	-	Maximum meets HHSL
Mercury	0.06	NC	1	24	CCME SQG	3.9	OMOE, 2011	Maximum meets HHSL
Molybdenum	7	NC	1.1	1200	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Nickel	69	NC	72	310	CCME SQG	Not Volatile	-	Maximum meets HHSL
Selenium	<1	NC	1.0	125	CCME SQG	Not Volatile	-	Maximum meets HHSL
Silver	<0.5	NC	0.25	490	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Thallium	<0.1	NC	0.27	1	CCME SQG	Not Volatile	-	Maximum meets HHSL
Tin	4	NC	4.1	9400	NSE PSS (USEPA 2018)	Not Volatile	-	Maximum meets HHSL
Uranium	0.6	NC	2.2	33	CCME SQG	Not Volatile	-	Maximum meets HHSL
Vanadium	100	66	86	160	NSE PSS (USEPA 2018)	Not Volatile	-	EPC meets background
Zinc	329	NC	120	16000	CCME SQG	Not Volatile	-	Maximum meets HHSL
Petroleum Hydrocarbons	•				•		•	
Benzene	< 0.03	NC	Not Available	360	ARBCA Tier II PSSL ¹	2.5	ARBCA Tier II PSSL ²	Maximum meets HHSL
Toluene	<0.04	NC	Not Available	31000	ARBCA Tier II PSSL ¹	>450	ARBCA Tier II PSSL ²	Maximum meets HHSL
Ethylbenzene	<0.03	NC	Not Available	14000	ARBCA Tier II PSSL ¹	>240	ARBCA Tier II PSSL ²	Maximum meets HHSL
Xylenes	<0.05	NC	Not Available	210000	ARBCA Tier II PSSL ¹	110	ARBCA Tier II PSSL ²	Maximum meets HHSL
Modified TPH - Diesel/ #2 Fuel Oil	7640	NC	Not Available	13,000	ARBCA Tier II PSSL ¹	4000	ARBCA Tier II PSSL ²	Maximum exceeds HHSL - Indoor Air

Notes

BOLD - identified as a COPC

NC - Not Calculated

Human Health Screening Levels (HHSLs):

CCME SQG: Canadian Council of Ministers of the Environment, Soil Quality Guidelines for the Protection of Human Health, commercial, coarse soils.

NSE PSS - Nova Scotia Environment Pathway Specific Standards (original source reference in brackets)

Atlantic RBCA Tier II PSSL1 - Commercial, Non-Potable Water Use with Coarse-Grained Soil, Soil Ingestion Pathway

Atlantic RBCA Tier II PSSL² - Commercial, Non-Potable Water Use with Coarse-Grained Soil, Indoor Air Pathway

OMOE, 2011 - Ontario Ministry of the Environment, Rationale Document, Components for Table 3 - Full Depth, Non-potable Water Scenario, Coarse textured soil, Industrial/Commercial Land Use

Adjusted to risk = 1 x 10-5 and HQ = 0.2), April 2011

USEPA 2018: United States Environmental Protection Agency Regional Screening Levels, Resident Soil (adjusted to risk = 1 x 10⁻⁵ and HQ = 0.2), May 2018.



7.1.1.2 Groundwater

For groundwater, there were two potential exposure pathways identified, including: (1) direct contact (ingestion, dermal contact, and inhalation); and (2) inhalation of indoor air. Based on the GHD's recent investigations at the Site, groundwater at the Site is located at depths ranging from 0.82 to 2.95 metres below grade. Given these depths, the direct contact pathway is applicable only for subsurface workers conducting ground intrusive activities that could intersect the water table. The subsurface worker could be exposed through dermal contact and incidental ingestion through hand to mouth contact. There are no HHSLs that address this exposure pathway, and therefore, HHSLs protective of drinking water were conservatively applied in the groundwater screening to address potential direct contact with groundwater. However, to reduce some of this extreme conservatism, the drinking water HHSLs were multiplied by a factor of 10, consistent with the approach outlined in WHO (2003), since subsurface workers will only have incidental ingestion of groundwater.

The HHSLs protective of direct contact were the Maximum Acceptable Concentrations (MACs) from Health Canada's Guidelines for Canadian Drinking Water Quality Summary Table, dated February 2017 (Health Canada, 2017a).

Where Health Canada MACs were not available, screening values were selected from the following sources:

- Atlantic RBCA (2012, revised 2015). Atlantic Risk-Based Corrective Action (RBCA) Tier II
 Pathway Specific Screening Levels (PSSLs) for Commercial, Non-Potable Water Use,
 Coarse-Grained Soil, Soil Ingestion Pathway and Indoor Air Pathway
- NSE (2014). Nova Scotia Environmental (NSE) Pathway Specific Standards (PSS) NSE PSS for Commercial, Non-Potable Water Use, Coarse-Grained Soil, Soil Ingestion Pathway
- OMOE (2011) OMOE, 2011: Ontario Ministry of the Environment, Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario
- USEPA (2017) Tapwater RSLs

The Ontario MOECC component values and USEPA RSLs were adjusted (multiplied by 10) to the Health Canada and CCME target incremental cancer risk of 1.0 x 10⁻⁵. The USEPA RSLs for a target HQ of 0.1 were adjusted (multiplied by 2) to the Health Canada and CCME target HQ of 0.2.

As indicated in Table 7-2, arsenic, vanadium and mTPH exceed the HHSLs for direct contact with groundwater (construction worker) and; therefore, require further assessment.

Table 7-2 Human Health Screening of Groundwater for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration			Human Health Scree (µg	Comment		
- Cricinical	(μg/L)	(EPC) (μg/L)	Direct Contact (1)	Reference	Vapour Inhalation	Reference	Comment
Metals							
Antimony	<2	NC	60	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Arsenic	362	NC	100	NSE PSS (HC DWG)	Not Volatile	-	Maximum exceeds HHSL - Direct Contact
Barium	483	NC	10000	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Beryllium	<2	NC	40	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Cadmium	0.16	NC	50	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Chromium	7	NC	500	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Cobalt	2	NC	100	NSE PSS (CCME 2013)	Not Volatile	-	Maximum meets HHSL
Copper	7	NC	10000	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Lead	0.5	NC	100	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Molybdenum	5	NC	700	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Nickel	10	NC	1000	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Selenium	156	NC	500	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Silver	0.2	NC	1000	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Thallium	0.1	NC	20	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum meets HHSL
Tin	<2	NC	24000	NSE PSS (USEPA RSL)	Not Volatile	-	Maximum meets HHSL
Uranium	1.9	NC	200	NSE PSS (HC DWG)	Not Volatile	-	Maximum meets HHSL
Vanadium	494	NC	62	NSE PSS (OMOE, 2011)	Not Volatile	-	Maximum exceeds HHSL - Direct Contact
Zinc	32	NC	50000	HC DWG	Not Volatile	-	Maximum meets HHSL
Petroleum Hydrocarbons							
Benzene	<1	NC	50	APIRI, 2015	30,000	APIRI, 2015	Maximum meets HHSL
Toluene	<1	NC	240	APIRI, 2015	>515,000	APIRI, 2015	Maximum meets HHSL
Ethylbenzene	<1	NC	16	APIRI, 2015	<150,000	APIRI, 2015	Maximum meets HHSL
Xylenes	<2	NC	200	APIRI, 2015	390,000	APIRI, 2015	Maximum meets HHSL
Modified TPH - Diesel/ #2 Fuel Oil	447,000	357,200	32,000	APIRI, 2015	39,000,000	APIRI, 2015	Maximum and EPC exceed HHSL - Direct Contact

Notes

BOLD - identified as a COPC

NC - Not Calculated. For all metals, the EPC could not be calculated due to insufficient sample numbers.

For all other parameters the EPC was not required.

NGR - no guideline required

Human Health Screening Levels (HHSLs):

NSE PSS: Nova Scotia Environment Pathway Specific Standards for Groundwater, 2013 (Original reference source in brackets)

HC DWG: Health Canada's Guidelines for Canadian Drinking Water Quality, Summary Table, February 2017.

CCME 2013: CCME, 2013 (Draft) Canadian Council of Ministers of the Environment, Guidance Manual onSampling, Analysis and Data Management for Contaminated Sites Volume IV: Compendium of Analytical Methods for Contaminated Sites.

OMOE, 2011: Ontario Ministry of the Environment, Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, Potable GW1, coarse soils (adjusted to target risk = 1 x 10-5 and HQ = 0.2).

USEPA RSL: United States Environmental Protection Agency Regional Screening Levels, Resident Soil (adjusted to target risk = 1 x 10⁻⁵ and HQ = 0.2).

APIRI, 2015: Atlantic Partners in RBCA Implementation, Atlantic RBCA (Risk Based Corrective Action) Version 3.0 for Impacted Site in Atlantic Canada, User Guidance, June 2012, Updated 2015.

Appendix 4, Atlantic Canada Tier II Pathway Specific Screening Level (PSSL) Table

(1) Due to drinking-water guideline values relate to water ingestion and, in most cases, to lifetime exposure; WHO guidelines (2003) assume a contribution for direct contact of an equivalent of 10% of drinking-water consumption. Therefore WHO's simple screening approach is that a substance occurring in water at a concentration ten times that stipulated in the drinking-water guidelines may merit further consideration as referred to in Section 10.5. WHO, 2003: Guidelines for Safe Recreational Water Environments, Volume 1: Coastal and Freshwaters, World Health Organization, 2003.



7.1.1.3 Sediment

For sediment, the most likely potential exposure pathways identified are incidental ingestion and dermal contact with waterlot sediment by commercial workers at the Site. In the absence of screening values specific to this exposure scenario, the direct contact HHSLs (ingestion and dermal contact) from the sources listed above for the soil screening were applied. This approach to sediment screening is consistent with Health Canada's Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments (Health Canada, 2017b).

As indicated in Table 7-3, arsenic and lead concentrations exceed the HHSLs for sediment for direct contact. Therefore, further assessment of these COPCs in sediment is required.

Table 7-3 Human Health Screening of Sediment for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration (mg/kg)	Exposure Point Concentration (EPC) (mg/kg)	Sediment Reference Concentrations (mg/kg)	Human Health Screening Levels (HHSL) (mg/kg)	Statistically Similar to Background? Yes or No (1)	Reference	Comment
Metals							
Antimony	28	11.16	<1	63	Cannot be Determined	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Arsenic	78	40.43	11	31	No	CCME SQG	Maximum and EPC exceed HHSL
Barium	250	149.80	41	10000	No	CCME SQG	Maximum meets HHSL
Beryllium	<2	NC	<2	110	Yes	CCME SQG	Maximum meets HHSL
Cadmium	1	0.54	<0.3	49	Cannot be Determined	CCME SQG	Maximum meets HHSL
Chromium	98	47.36	16	630	Yes	CCME SQG	Maximum meets HHSL
Cobalt	22	15.23	8.3	250	No	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Copper	260	168.20	9.3	4000	No	CCME SQG	Maximum meets HHSL
Lead	728	362.00	7	260	No	CCME SQG	Maximum and EPC exceed HHSL
Mercury	0.64	0.16	0.05	24	Cannot be Determined	CCME SQG	Maximum meets HHSL
Molybdenum	9	6.06	2.5	1200	Yes	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Nickel	45	25.42	14	310	Yes	CCME SQG	Maximum meets HHSL
Selenium	3	1.62	<1	125	Cannot be Determined	CCME SQG	Maximum meets HHSL
Silver	<0.5	NC	<0.5	490	Yes	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Thallium	<0.1	<0.1	0.1	1	Yes	CCME SQG	Maximum meets HHSL
Tin	28	17.74	3.3	9400	No	NSE PSS (USEPA 2018)	Maximum meets HHSL
Uranium	2.5	1.69	1.3	33	Yes	CCME SQG	Maximum meets HHSL
Vanadium	63	47.12	33	160	Yes	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Zinc	5020	1681	34	16000	No	CCME SQG	Maximum meets HHSL
Polychlorinated Biphenyls							
PCBs	0.65	0.32	< 0.02	33	Cannot be Determined	NSE PSS (AEP RGV)	Maximum meets HHSL
Petroleum Hydrocarbons							
Benzene	< 0.03	NC	< 0.03	360	Yes	NSE (APIRI)	Maximum meets HHSL
Toluene	< 0.04	NC	< 0.04	31000	Yes	NSE (APIRI)	Maximum meets HHSL
Ethylbenzene	< 0.03	NC	< 0.05	14000	Yes	NSE (APIRI)	Maximum meets HHSL
Xylenes	< 0.05	NC	< 0.05	210000	Yes	NSE (APIRI)	Maximum meets HHSL
Modified TPH - Diesel/ #2 Fuel Oil	419	NC	22	13,000	No	NSE (APIRI)	Maximum meets HHSL
Polycyclic Aromatic Hydrocarbo				,			
1-Methylnaphthalene	0.27	0.13	< 0.05	560	Cannot be Determined	NSE PSS (OMOE, 2011)	Maximum meets HHSL
2-Methylnaphthalene	0.38	0.18	<0.01	560	Cannot be Determined	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Acenaphthene	0.728	0.37	<0.00671	8000	Cannot be Determined	NSE PSS (AEP RGV)	Maximum meets HHSL
Acenaphthylene	0.465	0.16	<0.004	96	Cannot be Determined	NSE PSS (OMOE, 2011)	Maximum meets HHSL
Acridine	0.465	0.10	<0.05	7.7	Cannot be Determined	USEPA RSL	Maximum meets HHSL
Anthracene	1.01	0.48	<0.03	37000	Cannot be Determined	NSE PSS (AEP RGV)	Maximum meets HHSL
Benzo(a)anthracene	1.55	0.48	0.025	see B(a)P TPE	Cannot be Determined	-	-
Benzo(a)pyrene	1.42	NC	<0.01	see B(a)P TPE	Cannot be Determined	-	-
Benzo(b+j)fluoranthene	1.96	NC NC	<0.05	see B(a)P TPE	Cannot be Determined	-	-
Benzo(e)pyrene	0.93	0.57	<0.05	7.7	Cannot be Determined	USEPA RSL	EPC meets ESLs
Benzo(g,h,i)perylene	0.86	NC	<0.03	see B(a)P TPE	Cannot be Determined	-	-
Benzo(k)fluoranthene	0.72	0.41	0.02	see B(a)P TPE	Cannot be Determined	-	-
Chrysene	1.7	0.99	0.03	see B(a)P TPE	No	_	-
Dibenzo(a,h)anthracene	<0.006	NC	<0.006	see B(a)P TPE	Yes	_	_
Fluoranthene	3.93	2.19	0.07	5300	No	NSE PSS (AEP RGV)	- Maximum meets HHSL
Fluoranthene	0.94	0.36	<0.01	4100	Cannot be Determined	NSE PSS (AEP RGV)	Maximum meets HHSL
Indeno(1,2,3-cd)pyrene	1.13	0.36 NC	<0.01	see B(a)P TPE	Cannot be Determined	NOE FOO (AEF ROV)	waxiiiuiii iiieeis nhol
Naphthalene	0.62	0.19	<0.01	2800	Cannot be Determined	NSE PSS (AEP RGV)	- Maximum meets HHSL
Perylene	0.62	0.19	<0.01	3200	Cannot be Determined	NSE PSS (AEP RGV)	Maximum meets HHSL
Phenanthrene	4.05	1.89	0.05	2800	No	NSE PSS (AEP RGV)	Maximum meets HHSL
	2.98	1.69	0.05	3200		` '	
Pyrene		1.69 NC			No	NSE PSS (AEP RGV)	Maximum meets HHSL
Quinoline	<0.05		<0.05	7.7	Yes	USEPA RSL	Maximum meets HHSL
B(a)P TPE Notes	1.9	1.12	0.017	5.3	No	CCME SQG	Maximum meets HHSL

Notes

BOLD - identified as a COPC

NC - Not Calculated.

B(a)P TPE - benzo(a)pyrene total potency equivalents

Sediment reference concentrations are the based on the mean concentrations from 18-MNMA-REF1, 18-MNMA-REF2, and 18-MNMA-REF3.

(1) Refer to Section 2.5 for details on statistical comparison with background data. Background analysis conducted only if maximum concentration and EPC is greater than the reference concentration. Background statistical analysis not determined for parameters where background sediment data was not detected.

Human Health Screening Levels (HHSLs):

NSE PSS - Nova Scotia Environment Pathway Specific Standards (original source reference in brackets)

CCME SQG: Canadian Council of Ministers of Environment, Soil Quality Guidelines for the Protection of Human Health, commercial, coarse soils.

AEP RGV : Alberta Environment and Parks, Alberta Tier 1 Soil and Groundwater Remediation Guidelines, Table A-4, commercial, coarse soils.

For perylene, the guideline value for pyrene was applied. For phenanthrene, the guideline value for naphthalene was applied.

OMOE, 2011 - Ontario Ministry of the Environment, Rationale Document, Components for Table 3 - Full Depth, Non-potable Water Scenario, Coarse textured soil, Industrial/Commercial Land Use Adjusted to risk = 1 x 10-5 and HQ = 0.2), April 2011.

USEPA RSL: United States Environmental Protection Agency Regional Screening Levels, Industrial Soil (adjusted to risk = 1 x 10⁻⁵ and HQ = 0.2). For acridine and benzo(e)pyrene, the RSL for quinoline was applied

APIRI - Tier II PSSL (Pathway Specific Screening Level), Commercial, Non-Potable Water Use with Coarse-Grained Soil, Soil Ingestion Pathway, 2012, Updated 2015



7.1.1.4 Determination of COPCs for Consideration in Shellfish

As indicated in Sections 4 and 5, as part of the Supplemental Phase II ESA investigation, invertebrate tissue samples were collected from the waterlot and the reference area for selected chemical analysis. Information obtained during the Site reconnaissance indicates that shellfish harvesting, specifically scallop harvesting, does occur within the waterlot as well as Mortier Bay adjacent to the waterlot boundary. Fishing for finfish is not known to occur directly within the waterlot and finfish were not observed to be present within the waterlot at the time of the Supplemental Phase II ESA.

As the Site waterlot contains shellfish and harvesting of shellfish for human consumption is known to occur in the area, specifically scallops, risk to human health through the shellfish consumption pathway was included in the HHRA evaluation using Site-specific tissue data. However, as fishing is not known to occur directly in the waterlot, risk to human health through the fish (finfish) consumption pathway was not included in the HHERA for the following reasons:

- Finfish were generally not observed in the waterlot at the time of the Supplemental Phase II ESA.
- Anecdotal evidence indicates fishing that does occur in Mortier Bay is primarily limited to migratory sea trout that would have limited exposure to COPCs in sediment in the waterlot.
- Evaluation of risk to human health from consumption of shellfish is considered to be a
 conservative surrogate for the fish consumption pathway as shellfish are in direct contact with
 sediment.
- COPCs that are considered to be bioaccumulative in sediment such as mercury and PCBs were
 not detected in shellfish samples collected from the waterlot. In addition, bioaccumulation of
 PAHs and petroleum hydrocarbons (mTPH) in fish is expected to be low and considered to be
 insignificant for assessing receptors that can metabolize these compounds (Eisler, 1987;
 CCME, 2008).

The COPCs that were selected to be considered for human health screening based on consumption of shellfish included:

1) Those COPCs where the background analysis indicates that the sediment concentrations in the waterlot of the Shipyard are statistically greater than background levels (see Section 6.5). As identified in Table 7-3, these COPCs include metals (arsenic, barium, cobalt, copper, lead, tin and zinc), mTPH and PAHs (chrysene, fluoranthene, phenanthrene, pyrene and B(a)P TPE). However, concentrations of barium, cobalt and tin in shellfish tissue samples collected from the waterlot and reference area were below laboratory detection limits. In addition, these three metals are not considered to be bioaccumulative in sediment (TCEQ, 2006) and the Federal Contaminated Sites Action Plan Guidance for Assessing and Managing Aquatic Contaminated Sites in Working Harbours (FCSAP, 2017) indicates screening of COPCs with respect to the food ingestion pathway should focus on chemicals with the potential to bioaccumluate or biomagnify. Based in the above noted rationale, barium, cobalt and tin were not carried forward in the HHRA for consumption of shellfish. In addition, although concentrations of mTPH in waterlot sediment were identified be statistically greater than background concentrations, the concentrations of mTPH in waterlot sediment were below Atlantic RBCA screening guidelines



- and mTPH is not considered to be bioaccumulative in fish or shellfish. As such, petroleum hydrocarbons (BTEX/mTPH) were eliminated as a COPC in shellfish tissue.
- 2) Those COPCs where the background analysis could not be conducted because the COPCs were not detected in the background data. As identified in Table 7-3, these COPCs include metals (antimony, cadmium, mercury and selenium), PCBs and PAHs (1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Acridine, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b+j)fluoranthene, Benzo(e)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene and Perylene). Similar to several metals noted above, antimony was not detected in the shellfish tissue samples collected from the waterlot or the reference area. Antimony was not carried forward in the HHRA with respect to the consumption of shellfish as antimony is not considered to be bioaccumulative (TCEQ, 2006).
- Beryllium, silver, thallium, benzene, toluene, ethylbenzene, and xylene were not included in the screening for consumption of shellfish because these COPCs were not detected in the waterlot sediments.

Based on the above noted rationale, the COPCs carried forward in the HHRA with respect to consumption of shellfish tissue include the following:

- Metals specifically arsenic, cadmium, copper, lead, mercury, selenium and zinc
- PAHs specifically 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Acridine, Anthracene, Benzo(e)pyrene, fluoranthene, fluorine, naphthalene, perylene, phenanthrene, pyrene and B(a)P TPE
- PCBs

Shellfish Concentrations

In order to conduct a human health screening for this pathway, maximum concentrations of COPCs in shellfish tissue obtained from the waterlot were tabulated and are provided in Table 7-4 along with the maximum concentration identified in the tissue samples collected from the reference area. The maximum concentration of the three types of invertebrates collected from the waterlot and reference area (crab, mussels and scallops) is also provided in Table 7-4 and will be discussed in the human health risk evaluation.

Table 7-4 Shellfish Tissue Concentrations for Assessing Human Consumption Exposure

Sediment Concentration		Crab Tissue Concentration (mg/kg)			e Concentration g/kg)	Scallop Tissue Concentration (mg/kg)		
Chemical of	(mg/l C _{se}	ed	Maximum Site	Maximum Reference	Maximum Site	Maximum Reference	Maximum Site	Maximum Reference
Potential Concern	Maximum	EPC						
Metals								
Arsenic	78	40	4.0	5.0	4.0	5.0	3.0	2.0
Cadmium	1.0	0.5	2.9	<0.3	4.8	3.5	17.8	4.9
Copper	260	168	20.0	19.0	9.0	<2	<2	<2
Lead	728	362	<0.4	<0.4	0.7	1.1	<0.4	<0.4
Mercury	0.64	0.16	< 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	3.0	1.6	<1	1.0	<1	<1	<1	<1
Zinc	5,020	1,681	28.0	27.0	108.0	74.0	12.0	9.0
PAHs								
1-Methylnaphthalene	0.270	0.126	0.037	0.012	0.014	0.002	0.028	0.008
2-Methylnaphthalene	0.38	0.2	0.034	0.021	0.027	0.027	0.051	0.015
Acenaphthene	0.73	0.4	0.013	0.018	0.011	0.012	0.016	0.014
Acenaphthylene	0.465	0.2	0.002	0.002	0.001	0.002	0.002	0.001
Acridine	0.11	0.1	< 0.0003	< 0.0003	<0.0001	<0.0002	<0.0002	<0.0001
Anthracene	1.01	0.5	0.001	0.001	0.002	0.001	0.001	0.000
Benzo(e)pyrene	0.9	0.6	0.004	0.016	0.003	0.002	0.007	0.004
Fluoranthene	3.9	2.2	0.022	0.015	0.011	0.006	0.015	0.003
Fluorene	0.94	0.4	0.004	0.003	0.002	0.002	0.002	0.002
Naphthalene	0.62	0.2	0.002	0.014	0.016	0.002	0.032	0.012
Perylene	0.41	0.2	<0.0001	<0.0001	<0.0001	<0.0001	0.002	0.001
Phenanthrene	4.1	1.9	0.018	0.008	0.004	0.005	0.006	0.003
Pyrene	3.0	1.7	0.043	0.012	0.007	0.007	0.011	0.002
B(a)P TPE	1.94	1.1	0.006	0.018	0.003	0.001	0.013	0.005
PCBs								
Total PCBs	0.65	0.32	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes: Tissue concentrations are based on the maximum concentration detected in each specific tissue type. The results reported are based on a composite of soft tissue extracted from each organism.



7.1.1.5 Shellfish Screening

The human health screening for shellfish consumption pathways involved comparing Site-specific shellfish tissue concentrations to the following human health screening levels, in order of preference:

- Canadian Food Inspection Agency (CFIA, 2014) Appendix 3, Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products, amended August 2014.
- USEPA (2015) Regional Screening Levels (RSLs) for Fish, November 2015, adjusted for non-carcinogens to reflect 20% of the USEPA RfD and adjusted for carcinogens to reflect a target ILCR of 1 x 10⁻⁵. The RSLs were adjusted for a consumption rate of 0.009 kilograms per day (kg/day) for shellfish, consistent with the consumption rate provided by Health Canada (HC, 2007) for subsistence fisher.

Consumption of Shellfish

Maximum concentrations in shellfish tissue are compared to human health screening levels in Table 7-5. The maximum concentrations of COPCs in shellfish tissue were below applicable screening guidelines excluding arsenic, cadmium and lead. In particular, the maximum concentrations of PAH compounds were below applicable human health screening guidelines or background concentrations. Similarly, COPCs that are considered to be highly bioaccumulative such as mercury and PCBs were not detected in the tissue samples collected.

Although the maximum concentration of arsenic in shellfish tissue (crab and mussel) collected from the waterlot (4 mg/kg) marginally exceeded the CFIA quideline for fish and fish products of 3.5 mg/kg, the waterlot samples had lower concentrations of arsenic than the tissue samples collected from the reference area of Mortier Bay (5 mg/kg). The maximum concentration of arsenic identified in the scallop tissue samples collected from the waterlot was 3 mg/kg and below the CFIA guideline. Similar to arsenic, the maximum concentration of lead in tissue from the waterlot (0.7 mg/kg) was observed in the mussel sample and only marginally exceeded the CFIA guideline of 0.5 mg/kg. In addition, the maximum concentration of lead in mussel samples from the waterlot were below the concentration of lead observed in the mussel samples collected from the reference area of Mortier Bay (1.1 mg/kg). Lead was not detected in the crab or scallop samples collected from the waterlot or reference area. As such, the concentrations of arsenic and lead observed in the invertebrate tissue samples collected from the waterlot are considered to be representative of background conditions in the area. The above noted results for arsenic and lead in shellfish tissue are also consistent with concentrations of these metals observed in reference crustaceans and mollusk samples collected from other harbours on the southern coast of Newfoundland as part of on-going work being completed by GHD on behalf of the federal government (personnel knowledge). The concentrations of arsenic and lead in lobster, mussels and scallop samples collected from other reference areas in southern Newfoundland ranged from 3 to 7 mg/kg and <0.4 to 2 mg/kg, respectively.

Based on the above noted screening results, concentrations of COPCs in shellfish tissue collected from the waterlot are below applicable screening guidelines or are consistent with background concentrations in Mortier Bay excluding cadmium. Cadmium is carried through in the HHRA for consumption of waterlot shellfish.



7.1.1.6 Surface Water

For surface water, the most likely potential exposure pathways identified are incidental ingestion and dermal contact with surface water by commercial workers and recreational users. There are no HHSLs that address this exposure pathway, and therefore, HHSLs protective of drinking water were conservatively applied in the surface water screening to address potential direct contact with surface water. However, to reduce some of this extreme conservatism, the drinking water HHSLs were multiplied by a factor of 10, consistent with the approach outlined in World Health Organization (WHO, 2003), since commercial workers and recreational users will only have incidental ingestion of surface water.

The HHSLs protective of direct contact were the Maximum Acceptable Concentrations (MACs) from Health Canada's Guidelines for Canadian Drinking Water Quality Summary Table, dated February 2017 (Health Canada, 2017b). Where Health Canada MACs were not available, screening values were selected from the following sources:

- Atlantic RBCA (2015). Atlantic Risk-Based Corrective Action (RBCA) Tier II Pathway Specific Screening Levels (PSSLs) for Groundwater, Table 5b, Ingestion, Residential
- NSE (2013). Nova Scotia Environmental (NSE) Pathway Specific Standards (PSS) Table 3
 Pathway Specific Standards for Groundwater, Potable Groundwater Drinking Water
- Ontario Ministry of the Environment, Conservation and Parks (MECP) Groundwater components for Potable Water Scenario, GW1, Coarse-Textured Soils (Ontario MOECC, 2016)
- USEPA (2018) Tapwater RSLs

The Ontario MECP component values and USEPA RSLs were adjusted (multiplied by 10) to the Health Canada and CCME target incremental cancer risk of 1.0 x 10⁻⁵. The USEPA RSLs for a target HQ of 0.1 were adjusted (multiplied by 2) to the Health Canada and CCME target HQ of 0.2.

As indicated in Table 7-6, the maximum concentrations for all analyzed parameters in surface water are less than the HHSLs, with the exception of several general chemistry parameters (chloride, sodium and total dissolved solids). However, the concentrations of general chemistry parameters in the waterlot surface water samples are consistent with the background concentrations. Therefore, there were no COPCs carried forward for the waterlot with respect to human consumption or dermal contact with surface water.

Table 7-5 Human Health Screening for Consumption of Shellfish

Chemical	Maximum Site Concentration (mg/kg)	Maximum Reference Concentration (mg/kg)	Human Health Screening Levels (mg/kg)	Reference (1)	Comment
Metals					
Arsenic	4.0	5.0	3.5	а	Maximum exceed HHSL but below background
Cadmium	17.80	4.90	1.85	b	Maximum exceed HHSL and background
Copper	20	19	74	b	Maximum and background below HHSL
Lead	0.7	1.1	0.5	а	Maximum exceeds HHSL but below background
Mercury	<0.05	<0.05	0.5	а	Maximum and background below HHSL
Selenium	<1	1.0	9.3	b	Maximum and background below HHSL
Zinc	108	74	556	b	Maximum and background below HHSL
Polycyclic Aromatic Hydroc	arbons				
1-Methylnaphthalene	0.037	0.120	8.61	b	Maximum and background below HHSL
2-Methylnaphthalene	0.051	0.027	7.42	b	Maximum and background below HHSL
Acenaphthene	0.016	0.018	111	b	Maximum and background below HHSL
Acenaphthylene	0.002	0.002	111	b	Maximum and background below HHSL
Acridine	<0.002	<0.002	-	b	Site and background below detection limits
Anthracene	0.002	0.001	556	b	Maximum and background below HHSL
Benzo(e)pyrene	0.007	0.016	0.25	b	Maximum and background below HHSL
Fluoranthene	0.022	0.015	74.2	b	Maximum and background below HHSL
Fluorene	0.004	0.003	74.2	b	Maximum and background below HHSL
Naphthalene	0.032	0.014	37.1	b	Maximum and background below HHSL
Perylene	0.002	0.001	55.6	b	Maximum and background below HHSL
Phenanthrene	0.018	0.008	37.1	b	Maximum and background below HHSL
Pyrene	0.043	0.012	55.6	b	Maximum and background below HHSL
B(a)P TPE	0.013	0.018	0.25	b	Maximum and background below HHSL
Polychlorinated Biphenyls					
Total PCBs	<0.5	<0.5	2	а	Maximum and background below HHSL

Notes

BOLD - identified as a COPC

- 1. Human health screening levels sources:
 - a. Canadian Food Inspection Agency Appendix 3, Canadian Guidelines for Chemical Contaminants and Toxins in Fish and Fish Products, amended August 2014.
 - b. USEPA Regional Screening Levels (RSLs) for Fish, May 2018, adjusted for target ILCR of 1 x 10^{-5} and HQ of 0.2.

Assumed a shellfish ingestion rate of 9 g/day, as indicated in Health Canada (2007).

For acenaphthylene, the guideline value for acenaphthene was applied.

For phenanthrene, the guideline value for naphthalene was applied

For perylene, the guideline value for pyrene was applied.

Table 7-6 Human Health Screening for Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Human Health Screening Levels (mg/L)	Reference (1, 2)	Background Concentration Range (mg/L)	Identified as a COPC for Human Health? Yes or No	Comment
Petroleum Hydrocarbons							
Benzene	<0.001	NC	0.05	а	<0.001	No	Maximum meets Human Health Screening Level
Toluene	<0.001	NC	0.6	а	<0.001	No	Maximum meets Human Health Screening Level
Ethylbenzene	<0.001	NC	1.4	а	<0.001	No	Maximum meets Human Health Screening Level
Xylenes	<0.002	NC	0.9	а	<0.002	No	Maximum meets Human Health Screening Level
C6-C10 (less BTEX)	<0.01	NC	-	-	<0.01	No	Maximum meets Human Health Screening Level
C10-C16	<0.05	NC	-	-	<0.05	No	Maximum meets Human Health Screening Level
C16-C21	<0.10	NC	-	-	<0.10	No	Maximum meets Human Health Screening Level
C21-C32	<0.1	NC	-	-	<0.1	No	Maximum meets Human Health Screening Level
Modified TPH	<0.1	NC	32	b	<0.1	No	Maximum meets Human Health Screening Level
Metals							
Aluminum	0.031	NC	1	а	0.012-0.021	No	Maximum meets Human Health Screening Level
Antimony	<0.002	NC	0.06	а	<0.002	No	Maximum meets Human Health Screening Level
Arsenic	<0.002	NC	0.1	а	<0.002	No	Maximum meets Human Health Screening Level
Barium	0.009	NC	10	а	0.007	No	Maximum meets Human Health Screening Level
Beryllium	<0.002	NC	0.04	С	<0.002	No	Maximum meets Human Health Screening Level
Bismuth	<0.002	NC	NG	-	<0.002	No	Maximum meets Background
Boron	3.57	NC	50	а	3.41-3.95	No	Maximum meets Human Health Screening Level
Cadmium	<0.00009	NC	0.05	а	<0.00009	No	Maximum meets Human Health Screening Level
Chromium	0.009	NC	0.5	а	0.008	No	Maximum meets Human Health Screening Level
Cobalt	0.003	NC	0.1	С	0.003	No	Maximum meets Human Health Screening Level
Copper	0.011	NC	10	а	0.011-0.013	No	Maximum meets Human Health Screening Level
Iron	0.21	NC	3	а	0.157-0.177	No	Maximum meets Human Health Screening Level
Lead	<0.0005	NC	0.1	а	<0.0005	No	Maximum meets Human Health Screening Level
Manganese	0.015	NC	0.5	а	0.005-0.009	No	Maximum meets Human Health Screening Level
Mercury	<0.000026	NC	0.01	а	<0.000026	No	Maximum meets Human Health Screening Level
Molybdenum	0.008	NC	0.7	С	0.007-0.009	No	Maximum meets Human Health Screening Level
Nickel	0.019	NC	1	С	0.020-0.024	No	Maximum meets Human Health Screening Level
Phosphorous	0.00003	NC	NG	-	0.00003	No	Maximum meets Background
Selenium	0.002	NC	0.5	а	<0.001	No	Maximum meets Human Health Screening Level
Silver	<0.0001	NC	1	С	<0.0001	No	Maximum meets Human Health Screening Level
Strontium	5.08	NC	44	С	4.62-5.69	No	Maximum meets Human Health Screening Level
Thallium	<0.0001	NC	0.02	С	<0.0001	No	Maximum meets Human Health Screening Level
Tin	<0.002	NC	44	С	<0.002	No	Maximum meets Human Health Screening Level

Table 7-6 Human Health Screening for Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Human Health Screening Levels (mg/L)	Reference (1, 2)	Background Concentration Range (mg/L)	Identified as a COPC for Human Health? Yes or No	Comment
Titanium	0.01	NC	NG	-	0.014-0.025	No	Maximum meets Background
Uranium	0.0021	NC	0.2	а	0.0020-0.0024	No	Maximum meets Human Health Screening Level
Vanadium	1.18	NC	200	а	0.930-0.944	No	Maximum meets Human Health Screening Level
Zinc	<0.005	NC	50	а	<0.005	No	Maximum meets Human Health Screening Level
Polycyclic Aromatic Hydrocarbon	ıs						
1-Methylnaphthalene	<0.00001	NC	0.12	С	<0.00001	No	Maximum meets Human Health Screening Level
2-Methylnaphthalene	0.00001	NC	0.12	С	<0.00001	No	Maximum meets Human Health Screening Level
Acenaphthene	<0.00001	NC	14	С	<0.00001	No	Maximum meets Human Health Screening Level
Acenaphthylene	<0.00001	NC	0.045	С	<0.00001	No	Maximum meets Human Health Screening Level
Acridine	<0.00001	NC	0.0024	f	<0.00001	No	Maximum meets Human Health Screening Level
Anthracene	<0.00012	NC	70.7	d	<0.000012	No	Maximum meets Human Health Screening Level
Benz[a]anthracene	<0.00018	NC	0.01	е	<0.000018	No	Maximum meets Human Health Screening Level
Benzo[a]pyrene	<0.00010	NC	0.0004	а	<0.000010	No	Maximum meets Human Health Screening Level
Benzo[b]fluoranthene	<0.00001	NC	0.001	е	<0.00001	No	Maximum meets Human Health Screening Level
Benzo(b+j)fluoranthene	<0.00001	NC	0.001	е	<0.00001	No	Maximum meets Human Health Screening Level
Benzo(e)pyrene	<0.00001	NC	0.01	е	<0.00001	No	Maximum meets Human Health Screening Level
Benzo[ghi]perylene	<0.00001	NC	0.01	е	<0.00001	No	Maximum meets Human Health Screening Level
Benzo[k]fluoranthene	<0.00001	NC	0.001	е	<0.00001	No	Maximum meets Human Health Screening Level
Chrysene	<0.00001	NC	0.001	е	<0.00001	No	Maximum meets Human Health Screening Level
Dibenz[a,h]anthracene	<0.00001	NC	0.0001	е	<0.00001	No	Maximum meets Human Health Screening Level
Fluoranthene	<0.00001	NC	9.43	d	<0.00001	No	Maximum meets Human Health Screening Level
Fluorene	<0.00001	NC	9.4	С	<0.00001	No	Maximum meets Human Health Screening Level
Indeno[1,2,3-cd]pyrene	<0.00001	NC	0.001	е	<0.00001	No	Maximum meets Human Health Screening Level
Naphthalene	<0.00001	NC	4.7	С	<0.00001	No	Maximum meets Human Health Screening Level
Perylene	<0.00001	NC	7.1	С	<0.00001	No	Maximum meets Human Health Screening Level
Phenanthrene	<0.00001	NC	0.01	е	<0.00001	No	Maximum meets Human Health Screening Level
Pyrene	<0.00001	NC	7.1	С	<0.00001	No	Maximum meets Human Health Screening Level
Quinoline	<0.00001	NC	0.0024	f	<0.00001	No	Maximum meets Human Health Screening Level
General Chemistry							
Chloride	11600	NC	2500	а	11400-12900	No	Maximum meets Background
Fluoride	<24	NC	15	а	<24	No	Maximum meets Human Health Screening Level
Sulphate	1500	NC	5000	а	1480-1690	No	Maximum meets Human Health Screening Level
True Color	22 TCU	NC	150 TCU	а	<5-10 TCU	No	Maximum meets Human Health Screening Level
Turbidity	1.5 NTU	NC	3 NTU	а	0.8-1.4 NTU	No	Maximum meets Human Health Screening Level

Table 7-6 Human Health Screening for Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Human Health Screening Levels (mg/L)	Reference (1, 2)	Background Concentration Range (mg/L)	Identified as a COPC for Human Health? Yes or No	Comment
Nitrate as N	<10	NC	100	а	<10	No	Maximum meets Human Health Screening Level
Nitrite as N	<10	NC	10	а	<10	No	Maximum meets Human Health Screening Level
Total Sodium	7930	NC	2000	а	7140-8350	No	Maximum meets Background
Calculated TDS	22200	NC	5000	а	21500-24700	No	Maximum meets Background

Notes

NC - Not Calculated

NG - No Guidelines

BOLD - carried forward in the HHRA for further evaluation

- 1. Due to drinking-water guideline values relate to water ingestion and, in most cases, to lifetime exposure; WHO guidelines (2003) assume a contribution for direct contact of an equivalent of 10% of drinking-water consumption. Therefore WHO's simple screening approach is that a substance occurring in water at a concentration ten times that stipulated in the drinking-water guidelines may merit further consideration as referred to in Section 10.5. WHO, 2003: Guidelines for Safe Recreational Water Environments, Volume 1: Coastal and Freshwaters, World Health Organization, 2003.
- 2. Human health screening levels sources:
 - a. Health Canada Guidelines for Canadian Drinking Water Quality Summary Table, February 2017

 (https://www.canada.ca/en/health-canada/services/environmental-workplace-health/water-quality/drinking-water/canadian-drinking-water-guidelines.html).
 - b. ARBCA Tier II Pathway Specific Screening Levels for Groundwater, Table 5b, Ingestion, Residential, September 2015.
 - c. Nova Scotia Remediation Levels Protocol, Table 3: Pathway Specific Standards for Residential Groundwater, Coarse, Minister of Environment, PRO-500, July 2013 (potable groundwater drinking water).

 For perylene, the guideline value for pyrene was applied.
 - d. AEP Alberta Remediation Guidelines, Table C-11, Surface Water Quality Guidelines, Drinking Water, February 2016.
 - e. Ontario MECP Groundwater Components for Potable Water Scenario, GW1, Coarse Textured Soils.
 For benzo(e)pyrene, the lowest guideline value of the non-carcinogenic PAHs (phenanthrene)was applied.
 - f. USEPA Tap Water Regional Screening Level, November 2018. Note: RSLs are based on risk of 1 x 10⁻⁶, therefore quinoline RSL adjusted to a risk of 1 x 10⁻⁵. For acridine, the guideline value for quinoline was applied.



7.1.2 Receptor Identification

Existing and intended land use is an important factor in evaluating the potential exposures and estimating risk. It is important that the most protective assumptions are made about the potential receptors. The Site is currently an operating Shipyard and is expected to remain so. Therefore, the main human receptors at the Site include adult commercial workers and occasional construction workers. It is unknown if commercial or sport/subsistence fishing harvesting occurs within Mortier Bay. Although fishing and shellfish harvesting may be unlikely within the waterlot due to the commercial nature, fishing and harvesting may occur in close proximity. Therefore, fishers have been included as potential receptors in the assessment.

7.1.3 Exposure Pathway Assessment

The exposure assessment evaluated the likelihood that potential hazards may come into contact with potential human receptors. The likelihood of exposure is determined through consideration of the properties of individual hazards that control chemical mobility, and the various pathways through which the hazard could move to contact the receptor, or through which the receptor could move to contact the hazard. The exposure analysis also considers the possible mechanisms through which a hazard can be introduced to a human receptor (i.e., ingestion, dermal contact, and inhalation).

Exposure pathways are used to describe how a substance could move from the impacted media (soil, water, etc.) to a point where it can come in contact with the body. Only those pathways for which there is a reasonable potential for exposure were considered quantitatively in this risk assessment. The likelihood of exposure includes consideration of the duration and frequency of exposure to chemicals of potential concern. The exposure scenarios that have been considered for human receptors at the Site include:

- Ingestion/dermal contact with soil
- Inhalation/ingestion/dermal contact with dust
- Ingestion of vegetation or garden produce grown in impacted soil
- Ingestion of wild game present at the Site and exposed to impacted soil
- Ingestion/dermal contact with surface water
- Ingestion/dermal contact with groundwater
- Ingestion/dermal contact with sediment
- Ingestion of fish/shell fish present in Mortier Bay and exposed to impacted surface water and sediment
- Inhalation of vapours

GHD has identified the likelihood that the on-Site receptors may be exposed to the identified hazards through the various exposure scenarios using a qualitative method. The likelihood of exposure is considered and evaluated in terms of the series of definitions presented in Table 7-7.



Table 7-7 Exposure Definitions

Likelihood of Exposure	Definition
Very Unlikely	Level of exposure that could result in adverse effects is not expected.
Unlikely	Level of exposure that could result in adverse effects would probably not occur.
Possible	Level of exposure that could result in adverse effects might be expected.
Likely	Level of exposure that could result in adverse effects is expected. Exceedance of this exposure level might be expected.

The relevant exposure pathways are summarized in Table 7-8, which includes the qualitative evaluation of each pathway and a justification for the likelihood of exposure assigned based on Site-specific conditions. The likelihood of exposure includes consideration of the duration and frequency of exposure to each potential hazard and to the relative concentrations to which the receptor is likely to be exposed. Those hazard-exposure-receptor combinations considered to have the highest likelihood to contribute a health risk are carried forward for further quantitative analysis.

Table 7-8 Potential Exposure Scenarios - Human Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward?	Justification
Ingestion of soil			As indicated above, the concentrations of
Dermal contact with soil	Possible	No	COPCs in soil are less than the HHSLs for direct contact exposure (ingestion and dermal
Ingestion of dust	1 0331010	110	contact). Therefore, further assessment of direct contact exposure to soil is not required
Dermal contact with dust			in the HHRA.
Ingestion of vegetation naturally growing in impacted soil at the Site	Very Unlikely	No	Due to the commercial nature of the Site, it is not expected that on-Site vegetation will be harvested for human consumption. Therefore, further assessment of exposure to COPCs in soil through ingestion of vegetation grown at the Site is not required in the HHRA.
Ingestion of wild game present at the Site and exposed to impacted soil	Very Unlikely	No	Due to the commercial nature of the Site, it is not expected wild game will be present or hunted on the Site. Therefore, further assessment of exposure to COPCs in soil through ingestion of wild game is not required in the HHRA.



Table 7-8 Potential Exposure Scenarios - Human Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward?	Justification
Ingestion and dermal contact of surface water	Possible	No	Commercial and recreational vessels use the harbour for docking, loading/off-loading of equipment, boat maintenance, and re-fueling. Local residents are known to harvest shellfish from the harbour. It is considered possible that commercial workers and recreational users could come into contact with surface water from the harbour. However, there were no COPCs carried forward in the HHRA for direct contact with surface water. Therefore, further assessment of surface water exposure in the HHRA was not required.
Ingestion and dermal contact of sediment	Possible	Yes	It is considered possible that commercial workers at the shipyard could come into contact with sediment from the waterlot during the course of their work. Although workers are assumed to be working under a site specific health and safety program, COPCs identified as exceeding direct contact HHSLs (arsenic and lead) have been carried forward for further assessment in the HHRA.
Ingestion of fish/shellfish caught from Mortier Bay	Possible	Yes	Harvesting of shellfish occurs within the waters of Mortier Bay directly adjacent to the waterlot boundaries. However, concentrations of COPCs in shellfish tissue collected from the waterlot, specifically scallops, were below applicable guidelines and consistent with background concentrations excluding cadmium. As such, further assessment of COPCs in shellfish tissue through the ingestion pathway is limited to cadmium. Fishing for finfish is not known to occur directly in the waterlot boundary and finfish were not observed to be present in the waterlot at the time of the Supplemental Phase II ESA. Fishing reportedly occasionally occurs in other areas of Mortier Bay adjacent to the waterlot for migratory species. Given the shellfish results and the absence of observed finfish directly in the waterlot, it is reasonable to assume that migratory fish exposure to COPCs in sediment or food items from within the waterlot would be insignificant. Further evaluation of risk to human health through the fish consumption pathway is not deemed warranted.



Table 7-8 Potential Exposure Scenarios - Human Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward?	Justification
Ingestion and dermal contact of groundwater	Possible	Yes	As indicated previously, groundwater is currently not used as a potable source and this is not expected to change in the future. However, construction workers conducting ground intrusive activities at the Site during future redevelopment could intersect the water table and become exposed to groundwater. The concentrations of arsenic, vanadium and mTPH in groundwater at the Site exceed the direct contact HHSLs (incidental ingestion and dermal contact). Therefore, further assessment of direct contact exposure to groundwater is required in the HHRA.
Inhalation of vapours (indoors)	Possible	Yes	There are currently a number of buildings located at the Site. Petroleum-related (mTPH) impacts exceeding the indoor air HHSLs in soil have been identified at the Site that could potentially migrate into the indoor air space of on-Site buildings. Although groundwater mTPH impacts do not exceed the indoor air HHSLs, the depth to groundwater is in some cases significantly shallower than that assumed in the derivation of the HHSLs. Therefore, further assessment of this pathway is required.
Inhalation of vapours (outdoors)	Possible	No	Petroleum-related impacts in soil and groundwater could potentially volatilize to outdoor air; however, it can be expected that any petroleum hydrocarbon vapours emitted to the ambient air from soil and/or groundwater will be immediately dispersed and diluted in the atmosphere to negligible levels. Therefore, the human receptor inhalation of vapours emitted to the outdoor air pathway is considered insignificant and was not considered further in this HHRA.

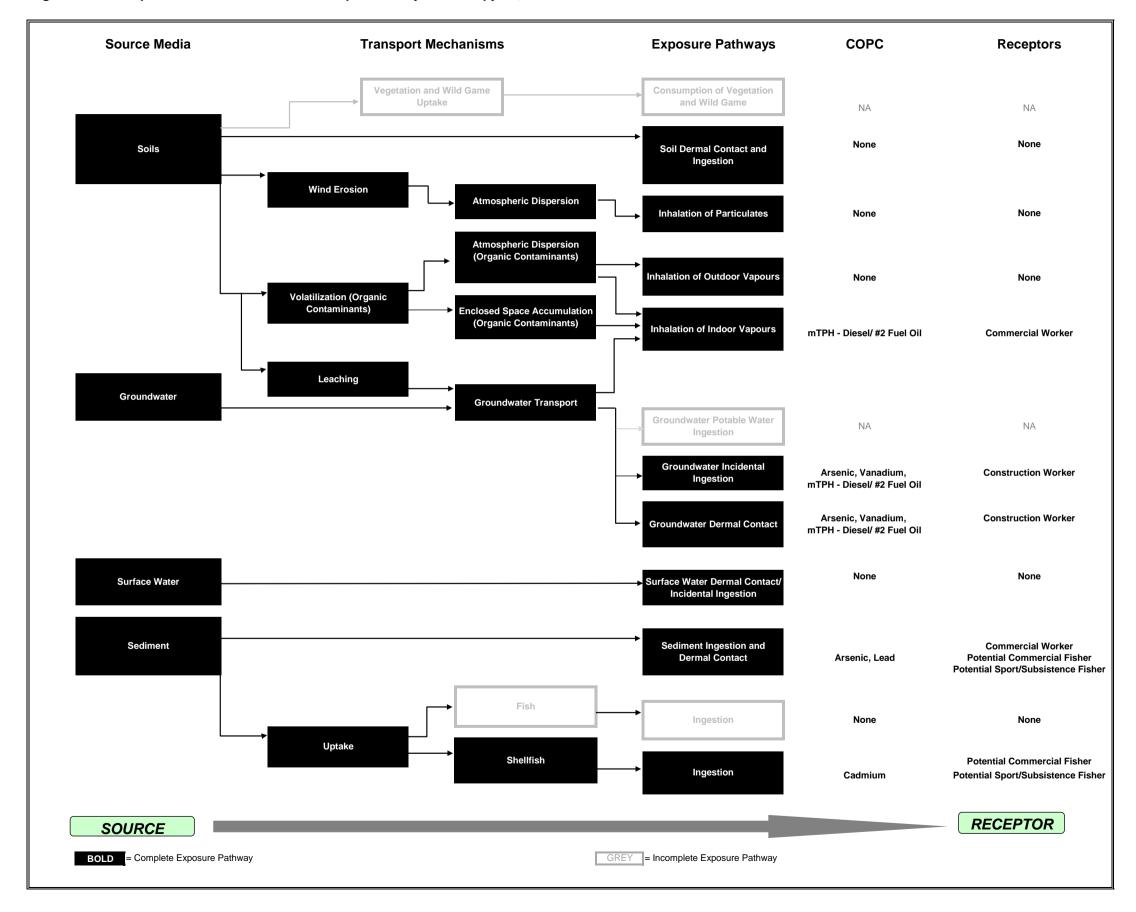
7.1.4 Human Health Conceptual Site Model

Based on the qualitative risk evaluation, the conceptual site model (CSM) developed for evaluating the quantitative exposure of the human receptor includes:

- Modified TPH in soil and groundwater for potential indoor air exposure within an enclosed structure utilized for commercial purposes (commercial worker).
- Arsenic, vanadium, and mTPH in groundwater for potential direct contact/incidental ingestion for commercial land use (construction worker).
- Arsenic and lead in sediment for direct contact/soil ingestion (commercial worker and potential fishers).
- Cadmium for potential consumption of shellfish (commercial and recreational fisher).

The CSM constructed for this HHRA is presented as Figure 7.1. The CSM provides a simplified representation of potential exposure pathways, linking COPC to each identified receptor.

Figure 7.1 Conceptual Site Model for Human Receptors - Marystown Shipyard, Newfoundland & Labrador





7.2 Exposure Assessment

7.2.1 Assessment Tools

A risk assessment model was used to develop the SSTLs and calculate the human health risk associated with the sediment impacts identified in the waterlot of the Shipyard Site. The specific methods employed to calculate risks and develop the SSTLs are consistent with CCME and HC protocols and with standard HHRA methodologies. The equations used in the modelling of impacts are shown on the spreadsheets in Appendix E.

7.2.2 Receptor Characteristics and Exposures

Important receptor characteristics for the adult Commercial worker exposed to sediment are presented in Table 7-9 and in Appendix E.

Table 7-9 Receptor Characteristics - Adult Commercial Worker

Characteristic		Adult Commercial Worker
	EF ₁ (hours per day worked per 24 hour/day)	8
Evposuro	EF ₂ (days per week worked per 7 d/wk)	5
Exposure	ET ₃ (weeks per year worked per 52 wks/yr)	48
	ED (years exposed)	80
BW	Body Weight (kg)	Adult: 70.7
IR _{soil}	Soil Ingestion Rate (kg/day)	Adult: 0.00002
SDR	Soil dermal contact rate (kg/day) = (SA hands x M hands) + (SA body x M body) x 1E-6 (kg/mg)	Adult: 0.000114
IRair	daily inhalation rate (m³ air/day)	Adult: 16.6
LE	Life Expectancy (yr)	80

Note:

ED and LE - To be employed for the assessment of carcinogens only.

Important receptor characteristics for the sport/subsistence fisher are presented in Table 7-10 and in Appendix E.

Table 7-10 Receptor Characteristics - Commercial/Subsistence Fisher

Characteristic		Commercial/Subsistence Fisher
Exposure	EF ₁ (days per week shellfish consumed per 7 d/wk)	5
	ET ₂ (weeks per year shellfish consumed per 52 wks/yr)	26
BW	Body Weight (kg)	Toddler: 16.5
IR _{shellfish}	Shellfish Ingestion Rate (kg/day) – applied for crab/scallop/mussel ingestion	Toddler: 0.009



For non-carcinogenic COPCs, exposure is calculated for the most sensitive receptors (i.e., toddler). There were no carcinogenic COPC for this pathway.

For the commercial/subsistence fisher, it was assumed that the commercial fisher would bring fish/shellfish catches home for family consumption and; therefore, potential exposure to all life stages was assumed for the commercial worker.

7.3 Toxicity Assessment

The potential hazards associated with exposures to non-carcinogenic (threshold) substances are assessed based on the assumption that there is a dose (or concentration) of the chemical of concern that does not produce any adverse effect. A TDI is an estimate of a chemical intake that is unlikely to cause an increased incidence of deleterious health effects during a lifetime of exposure.

The potential cancer risks associated with exposures to carcinogenic (non-threshold) substances are assessed based on the assumption that there is no dose below which an adverse effect will not occur, but at very low doses the probability of an adverse effect is very low. A CSF is an estimate of a chemical intake that meets HC's acceptable cancer risk benchmark of 1 in 100,000 (one additional cancer per 100,000 population).

Toxicity values have been established by several agencies including HC, the USEPA, and the WHO. Preference has been given to HC or other Canadian values and where these are not established, values from the USEPA's IRIS have been employed as the best basis upon which to evaluate health risks. The toxicity profiles for the COPCs are provided in Appendix E. Summaries of the toxicity values (TDI for non-carcinogens and CSF for carcinogens) selected for inclusion in the HHRA are provided in Table 7-11 (Non-Carcinogens) and Table 7-12 (Carcinogens).

Table 7-11 Selected Toxicity Values for Non-Carcinogens

Chemical	Route of Exposure	Toxicological Reference Value (mg/kg-day)	Toxicological Basis	Source Agency
Cadmium	Ingestion	0.001	Renal effects	Health Canada (2010a)
Lead	Ingestion	0.0011	Behavioural effects and learning disabilities in children	AFWEI (2015)

Table 7-12 Selected Toxicity Values for Carcinogens

Chemical	Route of Exposure	Cancer Slope Factor (mg/kg-day)	Source Agency
Arsenic	Ingestion	1.8	HC (2010b)

Bioavailability refers to "the fraction of the total amount of material in contact with a body portal of entry (lung, gut, skin) that enters the blood". For example, not all COPCs incidentally ingested in sediment may be absorbed through the gut. Relative bioavailability is the amount of a substance



entering the blood via a particular route of exposure (e.g., gastrointestinal) relative to the study used to derive the toxicity values. These factors were then applied in the risk assessment to more realistically represent the portion of contaminants that are available. An assumed bioavailability factor of 1.0 was applied for ingestion exposure.

7.4 **Risk Characterization**

Non-Carcinogens

Risk characterization compares the estimated exposures to the identified toxicity values for each non-carcinogenic substance to determine the potential for an adverse effect, also known as the Hazard Quotient (HQ). The Health Canada target HQ of 0.2 was used to determine whether the calculated health risks were acceptable or unacceptable. Based on the published toxicity value (TDI), and calculation of intake rate from ingestion, safe chemical concentrations in sediment, fish tissue and shellfish tissue (SSTLs) were calculated at the acceptable HQ of 0.2.

Carcinogens

Risk characterization compares the estimated exposures to the identified toxicity values for each carcinogenic substance to determine the potential for an adverse effect, also known as the Incremental Lifetime Cancer Risk (ILCR). The Health Canada target ILCR of 1 in 100,000 (one additional cancer per 100,000 population, or 10⁻⁵) was used to determine whether the calculated health risks were acceptable or unacceptable. Based on the published toxicity value (CSF) and calculation of intake rate from ingestion, a chemical concentration in sediment (SSTL) was calculated at the acceptable cancer risk benchmark of 1 in 100,000 (one additional cancer per 100,000 population, or 10⁻⁵).

Details of the equations and parameter values used in the analysis are provided in Appendix E.

7.4.1 Site Specific Target Level Calculation Results

7.4.1.1 **Commercial Worker Exposure to Sediment**

The calculated sediment SSTL for the commercial worker (adult) direct contact with sediment, and the corresponding EPC in sediment for arsenic and lead are presented in Table 7-13.

Table 7-13 Human Health Risk Assessment Results - Commercial Worker Exposure to Sediment

Chemical	Sediment EPC (mg/kg)	Sediment SSTL (mg/kg)
Arsenic	40.43	69
Lead	362	8588

BOLD = EPC > SSTL

As indicated in Table 7-13, the calculated SSTLs for the Commercial worker exposure to arsenic and lead through direct contact to sediment are greater than the corresponding sediment EPCs.



7.4.1.2 Shellfish Consumption

The calculated shellfish tissue SSTLs for the sport and commercial fisher consumption of shellfish, and the corresponding shellfish tissue EPCs are presented in Table 7-14. As indicated in Table 7-14, the calculated SSTLs for cadmium for the commercial/subsistence fisher consumption of shellfish exceeds the corresponding shellfish EPC concentrations (EPC value calculated based on cadmium concentrations in all shellfish collected from the Site; see Appendix D). Further evaluation of risk associated with the shellfish consumption pathway is discussed in Section 7.5.

Table 7-14 Human Health Risk Assessment Results -Commercial or Subsistence Fisher Consumption of Shellfish

Chemical	Shellfish Tissue EPC (mg/kg)	Shellfish Tissue SSTL (mg/kg)
Cadmium	8.6	5.9

Note:

BOLD = EPC > SSTL

7.5 Human Health Risk Assessment Results

7.5.1 Commercial Land Use - Indoor Air

Table 7-15 compares the soil and groundwater HHSLs protective of commercial indoor air inhalation exposure (Atlantic RBCA Tier II PSSLs) to the concentrations of mTPH in soil and groundwater. Since there are buildings on the Site, and specifically in the area where the maximum soil and groundwater concentrations are located, the maximum concentrations were used in this comparison.

Table 7-15 Human Health Risk Results - Commercial Indoor Air

COPC	Commercial Indoor Air Inhalation HHSL	Maximum Concentration
Soil (mg/kg)		
Modified TPH	4,000	7640
Groundwater (mg/L)		
Modified TPH	39,000	447

As indicated in Table 7-15, the maximum concentration for mTPH in soil exceeds the commercial indoor air inhalation HHSLs (Atlantic RBCA Tier II PSSLs). This indicates that there is the potential for unacceptable health risks from exposure to indoor air if there is a commercial building located in the vicinity of the soil impacts at the Site.

There were four soil samples collected at the Site that have mTPH concentrations greater than the commercial indoor air inhalation HHSLs: MSBL-BH5-2018-SS6 (Service Building), MLLA-MW3-2015-SS7 (Maintenance Parts Building) and MFPA-MW1-2018-SS5 (no building with 5 metres) as well as MAEB-MW2-2018-S4 near the Preparation Shop building. As illustrated on Figures 5A to 5C, it is estimated that the areas of impacts exceeding the commercial indoor air criteria total 431 square metres, at an average thickness of 1 metre.



Due to the locations of the commercial buildings on the Site, it is recommended that the soil exceedance areas illustrated on Figures 5A to 5C be further assessed through the installation and seasonal sampling of soil vapour probes.

Although the maximum groundwater concentration (447 mg/L in MGSB-MW15, near the Carpenters & Joiners Building) does not exceed the indoor air inhalation HHSL (Atlantic RBBC Tier II PSSL), the groundwater at the Site is shallower than that assumed in the derivation of the HHSLs and therefore the HHSL may not be applicable, which may warrant further assessment. Although no free product was measured in groundwater during the field work, the groundwater concentration measured in MGSB-MW15 is indicative of the possible presence of free product in the area. Therefore, it is recommended that consideration be given to further assessing the soil vapour to indoor air pathway in this area through the installation and seasonal sampling of soil vapour probes. Due to the monitor well's proximity to the existing building and the absence of elevated soil concentrations in the adjacent boreholes, sub-slab probes beneath the building may be preferred.

7.5.2 Construction Worker Direct Contact with Groundwater

Table 7-16 compares the groundwater HHSLs protective of commercial direct contact/incidental ingestion exposure to the concentrations of arsenic, manganese, vanadium and mTPH in groundwater.

Table 7-16 Human Health Risk Results - Construction Worker Direct Contact/Incidental Ingestion

COPC	Construction Worker Direct Contact/Incidental Ingestion HHSL	Maximum Concentration
Groundwater (mg/L)		
Arsenic	0.100	0.362
Vanadium	0.062	0.494
Modified TPH	32	447

As indicated in Table 7-16, the maximum concentrations for arsenic, vanadium and mTPH in groundwater exceed the direct contact/incidental ingestion HHSLs. This indicates that there may be the potential for unacceptable health risks to a construction worker on the Site from direct contact with the groundwater unless protected.

The groundwater samples collected at the Site that have arsenic and vanadium concentrations greater than the commercial direct contact/ingestion HHSLs were collected from the lower laydown area of the Shipyard. The groundwater samples that exceeded the mTPH direct contact/ingestion HHSLs were collected from monitor well MGSB-MW15, which is located on the south side of the general store building. The estimated groundwater plume exceeding the HHSLs for direct contact/ingestion exposure is illustrated on Figure 6 and further highlighted on Figure 6A. As the on-Site groundwater is not being consumed, the only receptor with potential groundwater contact would be a construction worker. Therefore, it is recommended that a Site specific health and safety plan be developed to address possible contact with groundwater should sub-surface work (where



groundwater will be intersected) be planned in the lower laydown area and the south side of the general store building.

7.5.3 Commercial Worker Direct Contact with Sediment

Table 7-17 compares the sediment HHSLs protective of commercial direct contact/soil ingestion exposure to the concentrations of arsenic and lead in sediment.

Table 7-17 Human Health Risk Results - Commercial Direct Contact/Incidental Ingestion

COPC	Commercial Direct Contact / Incidental Ingestion HHSL	EPC Concentration
Sediment (mg/kg)		
Arsenic	69	40.43
Lead	8588	362

As indicated in Table 7-17, the EPC concentrations for arsenic and lead in sediment are within the commercial direct contact/soil ingestion HHSLs. This indicates no further work is required to assess health risks to a commercial worker from direct contact with sediment at the Site.

7.5.4 Potential Consumption of Shellfish

Table 7-18 compares the shellfish SSTLs calculated to be protective of potential consumption of shellfish from the waterlot by commercial or subsistence shellfish eaters. As indicated in Table 7-18, the EPC concentration for cadmium in shellfish collected from the waterlot exceed the shellfish SSTL for the protection of shellfish consumption (heavy eater). However, the commercial/subsistence SSTL developed for the Site is based on the most sensitive receptor (toddler) consuming shellfish collected from the waterlot 5 days/week, 26 weeks/year (heavy consumer). This is a very conservative assumption as subsistence or commercial fishing is not known to occur directly in the waterlot and it is considered unlikely a toddler would be consuming 5 meals of shellfish collected exclusively from the waterlot on a weekly basis. As such, an additional SSTL was developed for the Site that assumes a toddler would consume shellfish from the waterlot 2 days/week, 26 weeks per year and is considered to be representative of a recreational consumer. An SSTL was also developed specific for an adult receptor that may consume shellfish from the waterlot 5 days/week, 26 weeks per year (commercial/subsistence fisher). The revised SSTLs based on an adult subsistence fisher and a recreational toddler with reduced shellfish consumption are included in Table 7-18.



Table 7-18 Human Health Risk Results - Shellfish Consumption Pathway

COPC	Shellfish SSTL – Subsistence Toddler Consumption of Shellfish (5 days/wk, 26 wks/year)	Shellfish SSTL – Recreational Toddler Consumption of Shellfish(2 days/wk, 26 wks/year)	Shellfish SSTL – Subsistence/ Commercial Adult Consumption of Shellfish (5 days/wk, 26 wks/year)	EPC based on whole body concentration	EPC based on abductor muscle only
Shellfish Tissue (mg/kg)					
Cadmium	5.9	10.1	9.3	8.6	0.86

Note: Abductor muscle conservatively assumed to be 10% of wholebody as per Department of Fisheries and Oceans, Research Branch (J.F. Uthe and C.L. Chou, 1986)

As indicated in Table 7-18, the EPC for cadmium in shellfish is below the SSTLs developed for the recreational toddler consumption of shellfish with reduced exposure frequency. The EPC for cadmium in shellfish is also below the SSTL developed for an adult subsistence/commercial (heavy) consumer of shellfish. As such, it is reasonable to assume that the concentrations of cadmium in shellfish at the Site is unlikely to pose a risk to human health based on the current/historical waterlot usage as a shipyard.

A review of the shellfish tissue data also indicated that the elevated cadmium EPC was primarily related to concentrations of cadmium in scallop tissue. The maximum concentrations of cadmium in crab and mussel tissue collected from the Site were 2.9 and 4.8 mg/kg, respectively, and well below the SSTL. However, concentrations of cadmium in scallops collected from the waterlot ranged from 2.7 to 17.8 mg/kg with the reference sample being 4.9 mg/kg. A literature review indicates that cadmium can be naturally elevated in sea scallops and not specifically associated with contaminated sediment or surface water (J.F. Uthe and C.L. Chou, 1986; S.Ray and V. Jerome, 1987 and G.M. Krusynski, 2003). The above noted results for cadmium in shellfish tissue are also consistent with concentrations of these metals observed in reference crustaceans and mollusk samples collected from other harbours on the southern coast of NL as part of on-going work being completed by GHD on behalf of the federal government (personnel knowledge). Specific to scallops, concentrations of cadmium in tissue samples collected from other reference areas in southern NL ranged from 5.1 to 7.0 mg/kg. As concentrations of cadmium in soil, groundwater, sediment and surface water at the Site were either below detection limits or applicable screening guidelines, it is reasonable to assume that the elevated concentrations of cadmium in tissue samples collected from the waterlot are related background conditions in the Mortier Bay area and not specific to the Site.

Although the maximum concentration of cadmium in scallop tissue samples collected from the waterlot exceeded the SSTL, the scallop tissue concentration is based on a composite of soft tissue within the scallop shell and not just the abductor muscle which is generally considered the edible



portion of sea scallops. A study conducted by the Department of Fisheries and Oceans, Research Branch (J.F. Uthe and C.L. Chou, 1986) indicates that 75 to over 90% of the total cadmium in the soft tissue of scallops is concentrated in the digestive gland, with less than 1% in the abductor muscle. This same study identified the mean concentration of cadmium in digestive glands of scallops collected from various areas in the Maritime Provinces being 94.68 mg/kg wet weight. The corresponding whole abductor muscle had a cadmium concentration of 0.117 mg/kg wet weight. As indicated in Table 7-18, it has been conservatively assumed that the abductor muscle is 10% of wholebody which would result in an EPC that is well below the SSTLs developed for both a toddler and adult receptor (subsistence, recreational/commercial consumption). As such, it is reasonable to assume that the concentration of cadmium in the edible portion of scallops (abductor muscle) collected from the Site is well below concentrations that are considered to pose a potential risk to human health.

In addition to natural bioaccumulation of cadmium in digestive glands of scallops with the negligible concentrations present in the edible abductor muscles, the health risks for consumption of shellfish were calculated using other highly conservative assumptions, including:

- 1) Absorption into the bloodstream from shellfish ingestion was assumed to be 100 percent.
- 2) It was assumed that the shellfish consumed by the receptors have spent their entire lives within the waterlot limits. This is highly conservative given the mobile nature of these food items.
- 3) It was assumed that the sport/subsistence and commercial fish consumers only harvest and consume shellfish collected from within the waterlot.

Based on the above noted rationale, the concentrations of cadmium in shellfish tissue in the waterlot (specifically scallops) are considered to be related to background conditions in the area and unlikely to pose an unacceptable risk to human health based on current Site usage. It has been confirmed recreational fishing for scallops does occur in the waterlot or adjacent areas; however, the DFO recreational and commercial harvesting licenses specify "On the recommendation of the Canadian Food Inspection Agency (CFIA), DFO wishes to advise both commercial and recreational harvesters not to consume any portion, other than the adductor muscle ("meat"), from scallops that are harvested from the shoreline and adjacent waters surrounding the province of Newfoundland and Labrador". As indicated above, cadmium concentrations in abductor muscles typically constitute less than 1% of the total cadmium concentrations in the soft tissue of scallops and; therefore, below the SSTLs developed for substance/commercial for both a toddler and adult receptor.

7.6 Summary of Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance that have been undertaken or followed in the preparation of this HHRA, it is believed that the risk assessment results present a reasonable yet conservative evaluation of the risk to human receptors present at the Site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable yet conservative assumptions were made, or data were selected, in order to ensure that risks were not underestimated.



The soil and groundwater to indoor air exposure pathways were assessed using published pathway specific guidelines. These guidelines are based on default assumptions that may or may not be consistent with all conditions at the Site. For example, the depth to groundwater at the site appears to be shallower than the default depth to groundwater used to derive the guidelines. In addition, the soil mTPH impacts observed appear to occur below the groundwater table in some cases and therefore may not be available to release soil vapour to indoor air. Therefore, additional work to further assess this pathway has been recommended for risk management. It is noted that in areas of shallow groundwater, there is potential for groundwater elevations to vary based on seasonal conditions and would account for the soil impacts in the vadose zone.

The shellfish ingestion pathway was evaluated using tissue data collected directly from the waterlot and reference areas. However, risk from the fish ingestion pathway was inferred based on the results of the Site-specific shellfish data, anecdotal evidence that fishing for finfish does not occur in the waterlot and the lack of observable finfish in the waterlot. The risk to human health from consumption of fish caught in Mortier Bay or the waterlot was not quantitatively evaluated as part of this evaluation given the lack of available Site-specific fish tissue.

Harvesting and consumption of shellfish specifically caught from within the waterlot boundaries is a major uncertainty. Anecdotal reports indicate that commercial harvesting of scallops occurs in Mortier Bay and, as noted previously, recreational harvesting is noted to occur in the waterlot and adjacent areas. In addition, the risk assessment conservatively assumes harvesting of shellfish for subsistence purposes occurs in the waterlot but the actual usage of waterlot as a subsistence food supply is considered unlikely. The risk to human health also assumed that it is unlikely a toddler would consume shellfish from the waterlot 5 meals/week, 26 weeks per year. However, the actual usage of the waterlot for harvesting shellfish, specifically scallops, and the actual consumption rate of shellfish collected from the waterlot is not known.

The elevated concentrations of cadmium in scallop tissue was assumed to be related to natural background conditions given the low concentrations of cadmium in soil, groundwater, sediment and surface water at the Site; however, the mechanism for bioaccumulation of cadmium in shellfish tissue is not known. The risk evaluation is based on the concentration of COPCs detected in soft tissue of shellfish and is not specific to edible portions of shellfish. Based on a literature review, it is reasonable to assume that the concentration of COPCs such as cadmium are significantly reduced in the edible portions of shellfish compared to whole body concentrations but the actual concentrations of cadmium in edible shellfish tissue from the waterlot was not evaluated.

8. Ecological Risk Assessment

The purpose of this ERA is to evaluate the potential for adverse effects to occur to ecological receptors as a result of exposure to concentrations of COPCs in environmental media at the Site. As with the HHRA, the ERA process follows a recognized framework that progresses from a qualitative initial phase (i.e., problem formulation), through exposure and toxicity (effects) analysis, and culminates in a quantitative risk characterization. Following this framework, the limitations and uncertainties inherent to the ERA process, and the relevance of these limitations and uncertainties to the conclusions stemming from the assessment, are discussed. This ERA has been conducted in



a manner consistent with accepted ERA methodologies and guidance published by regulatory agencies, including the CCME (1996; 1997).

The framework used for this ERA considered effects at the community level for common plants and invertebrates, at the population level for mammals and birds, and at the individual level for species identified as endangered, threatened, or extirpated under the *Species at Risk Act* (SARA) or similar provincial legislation (where they occur).

As there is no single set of ecological values or resources to be protected that can be generally applied to every site. Ecological receptors were selected by focusing on wildlife species that are indigenous to the area (i.e., taking into consideration the types, quality and quantity of habitat present at the site), are most likely to receive the greatest exposure to contaminants (due to their habitat, behavioral traits, and home ranges), and are representative of various feeding guilds or trophic levels.

8.1 Ecological Screening

The analytical data for soil, groundwater, sediment and surface water were compared to ecological specific screening values (ESLs) developed or recognized by the CCME or other ecological screening values, if a CCME guideline was not available.

8.1.1 Soil

The following guidelines (in order of preference) were used for the screening of chemicals in soil for inclusion in the ERA.

- CCME (1999, revised 2018). Canadian Soil Quality Guidelines for Environmental Health (SQG_E). Pathway-specific information from the individual fact sheets was reviewed to confirm environmental health guidelines protective of eco soil contact (terrestrial plants and invertebrates) and soil and food ingestion (terrestrial wildlife). For soil eco contact, the CCME commercial SQGs were applied consistent with the land use of the Site. For soil and food ingestion, the CCME agricultural SQGs were applied given that corresponding commercial guidelines are not available.
- Atlantic Risk-Based Corrective Action Tier 1 Soil Ecological Screening Levels for Protection of Plants and Soil Invertebrates (Table 1a; commercial, coarse) and Wildlife (Table 1b), September 2015.
- Ontario MOECC (Ontario MOECC, 2016). Mammals & Birds component values, residential/parkland land use, coarse-textured soil.

As indicated in Table 8-1, petroleum hydrocarbon (PHC) fraction F2, and PHC fraction F3 exceed the soil ESLs and therefore require further assessment in the ERA. All other parameters were detected at concentrations below the soil ESLs or background soil concentrations. For lead, the maximum concentration is less than the ESL protective of terrestrial plants and invertebrates but is greater than the ESL protective of terrestrial wildlife. However, since the EPC for lead is less than the ESL protective of terrestrial wildlife, lead was not carried through the ERA for further evaluation. For PHC F2 and PHC F3, the concentrations (maximum or EPC) in soil exceed the ESLs for plants and soil invertebrates but do not exceed the ESLs protective of terrestrial wildlife. Therefore, PHC



F2 and PHC F3 are carried forward for further evaluation of plants and soil invertebrates only. Further evaluation of terrestrial wildlife in the ERA was not required.

8.1.2 Groundwater

For groundwater, the potential exposure pathway identified for the Site was groundwater discharging to surface water for the protection of aquatic life. The following guidelines (in order of preference) were used for the screening of chemicals in groundwater for inclusion in the ERA.

- CCME (1999, revised 2018). Canadian Water Quality Guidelines for the Protection to Aquatic Life (WQG), marine water.
- Atlantic Risk-Based Corrective Action Tier 1 Surface Water Ecological Screening Levels for Protection of Freshwater and Marine Aquatic Life, Table 3a, September 2015. Based on predominant fuel oil resemblance.
- NSE EQS: Nova Scotia Environment Tier 1 Environmental Quality Standards, Marine Water, July 2013.

Given that the Site is adjacent to Mortier Bay, the screening values for groundwater discharging to surface water do not account for any dilution due to groundwater migration.

As indicated in Table 8-2, arsenic, cadmium, copper, nickel, selenium, vanadium, zinc, and mTPH have concentrations exceeding the groundwater ESLs and therefore require further assessment in the ERA. Since titanium was detected in groundwater but does not have a groundwater ESL, it also requires further assessment in the ERA.

Many of these parameters were also detected in sediment at concentrations exceeding the sediment ESLs protective of aquatic life (see below sediment screening). Given the proximity to Mortier Bay, surface water samples were collected from the waterlot as well as a reference area in Mortier Bay to directly assess COPCs in surface water that may be associated with the Site. Additional assessment of sediment and surface water is provided in the subsequent sections.

8.1.3 Sediment

For the protection of aquatic life, the sediment ESLs were CCME's Interim Sediment Quality Guidelines (ISQGs) and Probable Effect Levels (PELs), marine. In the development of the sediment quality guidelines, CCME considered all components of the aquatic ecosystem, if the data were available.

The CCME ISQGs are described as the lowest concentrations, below which adverse effects are rarely observed, whereas the CCME PELs are concentrations above which adverse effects are likely to occur. No-effect benchmarks such as the CCME ISQGs are appropriate for site screening but are not appropriate to guide remedial decisions. This approach is supported in:

 Criteria for the Assessment of Sediment Quality in Quebec and Application Frameworks: Prevention, Dredging and Remediation, Environment Canada and the Province of Quebec (2008).



This document recommends that there is no need to initiate a remediation process for concentrations lower than the CCME PELs, unless development projects or dredging work is planned. The CCME PELs are considered to be protective of valued environmental components (VECs). Therefore, parameters with concentrations below the CCME PELs were not identified as COPCs requiring further evaluation in the ERA.

Where CCME PELs were not available, screening values were selected from the following sources:

- Atlantic Risk-Based Corrective Action (RBCA) (2015). Sediment ecological screening levels (ARBCA ESL), marine.
- NSE EQS: Nova Scotia Environment Tier 1 Environmental Quality Standards for Sediment, marine sediment, July 2013.
- Ontario MOECC's Sediment Quality Guidelines, Lowest Effect Levels (LELs), Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Ontario MOE, 1993).
- Maximum permissible concentrations (MPCs), obtained from Crommentuijn et al. (2000).
 Maximum permissible and negligible concentrations for metals and metalloids in the
 Netherlands, taking into account background concentrations. Journal of Environmental
 Management 60: 121-143.

The sediment concentrations from the reference sample locations were also considered in the ecological screening for sediment. If the maximum concentration or EPC is less than the mean concentration in the reference sediment samples, or if the background analysis (see Section 6.3) indicates that COPC concentrations in sediment are statistically similar to the concentrations in the reference sediment samples, then the parameter was not identified as sediment COPC.

As indicated in Table 8-3, antimony, arsenic, copper, lead, selenium, zinc, PCBs, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene have concentrations exceeding the sediment ESLs and are present at concentrations greater than the reference sediment samples. Therefore, these parameters require further assessment in the ERA. Acridine and benzo(e)pyrene also require further assessment in the ERA since these PAHs were detected in sediment but do not have sediment ESLs and/or are present at concentrations greater than the reference sediment samples.

8.1.4 Surface Water

For the protection of aquatic life, the surface water ESLs were CCME's Canadian Water Quality Guidelines for the Protection to Aquatic Life (WQG) (CCME, 1999, and updates), marine.

Where CCME WQGs were not available, screening values were selected from the following sources:

- Atlantic Risk-Based Corrective Action Tier 1 Surface Water Ecological Screening Levels for Protection of Freshwater and Marine Aquatic Life, Table 3a, September 2015. Based on predominant fuel oil resemblance.
- NSE EQS: Nova Scotia Environment Tier 1 Environmental Quality Standards, Marine Water, July 2013.



- AEP (2016) Alberta Environment and Parks (AEP) Alberta Remediation Guidelines, Table C-11
 Surface Water Quality Guidelines, Aquatic Life, February.
- Ontario MECP Aquatic Protection Values (APVs), Modified Generic Risk Assessment Model, Version 2, November 2016 (Ontario MOECC, 2016).

The surface water concentrations from the reference sample locations were also considered in the ecological screening for surface water. If the maximum concentration is equal to or less than the surface water concentration in the reference surface water samples, then the parameter was not identified as a surface water COPC.

As indicated in Table 8-4, concentrations of COPCs in surface water were below applicable ESLs or background conditions in the area excluding vanadium. The maximum concentration of vanadium in surface water of the waterlot exceeded the surface water ESL and also marginally exceeded the concentrations observed in the reference surface water samples. However, the average concentration of vanadium in the five waterlot samples (1.1 mg/L) is approximately equal to the average concentration of vanadium observed in the reference samples (0.94 mg/L). In addition, the RPD between the average vanadium concentration in the waterlot samples and the reference samples is approximately 16% and well within the 30% RPD accuracy objective recommended by the United States Environmental Protection Agency (USEPA) for analysis of inorganic parameters:

 EPA 2010, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, USEPA-540-R-10-011, October, 2010

The USEPA guidance considers a <30% RPD between duplicate samples to be an acceptable level of accuracy in analytical measurements. As such, it is reasonable to apply this level of accuracy when comparing Site concentrations that are based on accepted laboratory methodologies to the reference samples. As such, it is reasonable to assume that the concentrations of vanadium in the waterlot surface water samples are representative of background conditions in the area.

Based on the above noted screening evaluation, concentrations of COPCs in surface water at the Site are below applicable ESLs or are consistent with background conditions in the area and unlikely to pose an incremental risk to aquatic ecological receptors. Further evaluation of risk to ecological receptors from exposure to COPCs in surface water is not considered warranted.

Table 8-1 Ecological Screening of Surface Soil for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration	Exposure Point Concentration	Newfoundland and Labrador		Ecological Scree (mg	ning Levels (ESL /kg))	Comment
Girenical	(mg/kg) (EPC) (mg/kg)				Reference	Terrestrial Wildlife	Reference	Comment
Metals								
Antimony	<1	NC	1	40	CCME SQG	40	CCME SQG	Maximum meets ESL
Arsenic	23	NC	17	26	CCME SQG	380	CCME SQG	Maximum meets ESL
Barium	343	NC	81	2000	CCME SQG	2000	CCME SQG	Maximum meets ESL
Beryllium	<2	NC	1	8	CCME SQG	8	CCME SQG	Maximum meets ESL
Cadmium	0.7	NC	0.8	22	CCME SQG	3.8	CCME SQG	Maximum meets ESL
Chromium	107	49	52	87	CCME SQG	160	Ontario CV	EPC meets ESL and background
Cobalt	34	NC	17	300	CCME SQG	300	CCME SQG	Maximum meets ESL
Copper	87	NC	57	91	CCME SQG	300	CCME SQG	Maximum meets ESL
Lead	96.7	43	35	600	CCME SQG	70	CCME SQG	Maximum exceeds Wildlife ESL but EPC below Wildlife ESL
Mercury	0.06	NC	1	50	CCME SQG	20	Ontario CV	Maximum meets ESL
Molybdenum	7	NC	1.1	40	CCME SQG	40	CCME SQG	Maximum meets ESL
Nickel	69	NC	72	89	CCME SQG	528	CCME SQG	Maximum meets ESL
Selenium	<1	NC	1	2.9	CCME SQG	4.5	CCME SQG	Maximum meets ESL
Silver	<0.5	NC	0.25	40	CCME SQG	40	CCME SQG	Maximum meets ESL
Thallium	<0.1	NC	0.27	3.6	CCME SQG	1	CCME SQG	Maximum meets ESL
Tin	4	NC	4.1	300	CCME SQG	300	CCME SQG	Maximum meets ESL
Uranium	0.6	NC	2.2	2000	CCME SQG	33	CCME SQG	Maximum meets ESL
Vanadium	100	66	86	130	CCME SQG	18	Ontario CV	EPC meets background
Zinc	329	NC	120	450	CCME SQG	960	CCME SQG	Maximum meets ESL
Petroleum Hydrocarbons								
Benzene	<0.03	NC	Not Available	180	CCME SQG	25	CCME SQG	Maximum meets ESL
Toluene	<0.04	NC	Not Available	250	CCME SQG	1400	CCME SQG	Maximum meets ESL
Ethylbenzene	< 0.03	NC	Not Available	300	CCME SQG	910	CCME SQG	Maximum meets ESL
Xylenes	< 0.05	NC	Not Available	350	CCME SQG	3700	CCME SQG	Maximum meets ESL
F1 C6-C10	70	NC	Not Available	320	ARBCA ESL	11000	ARBCA ESL	Maximum meets ESL
F2 >C10-C16	3910	1062	Not Available	260	ARBCA ESL	9800	ARBCA ESL	Maximum exceeds ESL
F3 >C16-C32	4090	1255	Not Available	1700	ARBCA ESL	16000	ARBCA ESL	Maximum exceeds ESL

NC - Not Calculated.

Ecological Screening Levels (ESLs):

CCME SQG: Canadian Council of Ministers of Environment, Soil Quality Guidelines for the Protection of Environmental Health, agricultural, coarse soils.

For plants & invertebrates, the commercial SQGs were applied. For mammals & birds, the agricultural SQGs were applied since there are no available commercial SQGs protective of these receptors.

ARBCA ESL: Atlantic Risk-Based Corrective Action Tier 1 Soil Ecological Screening Levels for Protection of Plants and Soil Invertebrates (Table 1a; commercial, coarse) and Wildlife (Table 1b), September 2015.

Ontario CV: Ontario Ministry of the Environment, Conservation and Parks Component Values, Modified Generic Risk Assessment, Mammals & Birds - residential/parkland, coarse soils.

Table 8-2 Ecological Screening of Groundwater for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration (μg/L)	Exposure Point Concentration (EPC) (µg/L)	Ecological Screening Levels (ESL) (μg/L)	Reference	Comment
Metals					
Antimony	<2	NC	500	NSE EQS	Maximum meets ESL
Arsenic	362	NC	12.5	CCME WQG	Maximum exceeds ESL
Barium	483	NC	500	NSE EQS	Maximum meets ESL
Beryllium	<2	NC	100	NSE EQS	Maximum meets ESL
Cadmium	0.16	NC	0.12	CCME WQG	Maximum exceeds ESL
Chromium	7	NC	56	CCME WQG	Maximum meets ESL
Cobalt	2	NC	10	NSE EQS	Maximum meets ESL
Copper	7	NC	2	NSE EQS	Maximum exceeds ESL
Lead	0.5	NC	2	NSE EQS	Maximum meets ESL
Molybdenum	5	NC	73	NSE EQS	Maximum meets ESL
Nickel	10	NC	8.3	NSE EQS	Maximum exceeds ESL
Selenium	156	NC	2	NSE EQS	Maximum exceeds ESL
Silver	0.2	NC	1.5	NSE EQS	Maximum meets ESL
Thallium	0.1	NC	21.3	NSE EQS	Maximum meets ESL
Tin	<2	NC	-	-	Not detected
Titanium	6	NC	-	-	Detected
Uranium	1.9	NC	100	NSE EQS	Maximum meets ESL
Vanadium	494	NC	50	NSE EQS	Maximum exceeds ESL
Zinc	32	NC	10	NSE EQS	Maximum exceeds ESL
Petroleum Hydrocarbons					
Benzene	<1	NC	110	CCME WQG	Maximum meets ESL
Toluene	<1	NC	215	CCME WQG	Maximum meets ESL
Ethylbenzene	<1	NC	25	CCME WQG	Maximum meets ESL
Xylenes	<2	NC	330	NSE EQS	Maximum meets ESL
Modified TPH	447000	357200	100	ARBCA ESL	Maximum and EPC exceed ESL

NC - Not Calculated. For all metals, the EPC could not be calculated due to insufficient sample numbers. For all other parameters the EPC was not required.

Ecological Screening Levels (ESLs): freshwater guidelines applied in the absence of marine guidelines

CCME WQG: Canadian Council of Ministers of Environment, Water Quality Guidelines for the Protection of Aquatic Life, marine.

ARBCA ESL: Atlantic Risk-Based Corrective Action Tier 1 Surface Water Ecological Screening Levels for Protection of Freshwater and Marine Aquatic Life, Table 3a, September 2015. Based on predominant fuel oil resemblance.

NSE EQS: Nova Scotia Environment Tier 1 Environmental Quality Standards, Marine Water, July 2013.

Table 8-3 Ecological Screening of Sediment for Marystown Shipyard, Newfoundland & Labrador

Chemical	Maximum Concentration (mg/kg)	Exposure Point Concentration (EPC) (mg/kg)	Sediment Reference Concentrations (mg/kg)	Ecological Screening Levels (ESL) (mg/kg)	Statistically Similar to Background? Yes or No (1)	Reference	Comment
Metals							
Antimony	28	11	<1	25	Cannot be Determined	NSE EQS	Maximum exceeds ESL
Arsenic	78	40	11	41.6	No	CCME SeQG	Maximum exceeds ESL
Barium	250	NC	41	300	No	Crommentuijn et al., 2000	Maximum meets ESL
Beryllium	<2	NC	<2	1.2	Yes	Crommentuijn et al., 2000	Not detected
Cadmium	1	NC	<0.3	4.2	Cannot be Determined	CCME SeQG	Maximum meets ESL
Chromium	98	NC	16	160	Yes	CCME SeQG	Maximum meets ESL
Cobalt	22	NC	8.3	50	No	Ontario LEL	Maximum meets ESL
Copper	260	168	9.3	108	No	CCME SeQG	Maximum exceeds ESL
Lead	728	362	7	112	No	CCME SeQG	Maximum exceeds ESL
Mercury	0.64	NC	0.05	0.7	Cannot be Determined	CCME SeQG	Maximum meets ESL
Molybdenum	9	NC	2.5	250	Yes	Crommentuijn et al., 2000	Maximum meets ESL
Nickel	45	NC	14	75	Yes	NSE EQS	Maximum meets ESL
Selenium	3	1.6	<1	2	Cannot be Determined	NSE EQS	Maximum exceeds ESL
Silver	<0.5	NC	<0.5	2.2	Yes	NSE EQS	Maximum meets ESL
Thallium	<0.1	NC	0.1	2.6	Yes	Crommentuijn et al., 2000	Maximum meets ESL
Tin	28	NC	3.3	22000	No	Crommentuijn et al., 2000	Maximum meets ESL
Uranium	2.5	1.7	1.3	-	Yes	-	Site statistically similar to
Vanadium	63	47	33	56	Yes	Crommentuijn et al., 2000	hadinen und
Zinc	5020	1681	34	271	No	CCME SeQG	Maximum exceeds ESL
Polychlorinated Bipheny		T				T	
PCBs	0.65	0.32	<0.02	0.189	Cannot be Determined	CCME SeQG	Maximum exceeds ESL
Petroleum Hydrocarbon		1 110				LABBOA FOI	
Benzene	<0.03	NC	<0.03	5.4	Yes	ARBCA ESL	Maximum meets ESL
Toluene	<0.04	NC NC	<0.04	6.1	Yes	ARBCA ESL	Maximum meets ESL
Ethylbenzene	<0.03	NC	<0.05	5	Yes	ARBCA ESL	Maximum meets ESL
Xylenes	<0.05	NC	<0.05	5.5	Yes	ARBCA ESL	Maximum meets ESL
Modified TPH	419	NC	<20	500	Cannot be Determined	ARBCA ESL	Maximum meets ESL
Polycyclic Aromatic Hyd		0.40	0.05	0.004	Cannot be Determined	00ME 0-00	
1-Methylnaphthalene	0.27	0.13 0.18	<0.05	0.201	Cannot be Determined	CCIVIE SEQUE	
2-Methylnaphthalene	0.38		0.04	0.004			Maximum exceeds ESL
Acenaphthene	0.700		<0.01	0.201	Cannot be Determined	CCME SeQG	Maximum exceeds ESL
	0.728	0.37	<0.00671	0.0889	Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene	0.465	0.37 0.16	<0.00671 <0.004	0.0889 0.128	Cannot be Determined Cannot be Determined Cannot be Determined	CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene Acridine	0.465 0.11	0.37 0.16 NC	<0.00671 <0.004 <0.05	0.0889 0.128 -	Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected
Acenaphthylene Acridine Anthracene	0.465 0.11 1.01	0.37 0.16 NC 0.48	<0.00671 <0.004 <0.05 <0.03	0.0889 0.128 - 0.245	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene	0.465 0.11 1.01 1.55	0.37 0.16 NC 0.48 0.97	<0.00671 <0.004 <0.05 <0.03 0.025	0.0889 0.128 - 0.245 0.693	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene	0.465 0.11 1.01 1.55 1.42	0.37 0.16 NC 0.48 0.97 0.81	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01	0.0889 0.128 - 0.245 0.693 0.763	Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene	0.465 0.11 1.01 1.55 1.42 1.96	0.37 0.16 NC 0.48 0.97 0.81 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05	0.0889 0.128 - 0.245 0.693 0.763 4.5	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(e)pyrene	0.465 0.11 1.01 1.55 1.42 1.96 0.93	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05	0.0889 0.128 - 0.245 0.693 0.763 4.5	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS	Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Detected
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.05	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG - CME SeQG NSE EQS - NSE EQS	Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.01 <0.05	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5	Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.01 <0.05 <0.05 <0.01 0.02 0.03	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5	Cannot be Determined No	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS NSE EQS NSE EQS NSE EQS CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g)h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.05 <0.05 <0.05 <0.01 0.02 0.03 <0.006	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135	Cannot be Determined No Yes	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS NSE EQS NSE EQS NSE EQS NSE EQS CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.05 <0.05 <0.01 <0.02 0.02 0.03 <0.006	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494	Cannot be Determined No Yes No	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS - NSE EQS CCME SeQG CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(b)fluoranthene Benzo(g)pyrene Benzo(g)h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93 0.94	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC 2.2 0.36	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.01 <0.05 <0.05 <0.01 0.02 0.03 <0.006 0.07 <0.01	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494 0.144	Cannot be Determined No Yes No Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS - NSE EQS CCME SeQG CCME SeQG CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.05 <0.05 <0.01 <0.02 0.02 0.03 <0.006	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494	Cannot be Determined No Yes No	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS - NSE EQS CCME SeQG CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(b)fluoranthene Benzo(g)pyrene Benzo(g)h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93 0.94	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC 2.2 0.36 0.58	<0.00671 <0.004 <0.005 <0.03 0.025 <0.01 <0.05 <0.01 0.02 0.03 <0.001 0.02 0.03 <0.006 0.07 <0.01 <0.01	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494 0.144	Cannot be Determined No Yes No Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS NSE EQS CCME SeQG CCME SeQG CCME SeQG CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(c)pyrene Benzo(c)h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Naphthalene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93 0.94 1.13 0.62	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC NC 0.99 NC 2.2 0.36 0.58	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.05 <0.05 <0.01 0.02 0.03 <0.006 0.07 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001 <0.001	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494 0.144 0.88 0.391	Cannot be Determined No Yes No Cannot be Determined Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS NSE EQS CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL
Acenaphthylene Acridine Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(e)pyrene Benzo(y,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Naphthalene Perylene	0.465 0.11 1.01 1.55 1.42 1.96 0.93 0.86 0.72 1.7 <0.006 3.93 0.94 1.13 0.62 0.41	0.37 0.16 NC 0.48 0.97 0.81 NC 0.57 NC NC 0.99 NC 2.2 0.36 0.58 0.19	<0.00671 <0.004 <0.05 <0.03 0.025 <0.01 <0.05 <0.05 <0.01 0.02 0.03 <0.006 0.07 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.01 <0.05 <0.01 <0.05 <0.01 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.05 <0.0	0.0889 0.128 - 0.245 0.693 0.763 4.5 - 3.2 4.5 0.846 0.135 1.494 0.144 0.88 0.391 1.398	Cannot be Determined No Yes No Cannot be Determined Cannot be Determined Cannot be Determined Cannot be Determined	CCME SeQG CCME SeQG CCME SeQG - CCME SeQG CCME SeQG CCME SeQG CCME SeQG NSE EQS - NSE EQS NSE EQS CCME SeQG	Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Detected Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum exceeds ESL Maximum meets ESL Detected Maximum meets ESL Maximum meets ESL Maximum meets ESL Maximum exceeds ESL

NC - Not Calculated.

Sediment reference concentrations are the based on the mean concentrations from 18-MNMA-REF1, 18-MNMA-REF2, and 18-MNMA-REF3.

Ecological Screening Levels (ESLs): freshwater guidelines applied in the absence of marine guidelines

CCME SeQG: Canadian Council of Ministers of Environment, Sediment Quality Guidelines for the Protection of Marine Aquatic Life, Probable Effects Level (PEL).

ARBCA ESL: Atlantic Risk-Based Corrective Action Tier 1 Sediment Ecological Screening Levels for Protection of Freshwater and Marine Aquatic Life, Table 4, September 2015.

Based on predominant lube oil resemblance and average sediment foc of 0.1074.

NSE EQS: Nova Scotia Environment Environmental Quality Standards, Sediment Environment for Marine Sediment, July 2013.

Note: For perylene and quinoline, the guideline value for pyrene was applied.

Ontario LEL: Ontario Sediment Quality Guidelines, Lowest Effect Levels, August 1993.

Crommentuijn et al., 2000: Crommentuijn et al., 2000. Maximum permissible and negligible concentrations for metals and metalloids in the Netherlands, taking into account background concentrations, Sediment - Maximum Permissible Concentration (MPC), J. Environ. Manag. 60: 121-143.

Table 8-4 Ecological Screening of Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Ecological Screening Levels (µg/L)	Reference (1)	Background Concentration Range (mg/L)	Identified as a COPC for Ecological Health? Yes or No	Comment		
Petroleum Hydrocarbons									
Benzene	<0.001	NC	0.11	а	<0.001	No	Maximum meets Ecological Screening Level		
Toluene	<0.001	NC	0.215	а	<0.001	No	Maximum meets Ecological Screening Level		
Ethylbenzene	<0.001	NC	0.025	а	<0.001	No	Maximum meets Ecological Screening Level		
Xylenes	<0.002	NC	0.33	b	<0.002	No	Maximum meets Ecological Screening Level		
C6-C10 (less BTEX)	<0.01	NC	NG	-	<0.01	No	Maximum meets Background		
C10-C16	<0.05	NC	NG	-	<0.05	No	Maximum meets Background		
C16-C21	<0.10	NC	NG	-	<0.10	No	Maximum meets Background		
C21-C32	<0.1	NC	NG	-	<0.1	No	Maximum meets Background		
Modified TPH	<0.1	NC	0.1	b	<0.1	No	Maximum meets Ecological Screening Level		
Metals									
Aluminum	0.031	NC	0.1	а	0.012-0.021	No	Maximum meets Ecological Screening Level		
Antimony	<0.002	NC	0.5	С	<0.002	No	Maximum meets Ecological Screening Level		
Arsenic	<0.002	NC	0.0125	а	<0.002	No	Maximum meets Ecological Screening Level		
Barium	0.009	NC	0.5	С	0.007	No	Maximum meets Ecological Screening Level		
Beryllium	<0.002	NC	0.1	С	<0.002	No	Maximum meets Ecological Screening Level		
Bismuth	<0.002	NC	NG	•	<0.002	No	Maximum meets Background		
Boron	3.57	NC	1.2	С	3.41-3.95	No	Maximum meets Background		
Cadmium	<0.00009	NC	0.00012	а	<0.00009	No	Maximum meets Ecological Screening Level		
Chromium	0.009	NC	0.056	а	0.008	No	Maximum meets Ecological Screening Level		
Cobalt	0.003	NC	0.01	С	0.003	No	Maximum meets Ecological Screening Level		
Copper	0.011	NC	0.002	С	0.011-0.013	No	Maximum meets Background		
Iron	0.21	NC	0.3	С	0.157-0.177	No	Maximum meets Ecological Screening Level		
Lead	<0.0005	NC	0.002	С	<0.0005	No	Maximum meets Ecological Screening Level		
Manganese	0.015	NC	0.82	С	0.005-0.009	No	Maximum meets Ecological Screening Level		
Mercury	<0.000026	NC	0.000016	а	<0.000026	No	Maximum meets Background		
Molybdenum	0.008	NC	0.073	а	0.007-0.009	No	Maximum meets Ecological Screening Level		
Nickel	0.019	NC	0.0083	С	0.020-0.024	No	Maximum meets Background		
Phosphorous	0.00003	NC	NG	-	0.00003	No	Maximum meets Background		

Table 8-4 Ecological Screening of Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Ecological Screening Levels (μg/L)	Reference (1)	Background Concentration Range (mg/L)	Identified as a COPC for Ecological Health? Yes or No	Comment
Selenium	0.002	NC	0.002	С	<0.001	No	Maximum meets Ecological Screening Level
Silver	<0.0001	NC	0.0015	а	<0.0001	No	Maximum meets Ecological Screening Level
Strontium	5.08	NC	21	С	4.62-5.69	No	Maximum meets Ecological Screening Level
Thallium	<0.0001	NC	0.0213	С	<0.0001	No	Maximum meets Ecological Screening Level
Tin	<0.002	NC	NG	-	<0.002	No	Maximum meets Background
Titanium	0.01	NC	NG	-	0.014-0.025	No	Maximum meets Background
Uranium	0.0021	NC	0.1	С	0.0020-0.0024	No	Maximum meets Ecological Screening Level
Vanadium	1.18	NC	0.05	С	0.930-0.944	Yes	Maximum exceeds Ecological Screening Level and Background
Zinc	<0.005	NC	0.01	С	<0.005	No	Maximum meets Ecological Screening Level
Polycyclic Aromatic Hydrocarbons	s						
1-Methylnaphthalene	<0.00001	NC	0.001	С	<0.00001	No	Maximum meets Ecological Screening Level
2-Methylnaphthalene	0.00001	NC	0.002	С	<0.00001	No	Maximum meets Ecological Screening Level
Acenaphthene	<0.00001	NC	0.006	С	<0.00001	No	Maximum meets Ecological Screening Level
Acenaphthylene	<0.00001	NC	0.006	С	<0.00001	No	Maximum meets Ecological Screening Level
Acridine	<0.00001	NC	0.0034	а	<0.00001	No	Maximum meets Ecological Screening Level
Anthracene	<0.000012	NC	0.000012	а	<0.000012	No	Maximum meets Ecological Screening Level
Benzo(a)anthracene	<0.00018	NC	0.000018	а	<0.00018	No	Maximum meets Ecological Screening Level
Benzo(a)pyrene	<0.000010	NC	0.00001	С	<0.000010	No	Maximum meets Ecological Screening Level
Benzo(b)fluoranthene	<0.00001	NC	0.00042	е	<0.00001	No	Maximum meets Ecological Screening Level
Benzo(b+j)fluoranthene	<0.00001	NC	0.00048	С	<0.00001	No	Maximum meets Ecological Screening Level
Benzo(e)pyrene	<0.00001	NC	0.00001	С	<0.00001	No	Maximum meets Ecological Screening Level
Benzo(g,h,i)perylene	<0.0001	NC	0.00002	е	<0.00001	No	Maximum meets Ecological Screening Level
Benzo(k)fluoranthene	<0.0001	NC	0.00014	е	<0.00001	No	Maximum meets Ecological Screening Level
Chrysene	<0.0001	NC	0.0001	С	<0.00001	No	Maximum meets Ecological Screening Level
Dibenzo(a,h)anthracene	<0.0001	NC	0.00004	е	<0.00001	No	Maximum meets Ecological Screening Level
Fluoranthene	<0.0001	NC	0.011	С	<0.00001	No	Maximum meets Ecological Screening Level
Fluorene	<0.0001	NC	0.012	С	<0.00001	No	Maximum meets Ecological Screening Level
Indeno(1,2,3-cd)pyrene	<0.0001	NC	0.00014	е	<0.00001	No	Maximum meets Ecological Screening Level

Table 8-4 Ecological Screening of Surface Water

Chemical	Maximum Concentration (mg/L)	EPC (mg/kg)	Ecological Screening Levels (µg/L)	Reference (1)	Background Concentration Range (mg/L)	Identified as a COPC for Ecological Health? Yes or No	Comment
Naphthalene	<0.00001	NC	0.0014	а	<0.00001	No	Maximum meets Ecological Screening Level
Perylene	<0.00001	NC	0.00002	С	<0.00001	No	Maximum meets Ecological Screening Level
Phenanthrene	<0.00001	NC	0.0046	С	<0.00001	No	Maximum meets Ecological Screening Level
Pyrene	<0.00001	NC	0.00002	С	<0.00001	No	Maximum meets Ecological Screening Level
Quinoline	<0.00001	NC	0.0034	а	<0.00001	No	Maximum meets Ecological Screening Level
General Chemistry							
pH	7.93	NC	7.0-8.7	а	7.92-7.96	No	Maximum meets Ecological Screening Level
Chloride	11600	NC	120	а	11400-12900	No	Maximum meets Background
Fluoride	<24	NC	0.12	а	<24	No	Maximum meets Ecological Screening Level
Nitrate as N	<10	NC	200	а	<10	No	Maximum meets Ecological Screening Level
Nitrite as N	<10	NC	0.06	а	<10	No	Maximum meets Background

NC - Not Calculated

NG - No Guideline

BOLD - carried forward in the PQERA for further evaluation

- 1. Ecological screening levels sources: note freshwater guideline used in the absence of marine guidelines
 - a. CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life, Marine (http://ceqg-rcqe.ccme.ca/en/index.html#void).

For aluminum, the guideline value for freshwater aquatic life was applied due to the lack of marine values.

For acridine, the guideline value for quinoline was applied.

- b. ARBCA Tier II Pathway Specific Screening Levels for Groundwater, Table 3a, Tier 1 Surface Water and Groundwater Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life, September 2015.
- c. Nova Scotia Remediation Levels Protocol, Table 3: Tier 1 Environmental Quality Standards for Surface Water, Marine, July 2013.

For benzo(e)pyrene, the lowest guideline value of the PAHs was applied.

For perylene, the guideline value for pyrene was applied.

- d. AEP Alberta Remediation Guidelines, Table C-11, Surface Water Quality Guidelines, Aquatic Life, February 2016.
- e. Ontario MECP Table 3.1 Aquatic Protection Values (APV) to Protect Aquatic Biota Exposed to Contaminants from Migration of Contaminated Groundwater to Surface Water.



8.2 Problem Formulation

The Problem Formulation step is an important information gathering and interpretation stage, which serves to plan and focus the approach of the ERA. For the current assessment, key tasks requiring evaluation within the Problem Formulation Step included the following:

- Identification of potential hazards.
- Identification of potential ecological receptors (i.e., biological communities, populations, individuals or habitats that could potentially be affected by the site, including rare, threatened, or endangered species).
- Assessment of potential exposure pathways and routes through which ecological receptors may be exposed to COPCs in soil.
- Consideration of appropriate assessment and measurement endpoints for the ecological risk assessment.

The outcome of these tasks forms the basis of the approach taken in the current assessment. A more detailed methodology for each of these tasks is described in the sections that follow. The risk assessment is being conducted to establish whether ecological risks may exist as a step in identifying the need for further evaluation or action.

8.2.1 Receptor Identification

For the purpose of the ERA, is it not practical or necessary to individually assess each species that may potentially visit or occupy the site. Instead, the potential for adverse effects imposed on a selected subset of receptors exposed to COPCs at the site was evaluated. The receptors or valued environmental components (VECs) were selected for the ERA by focusing on ecological species that:

- Are indigenous to the area (taking into consideration the habitat types and areas available within the site)
- Are likely to be highly exposed to COPCs due to their habitat preference, behavioral traits and home range
- Are representative of various feeding guilds or trophic levels (e.g., herbivore, insectivore, carnivore)
- Are of cultural, economic or social importance

VECs are not always identified at the species level; rather, VECs can represent communities deemed to be important. The following VECs were identified based on the results of the ecological screening:

- Terrestrial Plant and Invertebrate Community
- Benthic Invertebrates Community
- Fish Community
- Aquatic Wildlife (Mammals and Birds)



Species at Risk

Species at Risk (SAR) that appear on Schedule 1 of the federal Species at Risk Act (SARA) benefit from the legal protection afforded and the mandatory recovery planning required under SARA. Similar protection is afforded to species listed on the Newfoundland and Labrador Endangered Species Act. A review and evaluation of SAR that may be found at the Site was conducted based on the ACCDC report presented in Appendix G.

The following species listed under Schedule 1 of SARA and/or the Newfoundland and Labrador Endangered Species Act have been recorded within 5 km of the site: harlequin duck (*Histrionicus histrionicus*) and seaside goldenrod (*Solidago sempervirens subsp. sempervirens*).

The harlequin duck prefers shallow, fast-flowing water with concentrations of aquatic invertebrates and adjacent available shelter for nesting, but breeding and brood rearing habitat varies geographically. Harlequin ducks overwinter in rocky outer marine coastlines, where the sea breaks against the shore. Here, they feed over or near subtidal ledges and close to shore near exposed headlands and archipelagos. They congregate on preferred rock shoals and may form large groups in coastal areas rich in food concentrations. The average distance from shore was approximately 11 metres in one study conducted in Newfoundland, in water less than 10 metres in depth. On the breeding grounds, harlequin ducks primarily eat freshwater aquatic invertebrates, such as chironimids, whereas on marine habitat they consume subtidal and intertidal aquatic invertebrates. During the non-breeding season, harlequin ducks feed mostly on marine crustaceans (Decapoda, Amphipoda, Isopoda, Cirridedia) and molluscs (Gastropoda, Polyplacophora, Bivalvia), and complement their diet with a variety of other marine prey, such as fish, fish eggs, insects, echinoderms, and sea cucumbers. The ACCDC report indicates that the harlequin duck was last sighted in 1995 several kilometres from the site. Therefore, the harlequin duck was not carried through the ERA. [Source:

https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_Harlequin%20Duck_2013_e.pdf]

There were no observations of the seaside goldenrod during the Site investigations. Furthermore, the ACCDC report indicates that the seaside goldenrod is not provincially or nationally listed, and is considered to be rare only in Newfoundland. Therefore, the seaside goldenrod has not been carried through the ERA.

The Expert Opinion Range Maps provided by ACCDC also indicated that the boreal felt lichen (*Erioderma pedicellatum*), banded killifish (*Fundulus diaphanus*), short-eared owl (*Asio flammeus*), and Barrow's Goldeneye (*Bucephala islandica*) could possibly be present in the vicinity of the Site. Specific observations of these species within 5 km of the site have not been identified and therefore, these species have not been carried through the ERA.

8.2.2 Exposure Pathway Identification

In order for chemicals to have deleterious effects, they need to gain access to the organism or receptor. The means by which a receptor is exposed to COPCs is referred to as an exposure pathway, and is dependent on the nature of both the chemical and receptor. A complete exposure pathway is one that meets the following four criteria (USEPA, 1989):

A source of COPCs must be present



- Transport mechanisms and media must be available to move the chemicals from the source to the ecological receptors
- An opportunity must exist for the ecological receptors to contact the affected media
- A means must exist by which the chemical is taken up by ecological receptors, such as direct contact, ingestion or inhalation

The relevant exposure pathways are summarized in Table 8-5, which includes the qualitative evaluation of each pathway and a justification for the likelihood of exposure assigned. Those hazard-exposure-receptor combinations considered to have the highest likelihood to contribute to an ecological health risk were carried forward in the quantitative ERA.

Table 8-5 Potential Exposure Scenarios - Ecological Receptors

Exposure Pathway Description	Likelihood of Exposure	Carried Forward for Analysis?	Justification			
Ingestion of soil	Likely	Yes	PHC impacts are present in soils at the site. Plants and invertebrates could be exposed to these PHC impacts through direct contact. As indicated in the ecological screening,			
Dermal contact with soil	,		the identified soil COPCs are not considered to be a concern for terrestrial wildlife. Therefore, terrestrial mammals and birds were not identified as VECs for the Site.			
Ingestion of terrestrial invertebrates, vegetation, or small animal prey living at the site and exposed to contaminated soil	Likely	No	As indicated in the ecological screening, the identified soil COPCs are not considered to be a concern for terrestrial wildlife. Therefore, terrestrial mammals and birds were not identified as VECs for the Site.			
Ingestion of surface water, freshwater, sediments, plants, invertebrates or fish Dermal contact with surface water or freshwater sediments	Likely	No	Freshwater sediment or surface water are not present within the water and all sediment and surface water data collected was considered marine.			
Ingestion of marine water, sediments, plants, invertebrates or fish Dermal contact with marine water or sediments	Likely	Yes	Sediment COPCs were identified in the ecological screening and therefore benthic invertebrates, fish, and aquatic wildlife were identified as VECs for the Site.			

8.2.3 Ecological Conceptual Site Model

The ecological CSM (Figure 8.1) illustrates contaminant fate and transport mechanisms, complete exposure pathways, and primary and secondary receptors. Generic endpoints were used in the COPC screening, but specific endpoints were considered in the subsequent analysis. The



ecological conceptual site model is based on the current understanding of the Site conditions, and serves as a framework for evaluating ecological exposure and risk. The ecological CSM for the Site describes:

- The source media (i.e., surface soil)
- Transport mechanisms (processes that introduce contaminants into environmental media)
- Exposure media (those environmental media through which organisms may be exposed to chemicals)
- Exposure route (direct contact, incidental ingestion, and dietary ingestion)
- Potential receptor organisms based on site ecological investigations

This figure schematically represents the interactions between the receptors and the COPCs, via the exposure pathways identified in previous elements of the Problem Formulation phase of the assessment. In Figure 8.1, the relevant exposure pathways are designated by arrows leading from the contaminant source media to each receptor. The pathway is considered to be complete (i.e., functioning) for a receptor when the exposure pathway box is marked with an "X".

8.3 Evaluation of Terrestrial Plants and Invertebrates

Terrestrial plants and soil invertebrates were identified as VECs as explained below.

- Terrestrial Plants: The terrestrial plant community was selected as a VEC. As primary
 producers, plants are the base of the food chain in terrestrial ecosystems. Plants provide forage
 for herbivores and provide habitat for terrestrial animal species. Terrestrial plants are important
 in soil stabilization in floodplain and upland communities. Terrestrial plants may be exposed to
 and accumulate COPC from soil solution, where ions and dissolved fractions are freely
 available for absorption by plant roots. Plants may accumulate COPC in roots, stems, leaves, or
 fruits, which are then transferred to herbivores when consumed.
- Invertebrates: The soil invertebrate community was identified as a VEC. Soil invertebrates, such as insects and earthworms, may be exposed to and accumulate COPC. Exposure could result from direct contact between soil and outer membranes and respiratory surfaces, from the direct ingestion of soil during feeding activities, and from the consumption of affected prey or detritus, depending on species-specific feeding habits. Consumers, including birds and mammals, may be exposed to COPC accumulated in tissues of terrestrial invertebrate such as insects and earthworms.

Concentrations of chemicals in soil were screened against ecological health benchmark values based on CCME guidelines or equivalent sources (see Table 8-1). These guidelines are considered indicative of thresholds that could potentially lead to effects on plants and/or soil invertebrates, although they incorporate conservative assumptions in their derivation. Where soil concentrations of COPCs exceed the screening benchmarks, this alone should not be interpreted as evidence of effects. A weight-of-evidence approach is used in which benchmark comparisons are considered in combination with other lines of evidence; requirement for risk management or remedial action are generally not be based on screening guidelines. Other lines of evidence relevant to an assessment of plant and invertebrate communities are discussed below.

Figure 8.1 Conceptual Site Model for Ecological Receptors - Marystown Shipyard, Newfoundland & Labrador

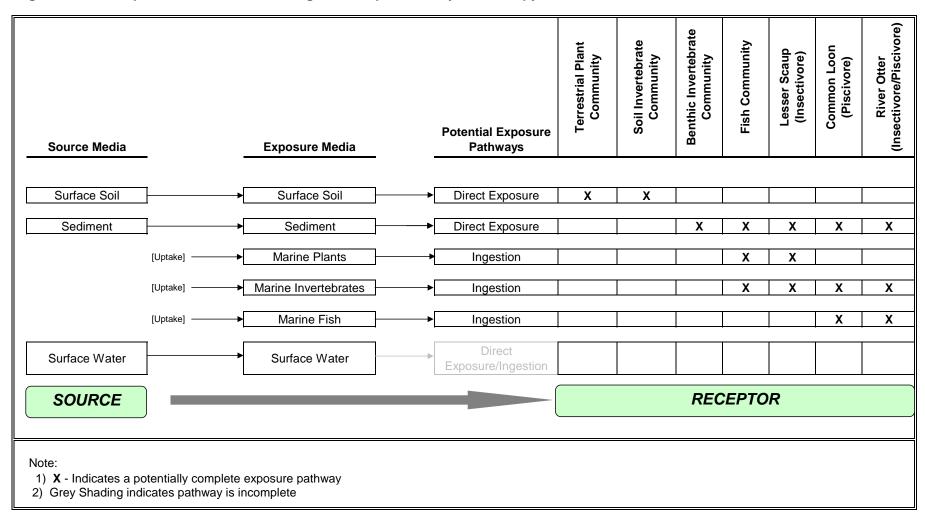




Table 8-6 provides a summary of the number of locations with PHC F2 and PHC F3 concentrations exceeding the soil ESLs protective of terrestrial plants and invertebrates. As indicated in the table below, the concentrations of PHC F2 in 10 of 37 sample locations exceed the ESL and for PHC F3, five of the 37 sample locations exceed the ESL. However, the table below also indicates that the depths of these exceeding samples range from 1.8 to 4.2 metres below grade. At many of these exceeding locations, shallower soil samples were collected and the PHC concentrations in these shallower soils met the soil ESLs. Plant and invertebrate communities are typically concentrated in the top 0.5 metres of soil, and therefore, most of these communities will not be exposed to the soil impacts at depths greater than 1.8 metres. Furthermore, the depths of the PHC impacts in soil are largely below the depth of shallow groundwater at the Site and since most plant and invertebrate communities would tend to avoid heavily saturated soils, exposure to the PHC impacts would be less likely to occur. In addition, the majority of the PHC-impacted soils are located in heavily disturbed areas adjacent to existing buildings or in areas that are currently devoid of vegetation.

Given these lines of evidence (i.e., PHC impacts are present at depths where potential exposure is not likely to occur; PHC impacts are present in areas of the Site with limited to no vegetation), the PHC impacts in soils at the Site are not likely to be a concern to terrestrial plant and invertebrate communities based on the existing conditions at the Site.

Table 8-6 Ecological Risk Results - Plants and Invertebrates

COPC	Soil ESL- Plants and Invertebrates (mg/kg)	Number of Sample Locations Exceeding	Exceeding Location Depths
PHC F2	260	10/37	1.8 to 4.2 metres
PHC F3	1700	5/37	1.8 to 4.2 metres

8.4 Evaluation of Benthic Invertebrates

Benthic invertebrates are an important group of organisms in marine environments and are critical components of a functioning ecosystem. Benthic invertebrates also serve as a food source for many fish species, as well as semi-aquatic birds and mammals. Benthic invertebrates are in direct contact with sediments and, therefore, are directly exposed to COPCs in sediment. Invertebrates, as a group, are also generally considered sensitive to environmental contaminants and are commonly used as an indicator of environmental degradation or chemical impacts.

Sediment dwelling organisms are potentially exposed to COPCs in sediment via several pathways, including ingestion, dermal contact, and uptake across respiratory membranes. All pathways are potentially complete for benthic invertebrates and may contribute in part to the overall exposure of chemicals in sediment. However, for the purposes of this evaluation, direct exposure to COPCs in sediment was primarily limited to quantifying concentrations of COPCs in bulk sediment and benthic community characterizations. Body burdens, or tissue concentrations, are useful for estimating uptake to other organisms (e.g., wildlife), and can also be used to evaluate effects to benthic organisms if data is available in literature.

A weight of evidence approach using the lines of evidence listed below were used to evaluate potential risks to benthic invertebrates from exposure to COPCs.



- 1. Chemical Characterization comparison of chemical concentrations in bulk sediment to concentrations protective of benthic invertebrates, and review of the identified exceedances, including spatial extent, representative concentrations, and magnitude of exceedances.
- 2. Benthic invertebrate community assessment.
- 3. Field evidence for ecological impairment.
- 4. Use of invertebrate tissue concentration to qualitatively evaluate body burdens.

8.4.1 Chemical Characterization

As indicated in the ecological screening, concentrations of COPCs exceeding the sediment ESLs are limited to metals (antimony, arsenic, copper, lead, selenium, and zinc), PCBs, and PAHs.

8.4.1.1 Spatial Extent of Metals Exceedances

Waterlot

For antimony, arsenic, and selenium, two or less samples of the 15 sediment sample locations have concentrations exceeding the sediment ESLs and therefore, these metal exceedances are limited to a couple localized areas of the waterlot. Conversely, between 12 and 14 of the 15 sediment sample locations have concentrations of copper, lead, and zinc exceeding the ESLs, which indicates that the exceedances of the sediment ESLs for these metals are located throughout the waterlot. However, the concentrations of all metals (including copper, lead and zinc) in the three step-out samples collected adjacent to the waterlot boundaries were below applicable ESLs indicating the elevated metal concentrations in sediment do not extend off-Site.

Reference

All metal concentrations in the sediment samples collected from the reference sites are below the sediment ESLs. Based on the above results, it is reasonable to assume that elevated concentrations of metals are not widespread in Mortier Bay.

8.4.1.2 Spatial Extent of PAH Exceedances

Waterlot

Several PAH compounds (1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and/or pyrene) were detected in 14 of the 15 sample locations at concentrations that exceeded the sediment ESLs. Based on these results, the PAH concentrations above the sediment ESLs are located throughout the entire waterlot. However, the concentrations of PAHs in the three step-out samples collected adjacent to the waterlot boundaries were below applicable ESLs indicating the elevated PAHs concentrations in sediment do not extend off-Site.



Reference

Most of the PAHs were not detected in the sediment samples collected from the reference sites or detected at concentrations less than the sediment ESL. Based on the above results, it is reasonable to assume that elevated concentrations of PAHs are not widespread in Mortier Bay.

8.4.1.3 Spatial Extent of PCB Exceedances

Waterlot

Concentrations of PCBs exceeded the sediment ESL at 3 of the 15 sediment sample locations (18-MNMA-S3, 18-MNMA-S6, and 18-MNMA-S12). These results suggest that PCB concentrations exceeding the sediment ESLs are limited to a few localized areas of the waterlot. However, PCBs were not detected in the three step-out samples collected adjacent to the waterlot boundaries indicating the elevated PCB concentrations in sediment do not extend off-Site.

Reference

PCBs were not detected in the sediment samples collected from the reference sites. Based on the above results, it is reasonable to assume that elevated concentrations of PCBs are not widespread in Mortier Bay.

8.4.1.4 Magnitude of Exceedances

The magnitude of exceedance for each COPC was expressed as a hazard quotient (HQ).

The goal of this ecological risk review for benthic invertebrates is to protect against adverse effects at the community level. Therefore, exposure is best represented by the EPC of the data. Though less conservative than applying the maximum concentration, the EPC better represents the concentrations to which populations of receptors would be exposed over time and across the waterlot. The EPC provides a more reasonable, though still conservative, estimate of the mean concentration and will be used to represent Site concentrations in the context of assessing requirements for remediation and/or risk management. In addition, given the inherent conservatism of the screening guidelines, comparing the EPC to the screening guideline is considered to be a better indicator of the magnitude of risk at the community level.

The maximum concentration and the EPC were both applied as the measured sediment sample concentration in the HQ calculation indicated above.

The HQ values are interpreted as follows:

- If the HQ is less than or equal to one, risk to ecological receptors is considered negligible
 because concentrations are below levels expected to cause adverse effects. In this case, no
 further assessment is required.
- If the HQ exceeds one, it may be inferred that adverse effects are possible. It is important to note that exceeding an HQ of one does not necessarily mean adverse effects will occur; rather, the possibility of adverse effects could not be discounted.

The higher the HQ, the greater the confidence that adverse effects will occur, but at low HQs close to one, confidence that adverse effects will actually occur is low.



Table 8-7 presents the calculated HQ values using the maximum concentrations and EPCs. As indicated in Table 8-7, the calculated HQ values for several PAHs (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene), copper, lead, zinc, and PCBs are greater than one using both the maximum concentrations and EPCs. The HQ values for 1-methylnaphthalene, 2-methylnaphthalene, indeno(1,2,3-cd)pyrene, naphthalene, antimony, arsenic, and selenium exceed the target HQ of one using the maximum concentrations, but are less than one using the EPCs.

Table 8-7 Hazard Quotients for Benthic Invertebrates in Sediment

Parameter	Sedir Concen (mg/	tration	Sediment ESL (mg/kg)	Hazard Q	Hazard Quotient				
	Maximum	EPC		Maximum	EPC				
	PAHs								
1-Methylnaphthalene	0.27	0.13	0.201	1.3	0.65				
2-Methylnaphthalene	0.38	0.18	0.201	1.9	0.90				
Acenaphthene	0.728	0.37	0.0889	8.2	4.2				
Acenaphthylene	0.465	0.16	0.128	3.6	1.3				
Anthracene	1.01	0.48	0.245	4.1	2.0				
Benzo(a)anthracene	1.55	0.97	0.693	2.2	1.4				
Benzo(a)pyrene	1.42	0.81	0.763	1.9	1.1				
Chrysene	1.7	0.99	0.846	2	1.2				
Fluoranthene	3.93	2.2	1.494	2.6	1.5				
Fluorene	0.94	0.36	0.144	6.5	2.5				
Indeno(1,2,3-cd)pyrene	1.13	0.58	0.88	1.3	0.66				
Naphthalene	0.62	0.19	0.391	1.6	0.49				
Phenanthrene	4.05	1.9	0.544	7.4	3.5				
Pyrene	2.98	1.7	1.398	2.1	1.2				
		Metals	S						
Antimony	28	11	25	1.1	0.44				
Arsenic	78	40	41.6	1.9	0.96				
Copper	260	168	108	2.4	1.6				
Lead	728	362	112	6.5	3.2				
Selenium	3	1.6	2	1.5	0.80				
Zinc	5020	1681	271	19	6.2				
		PCBs							
PCBs	0.65	0.32	0.189	3.4	1.7				

Notes: **Bold** = HQ>1

8.4.1.5 Evaluation of Metals

Concentrations of antimony, arsenic, and selenium in sediment from the waterlot exceed the sediment ESLs in two or less samples and the EPCs for these metals are less than the sediment



ESLs (i.e., HQ values less than one using the EPC). Therefore, antimony, arsenic, and selenium are considered to pose a low risk to benthic invertebrate communities in the waterlot.

Concentrations of copper, lead, and zinc in sediment from the waterlot exceed the sediment ESLs at 12 or more of the 15 sediment sample locations and the EPCs for these metals are greater than the sediment ESLs. The HQ values for copper (1.6), lead (3.2), and zinc (6.2) exceed the target HQ of one using the EPCs. Therefore, concentrations of copper, lead, and zinc above the sediment ESLs are located across the entire waterlot. Further assessment of risk to benthic invertebrates from exposure to these metals in waterlot sediments is warranted.

8.4.1.6 Evaluation of PAHs

The FOC and PAHs results were used to calculate the equilibrium partitioning sediment benchmark toxic unit (ESBTU) as per the *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures* (USEPA, November 2003). A sample calculation based on phenanthrene in 18-MNMA-S2 is as follows:

For each sediment sample, the dry weight concentration for each PAH, normalized to organic carbon content (Coc [micrograms COPC / gram organic carbon]), is calculated by dividing by the sample-specific FOC:

The C_{OC} is then divided by the PAH-specific sediment benchmark (C_{OC}, PAH, FCV) for each individual PAH provided in the supporting document referenced above to calculate the ESBTUs:

ESBTU_{FCVi} =
$$\frac{\text{Coc} (\mu g/goc)}{\text{Coc,PAH,FcV} (\mu g/goc)}$$

= 15.16/596
= 0.025

The sum of the toxicological contributions of the PAHs was used to calculate a HQ. Uncertainty factors have been developed since common practice usually includes the analyses of 13 or 23 commonly quantified PAHs instead of the full suite of 34 parent and alkylated PAHs. Laboratory analysis of PAHs in Atlantic Canada typically includes 20 individual PAH compounds. A correction factor of 4.14 based on the 95th percentile for measuring 23 PAH parameters provided by the USEPA (Table 6.1; USEPA, 2003) was applied to the calculated HQ to account for the potentially lower ESBTU value calculated using only 20 PAH parameters in the site specific analysis. Recent studies have shown that this method has a tendency to overestimate toxicity and a value equal to or less than one is protective of sensitive species, whereas a value of 3 is considered protective of common species (McDonough, et al., 2010; Kane-Driscoll and Burgess, 2007). Therefore, a threshold range of 1 to 3 for protecting sensitive and common species is used in the ERA. The results are provided in Table F-1 for the waterlot and reference sites (Appendix F).



Waterlot

As indicated in Table F-1 (Appendix F), none of the 15 sediment sample locations have calculated ESBTU HQ values greater than three, which is protective of common species. Only four (18-MNMA-S1, 18-MNMA-S3, 18-MNMA-S5, and 18-MNMA-S14) of the 15 sediment sample locations have calculated ESBTU HQ values greater than one, which is protective of sensitive species. Three of these four exceeding locations had HQ values ranging from 1.1 to 1.7, which only marginally exceed the HQ of one. These exceeding locations also correspond to the locations with the lowest FOC values (0.019 to 0.075) compared to the mean FOC (0.107), which has a significant effect on the calculated ESBTU HQs. Based on these results, the PAH concentrations in sediment samples collected from the waterlot are considered to pose a low risk to benthic invertebrates.

Reference

As indicated in Table F-1 (Appendix F), the calculated ESBTU HQ values were less than one for all reference site sediment samples. Based on the above results, it is reasonable to assume that elevated concentrations of PAHs are not widespread in Mortier Bay.

8.4.1.7 Evaluation of PCBs

Three of the 15 sediment sample locations have concentrations of PCBs exceeding the sediment ESL (18-MNMA-S3, 18-MNMA-S6, and 18-MNMA-S12). These sample locations are not associated with any particular location of the waterlot and therefore are considered to be localized exceedances. In addition, the HQ values for PCBs using both the maximum (3.4) and EPC (1.7) are greater than one. Further assessment of PCBs in waterlot sediments is considered warranted.

8.4.2 Benthic Invertebrate Community Assessment

A total of seven sediment samples from the waterlot (18-MNMA-BMI1, 18-MNMA-BMI3, 18-MNMA-BMI5, 18-MNMA-BMI6, 18-MNMA-BMI11, 18-MNMA-BMI12, and 18-MNMA-BMI14) and one sediment sample from a reference location (18-MNMA-BMI-REF2) were submitted for benthic invertebrate community assessment. The benthic invertebrate community assessment included analysis of species abundance, taxon richness, and biomass. In addition, the Shannon-Weaver diversity index (DI) was calculated for each of the sample locations using the formula:

$$DI = -sumN_i/NT \times LogN_i/NT$$

where N is the number of individuals of species i and NT is the total number of organisms in the sample.

The taxonomic results including a characterization of the benthic invertebrate community at each sample location is provided in Table F-2 in Appendix F and summarized below in Table 8-8.



Table 8-8 Benthic Invertebrate Community Results

Parameter	18-MNM A-BMI1	18-MNM A-BMI3	18-MNM A-BMI5	18-MNM A-BMI6	18-MNM A-BMI11	18-MNM A-BMI12	18-MNM A-BMI14	18-MNM A-BMI- REF2
Abundance (#/sample)	243	7	91	97	28	124	2	243
Taxon Richness (# taxa/sample)	33	5	17	24	14	17	1	7
Shannon-Weaver Diversity Index	2.75	1.55	2.2	1.6	2.3	1.5	NA	0.4
Copper Concentration (mg/kg)	147	171	207	170	144	159	260	8
Lead Concentration (mg/kg)	358	284	125	252	252	728	135	6.5
Zinc Concentration (mg/kg)	799	282	397	297	585	5020	375	34
HMW PAH Concentration (mg/kg)	3.13	5.59	12.76	4.89	2.33	2.15	9.64	0.11
LMW PAH Concentration (mg/kg)	2.38	5.12	12.13	3.62	1.63	1.23	8.36	0.11
PAH ESBTU HQ	1.7	1.1	2.9	0.59	0.21	0.096	1.4	0.048
PCB Concentration (mg/kg)	0.1	0.65	0.1	0.53	<0.02	0.27	0.07	<0.02

For samples collected from the waterlot, abundance values ranged from 2 to 243 individuals (average of 85 individuals) and taxon richness ranged from 1 to 33 taxa (average of 16 taxa). In comparison, abundance values for the reference sample was 243 individuals with a taxon richness of 7. These results indicate that the benthic community indices in the waterlot generally had a lower number of individual organisms but a substantially greater diversity of taxa.

The waterlot sediment samples were dominated by Polychaeta species (36 to 50% of the organisms observed). Polychaeta organisms are generally considered to be pollution tolerant and typically associated with soft substrate. However, these benthic invertebrates are integral to most sediment infaunal communities and provide a significant food source for fish (Fadhullah and Syakir, 2016). In addition, six of the seven samples collected from the waterlot had numerous pollution sensitive Polychaeta organisms such as *Eteone* sp., *Glycera capitata*, *Nephtys* sp., *Pherusa plumosa*, and *Phyllodoce groenlandica* (Borja et al., 2000; Simboura and Zenetos, 2002). In addition to the pollution sensitive Polychaeta species, four of the six samples also had Amphipoda organisms which are generally considered to be pollution sensitive and also associated with soft substrate (Dauvin et al., 2016). The only waterlot sample that did not contain pollution sensitive Polychaeta or Amphipoda organisms was sample 18-MNMA-BMI14. This sample only contained two individual Polychaeta organisms (*Goniada norvegica*). Although the invertebrates at this sample location was limited to this specific species, *Goniada* sp. organisms are considered to be pollution sensitive (Borja et al., 2000; Simboura and Zenetos, 2002).



Converse to the waterlot samples, the reference sample was dominated by one Nematoda species (*Oncholaimellus brevicauda*). Danovaro et al. (2009) indicates nematodes such as *Oncholaimellus* are generally insensitive to organic impacts or are able to recover quickly after an organic contaminant release. However, the majority of marine Nematode species are sensitive to metal impacted sediment and nematode diversity is sensitive to chemical concentrations.

Based on the benthic invertebrate data, the two samples collected from the waterlot with substantially decreased abundance or taxon richness compared to other waterlot samples or the reference sample is limited to 18-MNMA-BMI3 and 18MNMA-BMI14. These samples correspond to elevated PAH and metal concentrations, specifically copper. However, waterlot samples 18-MNMA-BMI1 and 18-MNMA-BMI5 also contained elevated concentrations of these same COPCs but have the highest abundance and diversity of all the samples collected. As such, it is reasonable to assume that concentrations of COPCs in sediment are not the primary factor affecting benthic invertebrate abundance and diversity. It is also noted that samples18-MNMA-BMI3 and 18MNMA-BMI14 are located in close proximity to the existing wharf structures and likely susceptible to physical disturbances related to boat traffic and propeller wash or other anthropogenic influences. The samples collected from the waterlot boundaries such as 18-MNMA-BMI1, 18-MNMA-BMI5 and 18-MNMA-BMI12 corresponded to samples with the highest invertebrate abundance and also contained the greatest diversity of organisms.

Based on the results of the benthic taxonomic evaluation, several samples collected from the waterlot had invertebrate abundance similar to the reference location but the waterlot samples had substantially higher diversity of organisms compared to the reference sample. In addition, the presence of numerous pollution sensitive invertebrates in the majority of the waterlot samples indicates that the concentrations of COPCs in waterlot sediments are unlikely to be adversely affecting the benthic invertebrate community in the area.

8.4.3 Field Evidence

Between October and December 2018, Sparkes Subsea Construction completed a dive survey to collect sediment samples and to document flora/fauna and substrate conditions at the sampling locations. Photos and video footage were collected and utilized to describe flora/fauna and substrate conditions at each sediment sampling locations (refer to Divers Report in Appendix H). The dive survey results are presented in Table 4-1 of Section 4.0, and summarized below.

Waterlot

The diver's notes and photos indicate that marine flora (kelp, algae and/or tubed weed) was present at most of the waterlot sampling locations but in relatively low abundance in most locations. However, marine macroinvertebrates (periwinkles, mussels, scallops, sea star and crab) were present at all of the sediment sampling locations within the waterlot. Sediment in the waterlot was generally characterized as silt with gravel or sand and gravel with the area north side of the wharf being characterized as fine grained sediment (black mud). Garage and debris such as cans and glass bottles were observed at most of the sample locations located directly adjacent to the wharf.

An overview of biota observed at each sample location is provided in Table 4-1.



Background/Reference Sites

The diver's notes and photos indicate that marine flora (specifically tubed weed, eel grass and algae) were common or abundant at the sample locations with marine macroinvertebrates (mussels, periwinkles, sea star, crab, and/or scallops) also present at all of the reference sediment sampling locations. Garage and debris were not observed in the reference samples.

An overview of biota observed at each sample location is provided in Table 4-1.

8.4.4 Invertebrate Tissue

As indicated in Section 4.0, scallop, crab, and mussel tissue samples were collected from several locations within the waterlot as well as the reference area and analyzed for metals, PCBs, and PAHs. The tissue analytical results provide qualitative evidence of body burdens for macroinvertebrates exposed to COPCs in sediment within the waterlot.

Only arsenic, boron, cadmium, copper, lead, selenium, strontium, vanadium, zinc, and PAHs were detected in the invertebrate tissues. Table 8-9 summarizes the maximum concentrations of these compounds in invertebrates collected from waterlot and compares them to the maximum concentration detected in the background invertebrate tissues collected from the reference sites. Aluminum, iron and manganese were also detected in several tissue samples but these are considered to essential elements with low inherent toxicity and therefore, not carried forward for further evaluation.

As indicated in Table 8-9, the concentrations of the majority of COPCs in the waterlot invertebrates are approximately equal to or less than the concentrations in the background invertebrates, with the exception of cadmium, zinc and total PAHs. For zinc, the EPC for the invertebrate tissue is 57.6 mg/kg, which is less than the background invertebrate tissue concentration (74 mg/kg). In addition, the maximum zinc concentration from the waterlot tissue samples was related to the mussel sample. The mussels from the reference area also contained elevated concentrations of zinc (74 mg/kg) compared to other tissue samples collected. The crab and scallop tissue samples collected from the waterlot had zinc concentrations approximately equal to the zinc concentrations in the crab and scallop samples collected from the reference area. Similarly for total PAHs, the EPC for the invertebrate tissue is 0.141 mg/kg, which is less than the concentration observed in the reference samples (0.179 mg/kg). Therefore, the concentrations of these detected compounds in the waterlot invertebrates are not expected to result in adverse toxicological effects. However, the EPC for cadmium (8.6 mg/kg) in tissue samples collected from waterlot exceeds the maximum concentration observed in the reference tissue samples collected.

Potential adverse effects on shellfish were also evaluated using data relating tissue concentrations of the COPCs with toxicological effects on aquatic organisms as provided by the USEPA (Jarvinen and Ankley, 1999; Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals, SETAC Technical Publication Series). Although the EPC of cadmium in waterlot invertebrates marginally exceeded the reference area tissue concentrations, the concentrations of cadmium in tissue samples are below the toxicological effects levels for shellfish (no adverse effect on reproduction, growth, and survival based on body burdens ranging from approximately 0.1-534.4~mg/kg with a 25^{th} percentile of



13.1 mg/kg). In addition, only one scallop sample collected from the waterlot had a cadmium concentration exceeding the 25th percentile body burden effect level of 13.1 mg/kg.

Table 8-9 Invertebrate Tissue Concentration

Parameter	Measured Shellfish Tissue Concentration – Maximum (mg/kg wet weight)	Measured Shellfish Tissue Concentration – EPC (mg/kg wet weight)	Background Shellfish Concentrations (mg/kg wet weight)	No Adverse Effect Range – Body Burdens (mg/kg
Arsenic	4	Not Evaluated	5	Not Evaluated
Boron	6	Not Evaluated	6	Not Evaluated
Cadmium	17.8	8.6	4.8	0.1 – 534.4 mg/kg - (25 th percentile - 13.1)
Copper	20	Not Evaluated	19	Not Evaluated
Lead	0.7	Not Evaluated	1.1	Not Evaluated
Selenium	<1	Not Evaluated	1	Not Evaluated
Strontium	113	Not Evaluated	210	Not Evaluated
Vanadium	6	Not Evaluated	6	Not Evaluated
Zinc	108	57.6	74	Not Evaluated
PAHs	0.194	0.141	0.179	Not Evaluated

Note: PAHs is the sum of all PAH compounds.

Based on the results of the tissue analysis, concentrations of COPCs in tissue samples collected from the waterlot are similar to concentrations observed in the reference tissue samples or were below levels expected to result in toxicological effects levels.

8.5 Evaluation of Fish

Although the waterlot portion of the Site is small, for the purposes of this ecological risk review, potential risk to fish that may consume flora and fauna from the waterlot or be directly exposed to COPCs in sediment from the waterlot were evaluated. The evaluation of risk to fish is considered a qualitative evaluation as fish were not directly observed to be present in the waterlot at the time of the field sampling program and, therefore, fish tissue samples could not be collected for quantitative evaluation.



8.5.1 Target Constituents for Assessing Fish

All parameters with concentrations exceeding the sediment ESLs from the ecological screening were carried through for evaluation of risks to fish. In addition, the primary route for exposure to COPCs in sediment of the waterlot for fish is considered to be via ingestion of benthic invertebrates, which have accumulated COPCs from sediment. To address potential bioaccumulation, parameters with detectable concentrations of COPCs in shellfish tissue samples collected from the waterlot were also carried through for evaluation of risks to fish.

Bioaccumulation of PAHs in fish is expected to be low and considered to be insignificant for assessing upper trophic level receptors that can metabolize these compounds (Eisler, 1987). Therefore, accumulation of PAHs in fish is assumed to be negligible. Therefore, PAHs were not carried forward for evaluation of fish.

Similarly, bioaccumulation of mTPH is expected to be low and considered to be insignificant for assessing upper trophic level receptors that can metabolize these compounds (CCME, 2008). Therefore, accumulation of mTPH in fish is assumed to be negligible. Further assessment of mTPH for fish was not required.

Based on the above discussion, antimony, arsenic, boron, cadmium, copper, lead, selenium, strontium, vanadium, and zinc were the only COPCs evaluated for fish. Aluminum, iron and manganese were also detected in several shellfish tissue samples but these are considered to essential elements with low inherent toxicity and therefore, not carried forward for further evaluation. In addition, highly bioaccumulative COPCs such as mercury and PCBs were not detected in shellfish tissue samples and, therefore, not carried forward for further evaluation with respect to fish.

8.5.2 Exposure of Fish to COPCs

The level to which contaminants accumulate in fish is a function of the physicochemical properties of the COPC, the rate of uptake into invertebrate tissue and subsequently into fish, and the ability of the COPC to be sequestered, metabolized, or otherwise eliminated. Potential risk to fish from exposure to COPCs in sediment was evaluated based on measured concentrations of COPCs in shellfish and assuming an uptake factor into fish tissue of 1 to predict fish tissue concentrations (body burden) and associated potential adverse effects. Although several metals were detected in the shellfish tissue samples collected from the waterlot, the concentrations of COPCs in the waterlot invertebrates are approximately equal to or less than the concentrations in the background invertebrates. As such, fish exposure to COPCs associated with the waterlot through the invertebrate consumption pathway is considered similar to background conditions in the Mortier Bay area.

The exception would be concentrations of cadmium in shellfish tissue samples collected from the waterlot, specifically scallops. As previously discussed in Sections 7.0 and 8.4.4, cadmium is preferentially accumulated in the digestive gland of scallops and can have significantly elevated concentrations in undisturbed or uncontaminated waters. In addition, concentrations of cadmium in sediment and surface water of the waterlot were generally below or approximately equal to laboratory detection limits with no known source of cadmium associated with the Site that would be contributing to the elevated concentrations in shellfish tissue. As all other metals had concentrations in shellfish tissue considered representative of background conditions in the area, it is reasonable to



assume that exposure of fish to cadmium from consumption of invertebrate tissue at the Site would be similar to background conditions and does not pose an incremental risk to fish populations in the area.

8.5.3 Risk Characterization for Fish

The primary route for exposure to COPCs for fish is generally considered to be through contaminants dissolved in surface water and exposure to bioaccumulative COPCs via ingestion of benthic invertebrates that have accumulated COPCs from sediment. As COPCs in surface water at the Site were below applicable ecological screening levels or background conditions, it is reasonable to assume COPC dissolved in water at the Site pose a low risk to fish or fish populations in the area. In addition, COPCs detected in sediment at the Site which are considered to be highly bioaccumulative such as mercury and PCBs were not detected in shellfish tissue collected from the Site. As such, it is reasonable to assume that these bioaccumulative COPCs pose a low risk to fish through the invertebrate consumption pathway. Other potentially bioaccumulative COPCs in sediment such as arsenic, cadmium, copper, lead and zinc had concentrations in shellfish tissue that were considered representative of background conditions in the area and also considered to pose a low incremental risk to fish or fish populations.

In addition to low concentrations of COPCs in invertebrates, the waterlot only covers an area of 17,000 m² and it is unlikely most fish species would spend significant periods of time in the waterlot or use the waterlot for a significant portion of their food source, specifically migratory fish.

Based on the rationale provided above, it is reasonable to assume COPCs in sediment, surface water and shellfish tissue of the waterlot do not pose a risk to fish or fish populations in the Mortier Bay area.

8.6 Evaluation of Aquatic Wildlife

Although the waterlot portion of the Site is small, for the purposes of this ERA, it was assumed that the waterlot might potentially serve as a source of food for a variety of aquatic bird and mammal species that forage on aquatic prey. Potential risk to aquatic avian and mammalian insectivores and piscivores, that may consume flora and fauna from the waterlot or be directly exposed to COPCs in sediment from the waterlot were evaluated.

8.6.1 Target Constituents for Assessing Aquatic Wildlife

Parameters with concentrations exceeding the sediment ESLs from the ecological screening were carried through for evaluation of risks to aquatic life and include arsenic, lead, selenium, zinc, PCBs and PAHs. Although mercury was below screening guidelines in sediment and not detectable in shellfish tissue samples, mercury is considered to be potentially bioaccumulative and also carried forward in the evaluation of risk to aquatic wildlife as a conservative measure. Maximum concentrations of antimony in sediment of the waterlot also exceeded screening guidelines but the EPC was below applicable screening guidelines and antimony was not detected in shellfish tissue collected from the Site. As such, antimony was not carried forward in the ERA with respect to evaluation of aquatic wildlife.



In addition to screening COPCs in sediment, potentially bioaccumulation parameters such as cadmium and copper were also detected in invertebrate tissue samples collected from the Site and carried forward in the ERA. The remainder of COPCs detected in shellfish tissue samples collected from the Site (aluminum, boron, iron, manganese, strontium and vanadium) were not carried forward in the risk evaluation as the tissue concentrations were similar to background conditions and these COPC are not considered to be bioaccumulative.

Bioaccumulation of PAHs in fish is expected to be low and considered to be insignificant for assessing upper trophic level receptors that can metabolize these compounds (Eisler, 1987). Therefore, accumulation of PAHs in fish and other upper trophic levels receptors is assumed to be negligible. However, detectable (low level) concentrations of PAHs were identified in the shellfish samples collected from the waterlot and further evaluation of risk to birds and mammals from exposure to PAHs was completed. To assess cumulative effects of PAHs, the individual PAHs were assessed as the combined risks for low molecular weight (LMW) and high molecular weight (HMW) PAHs.

Bioaccumulation of mTPH is also expected to be low and insignificant for assessing upper trophic level receptors that can metabolize these compounds (CCME, 2008). In addition, concentrations of mTPH in sediment of the waterlot were below applicable screening guidelines and further evaluation of risks to birds and mammals from exposure to mTPH was not considered warranted.

Based on the above discussion, arsenic, cadmium, copper, lead, selenium, zinc, PCBs, LMW PAHs and HMW PAHs were the only COPCs evaluated for aquatic receptors.

8.6.2 Receptors of Concern

It is not practical to evaluate the effects of COPCs for all species that potentially forage within the waterlot. Therefore, indicator species were used to represent ecological guilds, or groups of organisms within a taxonomic class of the same trophic level. Exposure factors and toxicological guidelines have been identified for the selected indicator species, which allows for evaluation of risk with a limited number of assumptions. For birds and mammals, three indicator species were selected to evaluate the potential for risk: lesser scaup (*Aythya affinis*; avian insectivore), common loon (*Gavia immer*, avian piscivore), and river otter (*Lontra canadensis*; mammalian insectivore/piscivore).

As previously indicated, further assessment of SAR was not required.

8.6.3 Exposure of Aquatic Wildlife to COPCs

Simple food chain models were used to evaluate the potential risk to upper trophic level receptors from exposure to COPCs identified in the sediment screening evaluation. To evaluate exposure of a wildlife receptor to a COPC, it is necessary to estimate the concentration of the COPC in sediment, aquatic plants, benthic invertebrates, and fish.

Concentrations of COPCs in benthic invertebrates was based on the EPC of the shellfish tissue samples collected from the waterlot. As fish were not present in the waterlot for analysis of fish tissue, the EPCs for COPCs in shellfish tissue were also assumed to be representative of COPCs in fish tissue at the Site (uptake factor of 1). The term "uptake factor" (UF) refers to the accumulation



of a COPC in an organism or biological tissue (e.g., fish) from a source medium (e.g., benthic invertebrates). This is considered to be a conservative assumption as highly bioaccumulative COPCs such as mercury and PCBs were not detected in shellfish tissue for uptake to fish tissue. The methods for calculating the concentrations of COPCs in aquatic plants, benthic invertebrates, and fish are presented in Table F-4 of Appendix F, and summarized below.

For metals, the UFs for aquatic plants, benthic invertebrates, and fish are based on the following:

- Regression equations from Efroymson et al. (2001) to estimate concentrations in aquatic plants from sediment concentrations 1. In the absence of regression equations from Efroymson et al. (2001), UFs from USEPA (2007) and Baes et al. (1984) were applied.
- EPCs based on measured concentrations of metals in shellfish tissue collected from the
 waterlot were used to estimate concentrations of COPCs in benthic invertebrates. As mercury
 was not detected in shellfish, the method detection limit was conservatively applied to as the
 concentration in benthic invertebrates.
- EPCs based on measured concentrations of metals in shellfish tissue collected from the waterlot were also conservatively applied as the estimated concentration of COPCs in fish.

The analysis of mercury in bulk sediment is based on total mercury. In cases when mercury is not speciated, it is typical practice to assume that total mercury is composed entirely of methylmercury as a conservative approach since methylmercury is more toxic than inorganic mercury. To reduce the conservativeness of this assumption, this ecological risk review evaluated both inorganic mercury and methylmercury separately and summed the risks to provide an overall risk associated with total mercury. The following assumptions were used for this mercury assessment:

- Kannan et al. (1998) reports that methylmercury accounts for 0.77% of total mercury in sediment and 83% of total mercury in fish tissue. Based in this information, the concentration of methylmercury in bulk sediment was assumed to be zero. Since methylmercury concentrations in bulk sediment are assumed to be zero, then the concentration of methylmercury in aquatic plants was also assumed to be zero.
- CCME (2003) indicates that benthic invertebrates are comprised of 50% inorganic mercury and 50% methylmercury; therefore, methylmercury and inorganic mercury concentrations in benthic invertebrates were calculated by multiplying the total mercury concentrations by 0.5.
- Inorganic mercury was calculated as the difference between the total mercury concentration and methylmercury concentration.

For PAHs, UFs for aquatic plants, benthic invertebrates, and fish are based on the following:

- Regression equations from USEPA (2007) to estimate concentrations in aquatic plants from sediment concentrations 2.
- EPCs based on measured concentrations of PAHs in shellfish tissue collected from the waterlot were used to estimate concentrations of COPCs in benthic invertebrates.

¹ USEPA (1999) considers soil-to-plant uptake to be similar to sediment-to-plant uptake. In the absence of sediment-to-plant uptake equations, soil-to-plant equations are used.

² See Footnote 1.



Bioaccumulation of PAHs in fish is expected to be low and considered to be insignificant for assessing upper trophic level receptors that can metabolize these compounds (Eisler, 1987). Therefore, accumulation of PAHs in fish is assumed negligible.

For PCBs, UFs for aquatic plants, benthic invertebrates, and fish are based on the following:

- Regression equation presented in Travis and Arms (1988) to estimate concentrations in aquatic plants from sediment concentrations 3.
- PCBs were not detected in EPCs based on measured concentrations of metals in shellfish tissue collected from the waterlot were used to estimate concentrations of COPCs in benthic invertebrates.
- EPCs based on measured concentrations of metals in shellfish tissue collected from the waterlot were also conservatively applied as the estimated concentration of COPCs in fish.

The UFs use the sediment EPCs to calculate concentrations in aquatic plants. The tissue concentrations calculated using the regression equations for aquatic plants (all COPCs) are reported in dry weight units (i.e., mg/kg dry weight plant / mg/kg dry weight sediment) and subsequently converted to wet weight assuming that aquatic plants typically have approximately 85% water content (Sample et al., 1994). The conversion to wet-weight is accomplished by multiplying the estimated concentrations derived from the regression equations by the dry solids fraction of 0.15 for aquatic plants. The measured concentration of COPCs in shellfish tissue collected from the Site was reported as wet weight (as received by the lab) and do not require additional conversion.

Equations for calculating EPCs for aquatic plants, benthic invertebrates, and fish using UFs or regression equations are identified in Table F-3 of Appendix F. The EPCs for shellfish tissue were generated using USEPA ProUCL Version 5.1 (USEPA, 2015) and the output sheets are provided in Appendix D.

Daily Dose

For representative wildlife receptors, exposure to a COPC was calculated as the average daily dose (ADD) ingested. The ADD is the amount of a COPC a modeled species might be exposed to, expressed as mg/kg-body weight (bw)/day. For each modeled species and COPC combination, the ADD was calculated by summing the intake from each applicable exposure pathway.

For exposure pathway j, the generalized equation for ADD is:

$$ADDj = (IRj \times AFj \times EPCj) / BW$$

Where:

ADDi = average daily dose for exposure pathway j (mg/kg – bw/day);

IRi ingestion rate (kg medium/day);

AFi absorption factor (default value of 1; most conservative);

³ See Footnote 1.



EPCj = exposure point concentration (mg COPC/kg medium); and

BW = receptor body weight (kg).

The AF relates to the potential for COPCs to be absorbed across the gut wall following ingestion. Trace elements are part of the natural environment and exist in many different forms, having potentially differing relative bioavailability. In this risk review, the AF is conservatively assumed to have a value of 1, or 100% of the COPC is bioavailable, for all ingested food items. In addition, for the purposes of the risk review, it is conservatively assumed that wildlife receptors obtain all their food from the waterlot.

Input parameters and exposure factors used to calculate average daily dose for the three indicator species are identified in Table F-4 of Appendix F. Module 3 of FCSAP (2012) is the source for all input parameters and exposure factors.

8.6.4 Effects Levels for Aquatic Wildlife

Similar to fish, the potential for risk to avian and mammalian wildlife was calculated by dividing the total ingestion of a COPC, as estimated by calculating an ADD, by a toxicological reference value (TRV) to produce an HQ. The HQ values for birds and mammals were calculated as follows:

 $HQ = ADD_{Total} / TRV$

Where:

 ADD_{Total} = total average daily dose (mg/kg – bw/day)

A potential for risk was identified if the HQ for a COPC was greater than one. An HQ value above one does not automatically indicate that there is an unacceptable level of potential for risk but that additional evaluation of predicted exposure levels and exposure limit derivations is likely required.

The toxicological database supporting a TRV preferably includes a number of chronic or multi-generational exposure studies involving exposure of relevant test species (i.e., the ecological receptor of interest or a phylogenetically similar species) to appropriate chemical forms of the COPC of interest. Ideally, one or more relevant biological endpoints such as growth, reproductive effects, or survival were measured in the study. Databases that meet this requirement are available for some chemicals, but in most cases, available toxicity data are limited to studies conducted with laboratory animals (e.g., mammals: mice, rats, rabbits; birds: quail, chicken, and ducks). Wildlife TRVs used for this ecological risk review are summarized in Table F-5 of Appendix F.

The TRVs used for indicator species were primarily derived from data presented in USEPA Ecological Soil Screening Level (EcoSSL) rationale documents (USEPA, 2010) or from Sample et al. (1996).

For species with no conservation status, the geomean of Lowest Observed Adverse Effect Levels (LOAELs) for survival, growth and reproduction endpoints are typically used to derive a TRV. The LOAEL-based benchmark represents a threshold level at which adverse effects are likely to become evident (Sample et al., 1996).



COPCs in sediment, aquatic plant, benthic invertebrate, and fish tissue are conservatively assumed to have bioaccessibility equivalent to that present in the TRV studies.

8.6.5 Hazard Assessment for Aquatic Wildlife

8.6.5.1 Mammals

Table 8-10 presents HQs for the river otter. The contribution of each exposure pathway to the HQ is provided in Table F-6 of Appendix F.

Table 8-10 Hazard Quotients for Mammalian Species

2022	HQ		
COPC	River Otter (Piscivore/Insectivore)		
Target HQ	<u>≤</u> 1.0		
Arsenic	0.071		
Cadmium	0.14		
Copper	0.017		
Lead	0.0017		
Mercury (total)	0.03		
Selenium	0.073		
Zinc	0.026		
LMW PAHs	0.000016		
HMW PAHs	0.00016		
PCBs	0.085		

The HQ values for the river otter exposed to all COPCs in waterlot sediment were less than one indicating that COPCs in sediment of the waterlot are unlikely to pose a significant potential for risk to mammalian piscivore/insectivore populations in the area.

8.6.5.2 Birds

Table 8-11 presents the HQs for the lesser scaup and common loon. The contribution of each exposure pathway to the HQ is provided in Tables F-7 and F-8 of Appendix F.

Table 8-11 Hazard Quotients for Avian Species

COPC	HQ		
COPC	Lesser Scaup (Insectivore)	Common Loon (Piscivore)	
Target HQ	<1.0	<1.0	
Arsenic	0.19	0.15	
Cadmium	0.27	0.21	
Copper	0.077	0.058	
Lead	0.014	0.01	
Mercury (total)	0.10	0.12	
Selenium	0.11	0.081	



COPC		HQ
COPC	Lesser Scaup (Insectivore)	Common Loon (Piscivore)
Zinc	0.09	0.067
LMW PAHs	-	-
HMW PAHs	0.0011	0.00042
PCBs	0.069	0.053

Notes: **Bold** = HQ>1

The HQ values for the lesser scaup and common loon are less than one for all COPCs indicating that the waterlot sediments are unlikely to pose a significant risk to avian insectivore or piscivore populations in the area.

8.7 Summary of Ecological Risks

Terrestrial Plant and Invertebrate Communities

• Only PHC F2 and PHC F3 were carried through the ERA for evaluation of risks to terrestrial plants and invertebrates. Based on the combined weight of evidence discussed above, adverse effects to existing plant and soil invertebrate communities at the Site under current conditions are not expected. This conclusion is based on the following lines of evidence: (1) PHC-impacted soils are located at depths (greater than 1.8 metres below grade) well below the depths where the majority of the plant and invertebrate communities reside; (2) PHC-impacted soils are located below the water table and since most terrestrial receptors would avoid heavily saturated soils, exposure to these PHC-impacted soils is expected to be limited; and (3) PHC-impacted soils are located in heavily disturbed areas adjacent to existing buildings where vegetation is currently not present.

Benthic Invertebrate Communities

 As indicated in the ecological screening, concentrations of COPCs exceeding the sediment ESLs are limited to select metals (antimony, arsenic, copper, lead, selenium, and zinc), PCBs, and PAHs.

The following lines of evidence were used to assess potential impacts to benthic invertebrates posed by specific metals, PAHs and PCBs:

• For antimony, arsenic, and selenium, two or less sediment samples out of the 15 total samples collected within the waterlot have concentrations greater than the sediment ESLs, and the EPCs for these metals are less than the sediment ESLs. PCBs were detected at concentrations exceeding the sediment ESL in three of the 15 sediment sample locations. Given the low number of exceedances, antimony, arsenic, selenium and PCBs are unlikely to result in significant adverse effects to benthic invertebrate communities. For copper, lead, and zinc, 12 or more sediment samples out of the 15 total samples collected within the waterlot have concentrations greater than the sediment ESLs, and the EPCs for these metals also exceed the sediment ESLs. Similarly, several PAHs were detected at concentrations exceeding the sediment ESLs in 14 of the 15 sediment samples collected from the waterlot. In addition, the EPCs for most of the PAHs also exceed the sediment ESLs. Therefore, concentrations of



copper, lead, zinc and PAHs above the sediment ESLs are located across the entire waterlot portion of the Site. However, the concentrations of all metals (including copper, lead and zinc), PAHs and PCBs in the three step-out samples collected adjacent to the waterlot boundaries were below applicable ESLs indicating the elevated concentrations of COPCs in sediment do not extend off-Site.

- ESBTU HQ: Potential impact posed by PAHs was also evaluated by calculating an ESBTU HQ for each sample location. There were no sediment samples with calculated ESBTU HQ values greater than 3 for common species. Furthermore, only four of the 15 sediment sample locations had a calculated ESBTU HQ values marginally greater than one for sensitive species (1.1 to 1.7). Based on these results, concentrations of PAHs in sediment of the waterlot are unlikely to result in significant adverse effects to benthic invertebrate communities.
- Benthic Invertebrate Community Assessment: Seven sediment samples from the waterlot and one reference sample were submitted for characterization of the benthic community. The benthic community assessment conducted in the waterlot focused on areas of maximum COPC concentrations in sediment and likely reflective of worst-case conditions. The benthic community in the waterlot samples were dominated by Polychaeta organisms whereas the reference sample was dominated almost exclusively by one Nematoda species. Although Polychaeata organisms are generally considered to be pollution tolerant and typically associated with soft substrate, six of the seven waterlot samples contained numerous Polychaeta species that are considered to be pollution sensitive. In addition, four of these samples had Amphipoda organisms which are generally considered to be pollution sensitive. Based on the results of the benthic taxonomic evaluation, several samples collected from the waterlot had invertebrate abundance similar to the reference but the waterlot samples had substantially higher diversity of organisms compared to the reference sample. In addition, the presence of numerous pollution sensitive invertebrates in the majority of the waterlot samples indicates that the COPC concentrations in waterlot sediments are unlikely to be adversely affecting the benthic invertebrate community in the area.
- <u>Field Observations</u>: The diver's notes and photos indicated that flora (kelp, algae or tube weed)
 and marine macroinvertebrates (periwinkles, mussels, scallops, sea star or crab) were present
 at all of the sediment sampling locations within waterlot, including locations with the highest
 concentrations of metals, PCBs, and PAHs.
- <u>Tissue Concentrations</u>: Only arsenic, boron, cadmium, copper, lead, selenium, strontium, vanadium, zinc, and PAHs were detected in the invertebrate tissues collected from the waterlot. However, the majority of COPCs concentrations in the invertebrate tissue samples were equal to or less than the concentrations measured in invertebrate tissue collected from the reference locations, with the exception of cadmium, zinc and total PAHs. For zinc and total PAHs, the EPCs for the waterlot invertebrates are less than the concentrations in the background invertebrates. These results indicate that the concentrations of COPCs invertebrate tissue concentration in the waterlot are consistent with background concentrations and unlikely to pose adverse toxicological effects. The EPC for cadmium in waterlot invertebrates exceeded the reference tissue concentrations. However, the concentrations of cadmium in shellfish tissue samples were generally less than benthic invertebrate body burden concentrations that result in toxicological effects based on survival, growth, and reproduction.



Based on the multiple lines of evidence discussed above, it is reasonable to assume the elevated concentrations of COPCs in sediment of the waterlot are not adversely affecting the benthic invertebrate communities in the area.

Fish Communities

- Fish were not observed to be present in the waterlot at the time of the field investigation and therefore, the evaluation of risk to fish is considered to be qualitative.
- The primary route for exposure to COPCs for fish is generally considered to be through contaminants dissolved in surface water, and exposure to bioaccumulative COPCs via ingestion of benthic invertebrates that have accumulated COPCs from sediment. As COPCs in surface water at the Site were below applicable ecological screening levels or background concentrations, it is reasonable to assume COPCs dissolved in water at the Site pose a low risk to fish or fish populations in the area. In addition, COPCs detected in sediment at the Site which are considered to be highly bioaccumulative such as mercury and PCBs were not detected in shellfish tissue collected from the Site. As such, it is reasonable to assume that these bioaccumulative COPCs pose a low risk to fish through the invertebrate consumption pathway. Other potentially bioaccumulative COPCs in sediment such as arsenic, cadmium, copper, lead and zinc had concentrations in shellfish tissue that were considered representative of background conditions in the area and also considered to pose a low incremental risk to fish or fish populations.
- The waterlot only covers an area of 17,000 m² and it is unlikely most fish species would spend significant periods of time in the waterlot or use the waterlot for a significant portion of their food source, specifically migratory fish.

Based on the rationale provided above, it is reasonable to assume COPCs in sediment, surface water and shellfish tissue of the waterlot do not pose an unacceptable risk to fish or fish populations in the Mortier Bay area.

Upper Trophic Level Receptors (Aquatic Wildlife)

- Arsenic, cadmium, copper, lead, mercury, selenium, zinc, LMW PAHs, HMW PAHs, and PCBs were the only COPCs carried through the ERA for evaluation of aquatic wildlife. The receptors evaluated were river otter (mammalian piscivore/insectivore); lesser scaup (avian insectivore); and common loon (avian piscivore). The ADD based on sediment ingestion and ingestion of prey were estimated for each COPC/receptor and compared to a TRV protective of survival, growth, and reproduction. A HQ was calculated by dividing the ADD by the TRV. Calculated HQs less than 1 indicate that a low potential for unacceptable health risks to aquatic wildlife receptors.
- The HQs for mammalian and avian receptors potentially exposed to the COPCs were less than 1 indicating that the concentrations of the COPCs in sediment are not a health concern for aquatic wildlife that may be using the waterlot for foraging.



8.8 Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance that have been undertaken or followed in the preparation of this ERA, it is believed that the risk assessment results present a reasonable evaluation of the risk to ecological receptors present at the Site. Where uncertainty or lack of knowledge were encountered in the development of the risk estimates, reasonable assumptions were made, or data were selected, in order to ensure that risks were neither grossly underestimated nor overestimated. Uncertainties are inherent in every aspect of the ERA process, as discussed in this section. This section qualitatively discusses some significant aspects of uncertainty inherent in this risk assessment.

Site Use

Marine environments undergo many changes over time due to tidal fluctuations, vessel traffic and increase or decrease in use for industrial or commercial activities. Some marine environments may become susceptible to municipal or commercial/industrial discharges that may influence the overall chemistry. Other marine environments may undergo regular dredging activities due to an abundance of sediment accumulation. As part of the data review, it is important to understand the activities undergoing at the Site currently, as well as historically. Not knowing the full extent of the activities presents uncertainty to the potential cause or source of contamination. A detailed document review was conducted as part of this assessment to limit the uncertainty.

Data Limitations

The uncertainty of a risk assessment calculation often depends on the sample size, extent of contamination and variability of the data set. Larger sample size generally reduces uncertainty. The data used to support the ERA were collected in 2018. Using recent data has reduced the uncertainty of the assessment. Benthic invertebrates were collected from the Site when available. Several benthic invertebrate samples were collected and analyzed to support the ERA; however, fish were not present in the waterlot at the time of the 2018 field investigation. Therefore, it has been conservatively assumed that the analytical results for shellfish samples are representative of the COPCs concentrations accumulated in fish tissue from exposure to waterlot sediment and/or invertebrates. However, the actual concentration of COPCs in fish tissue that may use the waterlot for foraging is not known.

Cadmium in Shellfish Tissue

Elevated concentrations of cadmium were identified in shellfish tissue collected from the waterlot, specifically scallops. Although several scallops collected from the waterlot had concentrations of cadmium greater than background conditions, the elevated concentrations were considered related to background conditions as a known source of cadmium is not associated with the Site (cadmium concentrations in soil, groundwater, sediment and surface water were below laboratory detection limits or applicable guidelines). In addition, available literature indicates that elevated concentrations of cadmium in scallops can naturally occur in waters of Atlantic Canada as scallops preferentially accumulate cadmium in their digestive gland. However, the mechanism causing elevated concentrations of cadmium in scallop tissue is not known.



Shellfish Tissue Benchmarks

Shellfish tissue benchmark concentrations were obtained from the Jarvinen and Ankley (1999) database, which are based primarily on limited number of species. Chemical body burden sensitivity between different shellfish species is not known.

Weight of Evidence

Various lines of evidence (i.e., concentrations of COPCs, spatial extent of exceedances, observed impairment, benthic community assessment) were used to assess the potential for unacceptable ecological risks to benthic communities within the waterlot. This approach does not present risk estimates solely based on calculations and elevated hazard quotients, but presents an integrated conclusion based on all the data to determine the level of action or remedial objectives.

Utilization of Indicator Species to Represent Other Organisms.

The use of indicator species is intended to limit the number of ecological receptors evaluated. The receptors selected are considered to be sensitive, and to be highly exposed to the COPCs present via relevant exposure pathways. Therefore, it is reasonable to assume that conclusions that are reached in respect of the modeled receptor organisms can be generalized to other biota that might use the waterlot.

9. Conclusions and Recommendations

9.1 Conclusions

GHD was retained by the NLDMAE to carry out a Supplemental Phase II ESA and a HHERA at the Marystown Shipyard located on the west side of Mortier Bay in the Town of Marystown, NL. A Site inspection of the area revealed various steel and other debris is stored at the Site, particularly in the lower laydown area as well as observed to be present in fill materials around the shoreline and ditching located along the southwest edge of the lower laydown area. The Supplemental Phase II ESA concluded there are petroleum hydrocarbon and/or metals impacts in the on-Site soil and groundwater. The study also reported exceedances of generic screening criteria for metals, PAHs, and PCBs in the waterlot sediment. The data collected during the completion of the Supplemental Phase II ESA was used to support the completion of a HHERA to further evaluate potential risks to human and ecological receptors at the Shipyard and associated waterlot.

Human Health Risk Assessment

Based on the results of the HHRA, there are petroleum hydrocarbon concentrations present in the soil above the HHSL for the protection of indoor air at locations near the on-Site commercial buildings that require further assessment.

There are groundwater samples collected at the Site that have arsenic and vanadium concentrations greater than the commercial direct contact/ingestion HHSLs located in the lower laydown area of the Shipyard. There are also groundwater samples that exceeded the mTPH direct contact/ingestion HHSLs collected from monitor well MGSB-MW15, which is located on the south



side of the general store building. As the on-Site groundwater is not being consumed, the only receptor with potential groundwater contact would be a construction worker.

The sediment located in the waterlot does not pose an unacceptable risk to the commercial worker receptors through direct contact pathway at the Site.

The HHRA indicated the consumption of shellfish collected from the waterlot are unlikely to pose a risk to human health based on current usage of the waterlot. However, the HHRA indicated that consumption of shellfish harvested from the waterlot, specifically scallops, could pose a risk to toddlers if consumed on subsistence or heavy consumer basis (5 days/week, 26 weeks per year). The shellfish consumption pathway was assessed based on measured concentrations of COPCs (e.g. cadmium) in composite samples of soft tissue and not specific to edible portions of shellfish. Using whole body tissue concentrations likely overstates the potential for risk as COPCs such as cadmium are known to preferentially accumulate in the digestive gland of scallops with substantially less concentrations being present in the edible portions of the shellfish such as abductor muscles. As indicated in literature from the Department of Fisheries and Oceans, Research Branch (J.F. Uthe and C.L. Chou, 1986), cadmium concentrations in abductor muscles typically constitute less than 1% of the total cadmium concentrations in the soft tissue of scallops. For the purposes of this risk assessment, it has been conservatively assumed that the abductor muscle is 10% of wholebody which would result in an EPC that is well below the SSTLs developed for both a toddler and adult receptor (subsistence, recreational/commercial consumption). It has also been noted that in the conditions of the DFO recreational/commercial licensing both commercial and recreational harvesters are not to consume any portion, other than the adductor muscle ("meat"), from scallops that are harvested from the shoreline and adjacent waters surrounding the province of NL. As such, it is reasonable to assume that the concentration of cadmium in the edible portion of scallops (abductor muscle) collected from the Site is well below concentrations that are considered to pose a potential risk to human health.

Ecological Risk Assessment

Based on the results of the ERA, the concentrations of COPCs in sediment of the waterlot are not considered to pose an unacceptable risk to benthic invertebrates, fish, or aquatic wildlife through the direct contact and consumption exposure pathways.

If sediment is required to be excavated/removed to facilitate any future wharf upgrades, leachate analyses on the sediment has confirmed the dredged material is not classified as a toxic hazardous waste. As a result, the excavated dredged material meets the requirements outlined in the Guidance Document entitled "Protocol for the Management of Excavated Soils, Concrete Rubble and Dredged Materials (GD-PPD-045.2)" and can be disposed at an approved landfill facility, pending landfill approval.

Similarly, concentrations of COPCs in surface water of the waterlot were below applicable screening guidelines or reference conditions and considered to pose a low risk to ecological receptors. Based on the surface water analytical results, groundwater at the Site with elevated concentrations of metals and mTPH exceeding guidelines for groundwater discharging to an aquatic receptor are unlikely to pose an unacceptable risk to aquatic ecological receptors.



9.2 Recommendations

The following recommendations are provided based on the results of the Supplemental Phase II ESA and HHERA:

- Conduct a groundwater monitoring program for seasonal variation including free product
 gauging in all of the on-Site monitor wells and recovery wells for analyses of petroleum
 hydrocarbons and metals (including mercury). A minimum of two monitoring events should be
 completed in the Spring and Summer months to assess seasonal variation and provide the
 analytical data to determine if a risk management plan is required.
- Due to the locations of the commercial buildings on the Site, it is recommended that the soil
 exceedance areas illustrated on Figures 5A to 5C be further assessed through the installation
 and seasonal sampling of soil vapour probes. A minimum of two monitoring events should be
 completed in the Summer and Winter months to assess seasonal variation and provide the
 analytical data to determine if a risk management plan is required.
- Although the maximum groundwater concentration (447 mg/L in MGSB-MW15, near the Carpenters & Joiners Building) does not exceed the indoor air inhalation HHSL, the groundwater at the Site is shallower than that assumed in the derivation of the HHSLs and therefore the HHSL may not be applicable, which may warrant further assessment. Although no free product was measured in groundwater during the field work, the groundwater concentration measured in MGSB-MW15 is indicative of the possible presence of free product in the area. Therefore it is recommended that consideration be given to further assessing the soil vapour to indoor air pathway in this area through the installation and seasonal sampling of soil vapour probes. Due to the monitor well's proximity to the existing building and the absence of elevated soil concentrations in the adjacent boreholes, sub-slab probes beneath the building may be preferred. As recommended above, a minimum of two groundwater events (to determine the presence/absence of free product) and a minimum of two soil vapour events would be required to assess seasonal variation. If free phase product is detected, additional assessment would be required that includes installation of monitor wells for delineation purposes.
- It is recommended that a Risk Management Plan including Best Management Practices and a Site specific health and safety plan be developed to address possible contact with groundwater impacts should sub-surface work be required in the lower laydown area and the south side of the general store building, which specifically address arsenic, vanadium, and modified TPH. It is noted that no soil samples collected contained metals or petroleum hydrocarbons above the applicable HHSLs for direct contact; therefore, the sub-surface soil at the Site does not present a risk to construction workers.
- If a remedial program is not completed to address the soil and groundwater impacts at the Site, impacts should be risk managed or a Phase III ESA is recommended to delineate the soil and/or groundwater impacts to meet minimal site assessment requirements. The Phase III ESA program would include delineation of petroleum hydrocarbon and chromium soil impacts south of MAEB-MW2, petroleum hydrocarbon soil impacts east and south of MSBL-MW6/BH5, petroleum hydrocarbons soil impacts west of MFPA-MW1, chromium soil impacts north of MFPA-BH3, petroleum hydrocarbon soil impacts north, south and east of MLLA-MW3, as well



as petroleum hydrocarbon impacts in groundwater north of MGSB-MW15. The Phase III ESA can be combined with the groundwater and soil vapour monitoring programs discussed above.

Although outside the scope to develop an environmental liability for the Site, the following recommendations are carried forward from previous ESA programs reviewed as part of the data gap analyses:

- Any ASTs remaining on the Site and intended to be used, should be inspected to ensure they
 meet the requirements specified in the Newfoundland and Labrador Gasoline and Associated
 Products (GAP) and/or Heating Oil Storage Tank (HOST) Regulations for their intended
 usages.
- Although no major surface stains were noted in the areas assessed during the Supplemental Phase II ESA, any surface stains noted at the Site should be assessed or remediated as per provincial requirements.
- Any drums, containers or other vessels remaining at the Site should be collected and consolidated in designated Site areas and those no longer required should be disposed of at an approved facility.
- The scrap steel and debris, particularly in the lower laydown area and observed to be present in fill materials around the shoreline and ditching to the southwest of the lower laydown area, should be removed from the Site and disposed of at approved facilities.
- If existing buildings are to remain, an inspection of the existing septic sewer systems should be completed to ensure sewage discharges meet provincial regulations.
- Any ODS containing equipment or PCB containing light ballasts remaining at the Site should be disposed of in accordance with the applicable regulations.
- Although the underground fuel distribution lines on Site were documented to be drained, purged, capped and abandoned in place in 2000 and petroleum hydrocarbon impacts were not found along the pipelines in 2000, regulatory approval for abandonment in place would be required. This should be included in any future submissions for regulatory closure of the Site.

10. Closure

This report has been prepared for the sole benefit of Newfoundland and Labrador Department of Municipal Affairs and Environment. The report may not be used by any other person or entity without the express written consent of GHD and the Newfoundland and Labrador Department of Municipal Affairs and Environment. Any use which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties GHD accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

GHD makes no representation or warranty with respect to this report other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or



facts provided by others and referred to or utilized in the preparation of this report was assumed by GHD to be accurate. Conclusions presented in this report should not be construed as legal advice.

This risk assessment was undertaken exclusively for the purpose outlined herein and was limited to those contaminants, exposure pathways, receptors, and related uncertainties specifically referenced in this report. This work was specific to the site conditions and land use considerations described herein. The report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

All of Which is Respectfully Submitted,

GHD

Prepared by:

Christine Plourde, P.Eng.

Reviewed by:

James O'Neill, P. Eng.

Prepared by:

Vincent Nero, M.Sc.

Reviewed by:



11. References

- Alberta Environment and Parks (AEP) 2016. Alberta Tier 1 Soil and Groundwater Remediation Guidelines, Land Policy Branch, Policy and Planning Division, 197 pp, February 2, 2016.
- Atlantic RBCA, 2015. Atlantic RBCA (Risk Based Corrective Action) for Petroleum Impacted Sites in Atlantic Canada, Version 3, User Guidance, January 2015.
- Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture. Oak Ridge National Laboratory, Health and Safety Research Division. September 1984.
- Borja, A., Franco, J., Perez, V., 2000. A Marine Biotic Index to Establish the Ecological Quality of Soft-Bottom Benthos Within European Estuarine and Coastal Environments, Marine Pollution Bulletin, Vol. 40, No 12, pp 1100-1114, 2000.
- Canadian Council of the Ministers of the Environment (CCME). 1996. A Framework for Ecological Risk Assessment: General Guidance. CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites. March, 1996.
- Canadian Council of the Ministers of the Environment (CCME). 1997. A Framework for Ecological Risk Assessment: Technical Appendices. CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites. March, 1997.
- Canadian Council of the Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines. Winnipeg, MB. Updated 2007.
- Canadian Council of the Ministers of the Environment (CCME). 2003. Canadian water quality guidelines for the protection of aquatic life: Inorganic mercury and methylmercury. In: Canadian environmental quality guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg.
- Canadian Council of the Ministers of the Environment (CCME). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. Winnipeg, MB.
- CCME, 2008. Canada Wide Standard for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document. January 2008.
- CFIA, 2014. Canadian Food Inspection Agency, Fish Products Standards and Methods Manual, August 2014.
- Crommentuijn, T., Sijm, D., De Bruijn, J., Van den Hoop, M. A. G. T., Van Leeuwen, K., Van de Plassche, E., 2000. Maximum permissible and negligible concentrations for metals and metalloids in the Netherlands, taking into account background concentrations. Journal of Environmental Management 60: 121 143.
- Dauvin, J.C., Andrade, H., de-la-Ossa-Carretero, J.A., Del-Pilar-Ruso, Y., Riera, R., 2016. Polychaete/amphipod ratios: An approach to validating simple benthic invertebrates. Ecological Indicators 63: 89-99.



- Danovaro, R., C. Gambi, S. Hoss, S. Mirto, W. Traunspurger and A. Zullini, 2009. Case Studies Using Nematode Assemblage Analysis in Aquatic Habitats, Nematodes as Environmental Indicators, pp. 146-171, CAB International, 2009.
- Efroymson, R.A., Sample, B.E., Suter II, G.W., 2001. Bioaccumulation of inorganic chemicals from soil by plants: regressions of field data. Environ. Toxicol. Chem. 20:2561 2571.
- Eisler, 1987. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service Biological Report 85(1.11).
- Environment Canada, 2008. Criteria for the Assessment of Sediment Quality in Quebec and Application Frameworks: Prevention, Dredging and Remediation, Environment Canada and the Province of Quebec.
- Fadhullah, W. and M.I. Syakir, 2016. Polychaetes as Ecosystem Engineers: Agents of Sustainable Technologies, Renewable Energy and Sustainable Technologies for Building and Environmental Applications, Spring Nature.
- FCSAP, 2012. Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance. Prepared by Azimuth Consulting Group Inc.
- FCSAP, 2016. Guidance Document on Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites, June 2016 (Version 4).
- FCSAP, 2017. Federal Contaminated Sites Action Plan Guidance for Assessing and Managing Aquatic Contaminated Sites in Working Harbours, Version 5.1, July 2017.
- GHD Limited, 2018. Document Review, Data Gap Analysis, and Scope of Work Development, Marystown Shipyard, Marystown, Newfoundland and Labrador.
- G.M. Krusynski, 2003. Cadmium in oysters and scallopsL the BC experience, George M Krusynski, Fisheries and Oceans Canada, Marine Environmental Quality Dividion, Institute of Ocean Sciences, Science Direct, Toxicology Letters, 148 (2004) 159-169, Accepted October 24, 2003.
- Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption, Bureau of Chemical Safety Food Directorate, Health Products and Food Branch, March 2007.
- Health Canada. 2010a. Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. September 2010, Revised 2012.
- Health Canada. 2010b. Federal Contaminated Site Risk Assessment in Canada. Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical Specific Factors, Version 2.0. September 2010.
- Health Canada 2010c. Federal Contaminated Site Risk Assessment in Canada, Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada, Version 2.0.



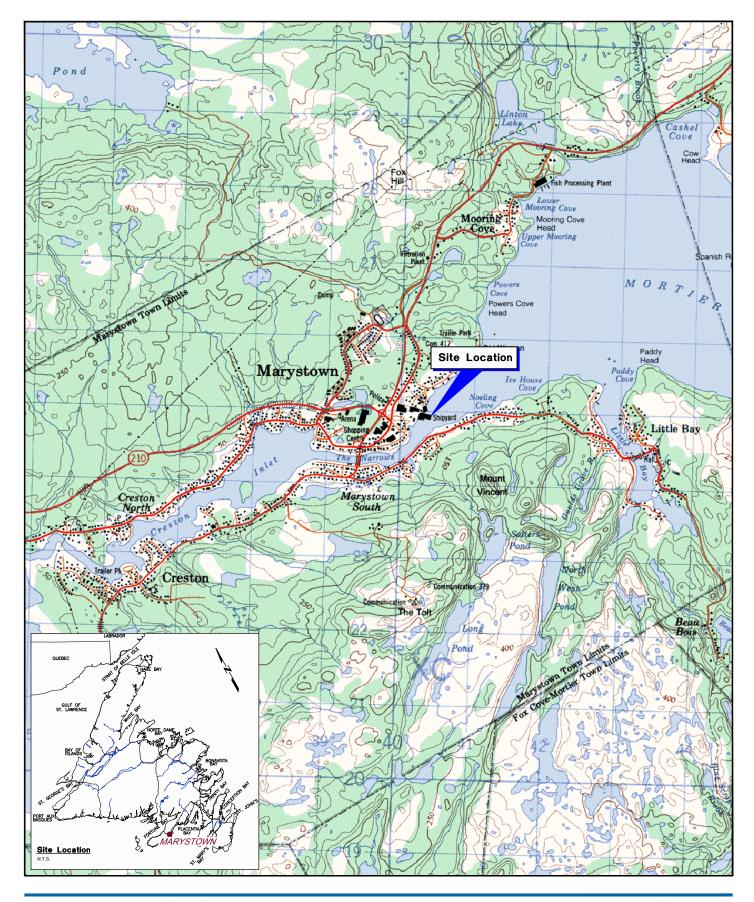
- Health Canada 2010d. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRAchem), September 2010.
- Health Canada 2010e. Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFOODs), October 2010.
- Health Canada, 2017a. Guidelines for Canadian Drinking Water Quality Summary Table, February 2017.
- Health Canada, 2017b. Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment of Contaminated Sediments: Direct Contact Pathway, March 2017.
- Jacques Whitford Environment Limited (JWEL), 1997. Phase I Environmental Site Assessment (ESA), Marystown Shipyard and Cow Head Facility.
- Jacques Whitford Environment Limited (JWEL), 1998. Phase II ESA, Marystown Shipyard and Cow Head Facility.
- Jacques Whitford Environment Limited (JWEL), 1999. Ecological Risk Assessment (ERA), Marystown Shipyard.
- Jacques Whitford Environment Limited (JWEL), 2001a. Human Health Risk Assessment (HHRA) Program, Friede Goldman Newfoundland's Facilities at Marystown.
- Jacques Whitford Environment Limited (JWEL), 2001b. Tank Removal and Replacement Program Marystown Shipyard.
- Jacques Whitford Environment Limited (JWEL), 2002a. Asbestos and Lead Based Paint Abatement Program Friede Goldman Newfoundland Limited's Facilities, Marystown.
- Jacques Whitford Environment Limited (JWEL), 2002b. Letter to Department of Industry, Trade and Rural Development (ITRD), Additional Testing and ERA Related to Marine Sediments, Marystown Shipyard.
- Jacques Whitford Environment Limited (JWEL), 2002c. Phase I Environmental Site Assessment (ESA), Marystown Shipyard and Cow Head Facility.
- Jarvinen, A.W., and G.T. Ankley, 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals, SETAC Technical Publication Series.
- J.F. Uthe and C.L. Chou, 1986. Cadmium in Sea Scallop (Placopecten magellanicus) Tissues from Clean and Contaminated Areas, J.F. Uthe and C.L. Chou, Department of Fisheries and Oceans, Fisheries Research Branch, Can. J. Fish. Aquat. Sci., Vol 44, 1987 Jarvinen, A.W., and G.T. Ankley, 1999. Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals, SETAC Technical Publication Series.

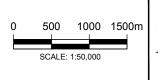


- Kane-Driscoll, S.B., R.M. Burgess, 2007.An overview of the development status, and application of equilibrium partitioning sediment benchmarks for PAH mixtures. Hum Ecol Risk Assess 13:286-301.
- Kannan, K., Smit Hr., R.G., Lee, R.I., Windom, H.L., Heitmuller, P.T., Macauley, J.M., Summert, J.K., 1998. Distribution of total mercury and methylmercury in water, sediment and fish from south Florida estuaries. Arch. Environ. Contam. Toxicol. 34: 109 118.
- Krantzberg, G. and D. Boyd, 1992. The biological significance of contaminants in sediment from Hamilton Harbour, Lake Ontario. Environ. Toxicol. Chem. 11: 1527 1540.
- McDonough, K.M., Azzolina, N.A., Hawthorne, S. B., Nakles, D.V., Neuhauser, E.F., 2010. An Evaluation of the Ability of Chemical Measurements to Predict Polycyclic Aromatic Hydrocarbon Contaminated Sediment Toxicity to Hyalella Azteca, Environmental Toxicology and Chemistry, Vol. 29, No. 7, pp 1545 1550, 2010 (SETAC Pres.).
- Nova Scotia Environment (NSE). 2013. Environmental Quality Standards for Contaminated Sites, July 2013.
- Ontario MOE, 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario, Ontario Ministry of the Environment, Toronto, Ontario. ISBN 0 7729 9248 7.
- Ontario MOECC. 2016. Modified Generic Risk Assessment Approved Model, Version 2, November 15, 2016.
- Pascoe, G.A., Blanchet, R.J., Linder, G., 1996. Food chain analysis of exposures and risks to wildlife at a metals contaminated wetland. Arch. Environ. Contam. Toxicol. 30: 306 318.
- Public Works and Government Services Canada (PWGSC). 2011. Technical Assistance Document No. 1. Background Soil Quality Data, Newfoundland and Labrador, Rev. 2. March 2011.
- Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM 86/.
- Simboura, N., and Z. Zenetos, 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index. Mediterranean Marine Science 3: 77-111.
- S.Ray and V. Jerome, 1987. Copper, Zinc, Cadmium and Lead in Scallops (Placopecten magellanicus) from the Maritimes, S.Ray and V. Jerome, Biological Station, St. Andrews, NB, Canadian Technical Report of Fisheries and Aquatic Sciences No. 1519, January 1987.
- Stantec, 2009. Paint Assessment, Carpenter and Joiner Building, Marystown Shipyard.
- Stantec, 2010. Paint Assessment, Maintenance, Marystown Shipyard.
- Stantec, 2011. Lead Paint Abatement, Carpenter and Joiners Building and Maintenance Building, Marystown Shipyard.
- Suter II, G.W., R.A. Efroymson, B.E. Sample, and D.S. Jones. 2000. Ecological Risk Assessment for Contaminated Sites. Lewis Publishers.



- Suter II, G.W. 2006. Ecological Risk Assessment, Second Edition. CRC Press, 680 pp.
- United States Environmental Protection Agency (USEPA). 1989. Risk assessment guidance for superfund, Volume I. Human Health Evaluation Manual (Part A); EPA/540/1 89/002; U.S. Environmental Protection Agency, Office of Emergency and Remedial Response; Washington, DC.
- United States Environmental Protection Agency (USEPA). 1999. U.S. Environmental Protection Agency. 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, USEPA/530 D 99 001A, August 1999.
- United States Environmental Protection Agency (USEPA). 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures (USEPA, November 2003).
- United States Environmental Protection Agency (USEPA). 2007. Attachment 4 1 Guidance for Developing Ecological Soil Screening Levels (Eco SSLs) Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco SSLs. OSWER Directive 9285.7 55. at http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4 1.pdf.
- United States Environmental Protection Agency (USEPA). 2010. Ecological Soil Screening Levels. Available at: http://www.epa.gov/ecotox/ecossl/.
- United States Environmental Protection Agency (USEPA). 2015. ProUCL Version 5.1, User Guide, Statistical Software for Environmental Applications for Data Sets with and without Non-detect Observations. EPA/600/R 07/041. October 2015.
- United States Environmental Protection Agency (USEPA). 2018. Regional Screening Levels (RSLs) Generic Tables (May 2018).
- WHO, 2003: Guidelines for Safe Recreational Water Environments, Volume 1: Coastal and Freshwaters, World Health Organization, 2003.





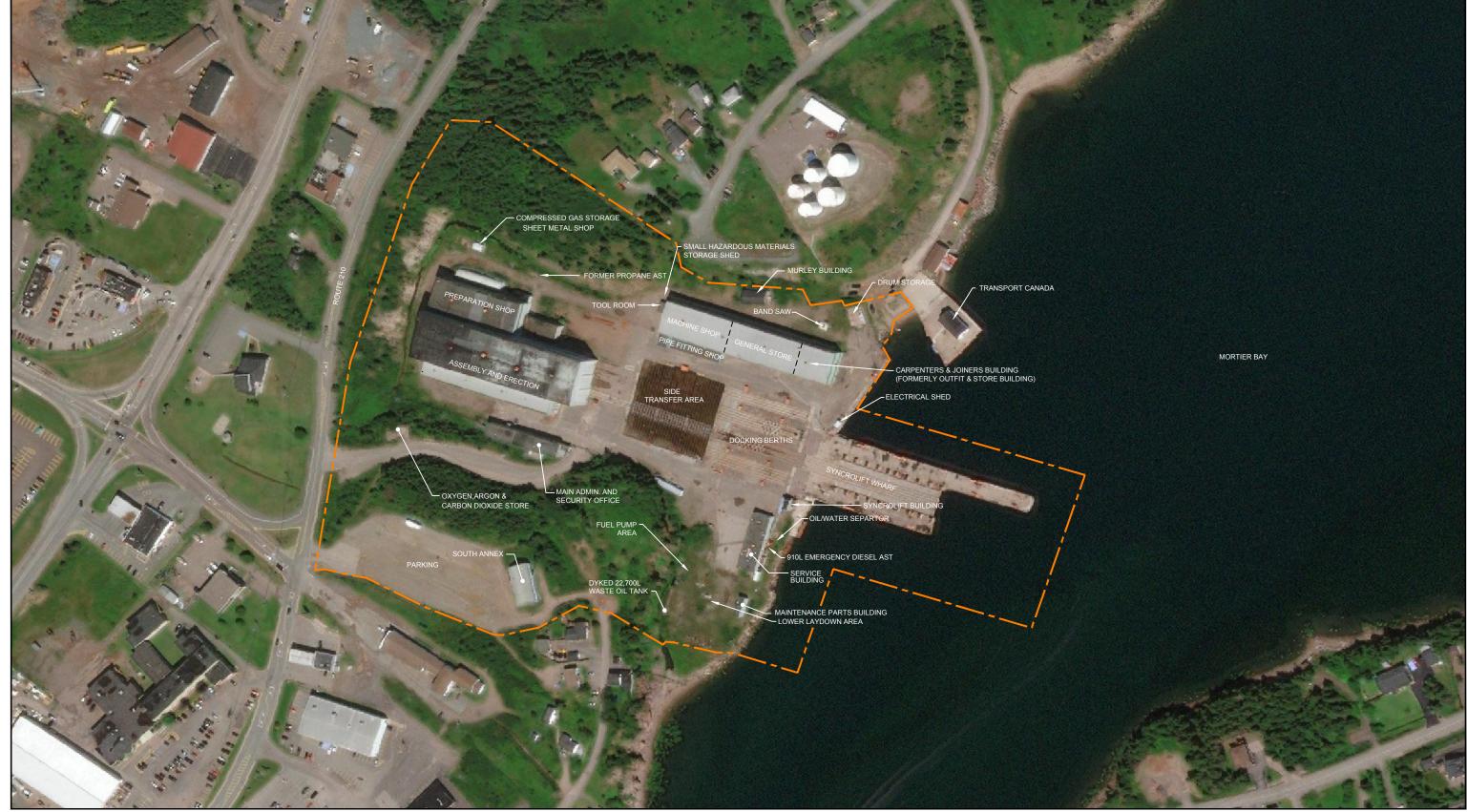


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NL

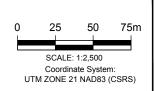
SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

SITE LOCATION MAP

11178792-02 Nov 5, 2018



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS



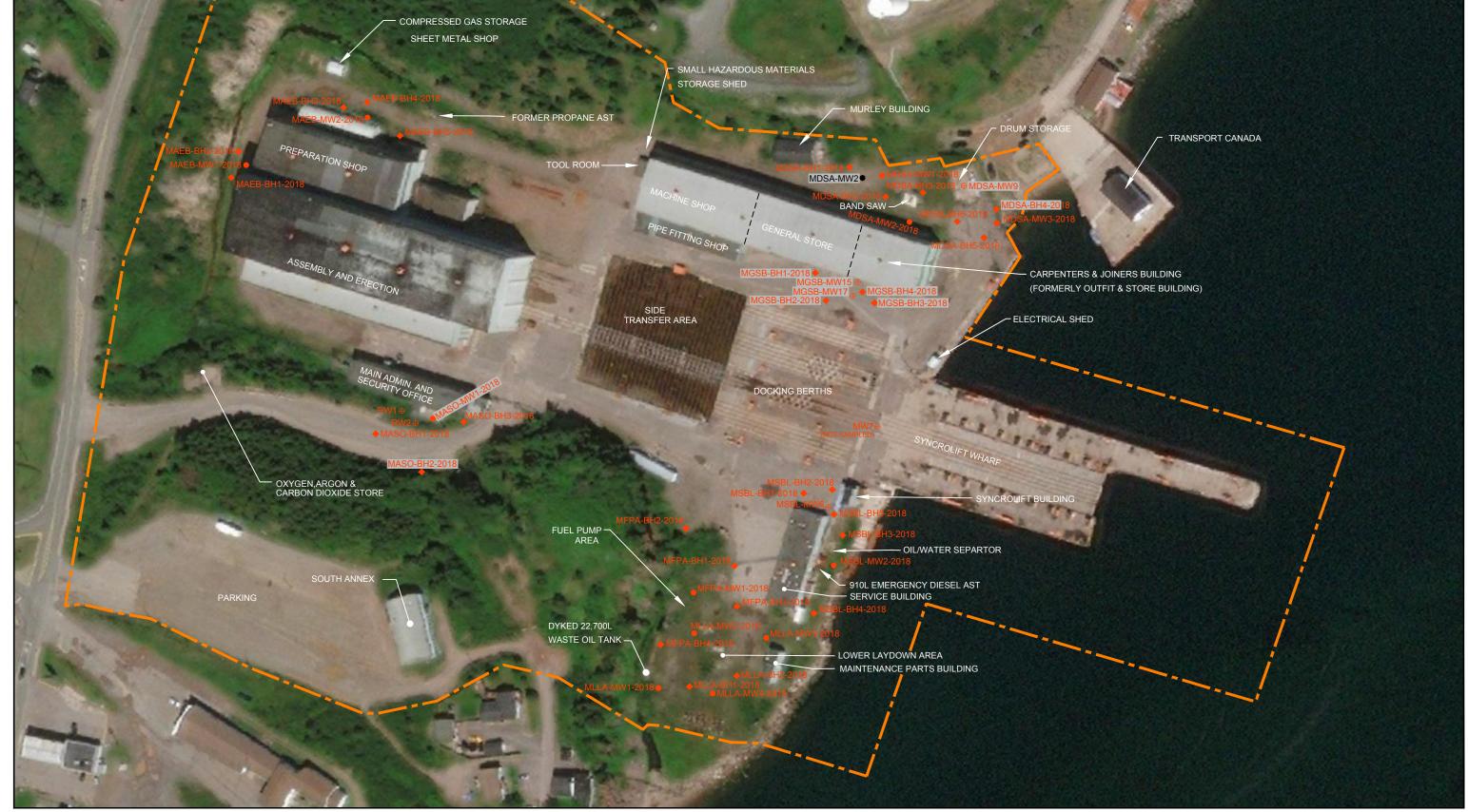


LEGEND:
PROPERTY BOUNDARY LINE

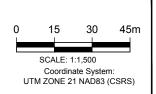


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA 11178792-02 Nov 5, 2018

PROPERTY PLAN



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS









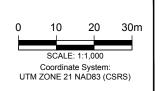
NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

11178792-02 Nov 20, 2018

SITE PLAN WITH SAMPLE LOCATIONS



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS







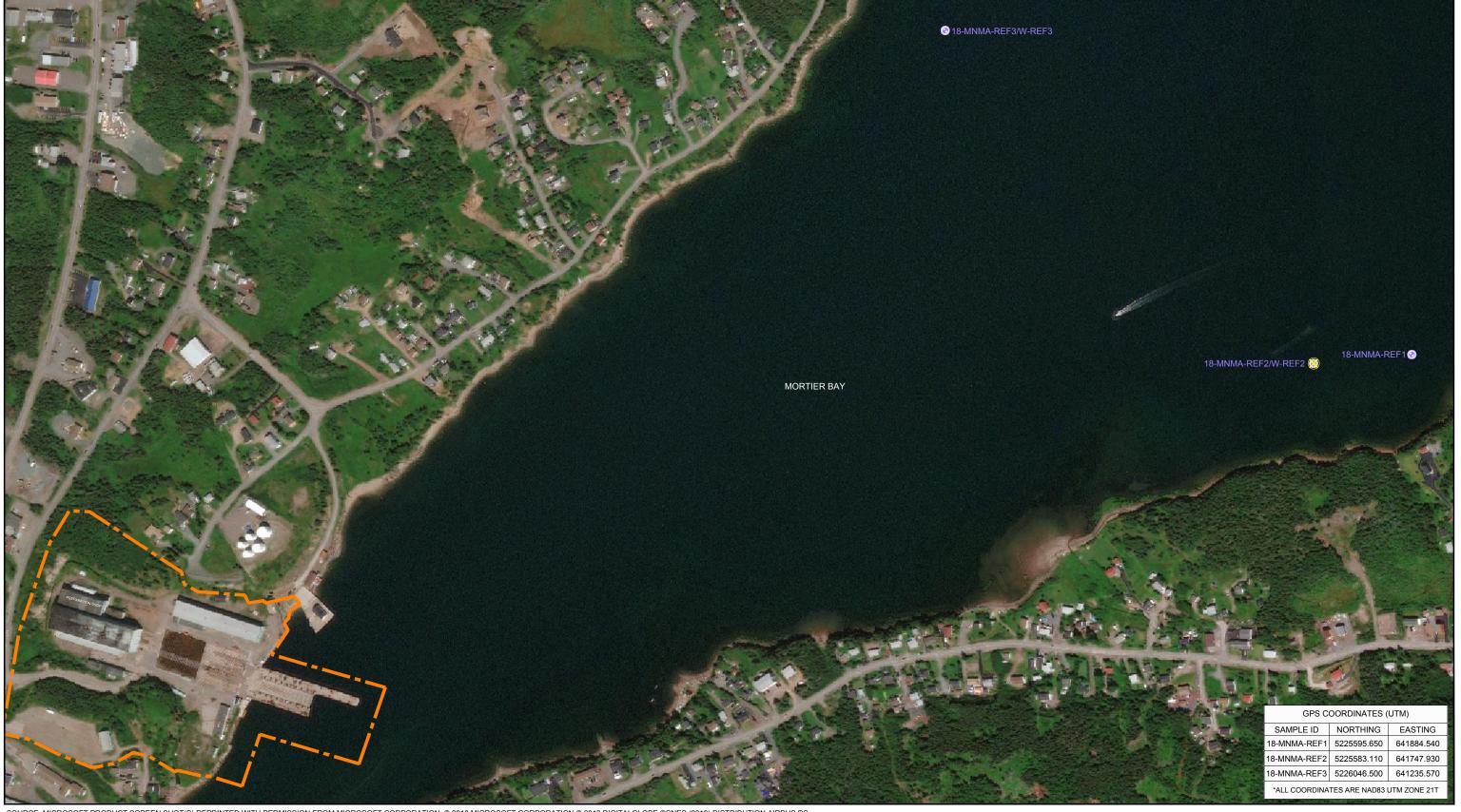


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

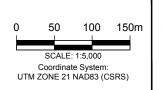
11178792-02 Feb 4, 2019

SITE PLAN WITH SAMPLE LOCATIONS - WATERLOT

FIGURE 4A



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS







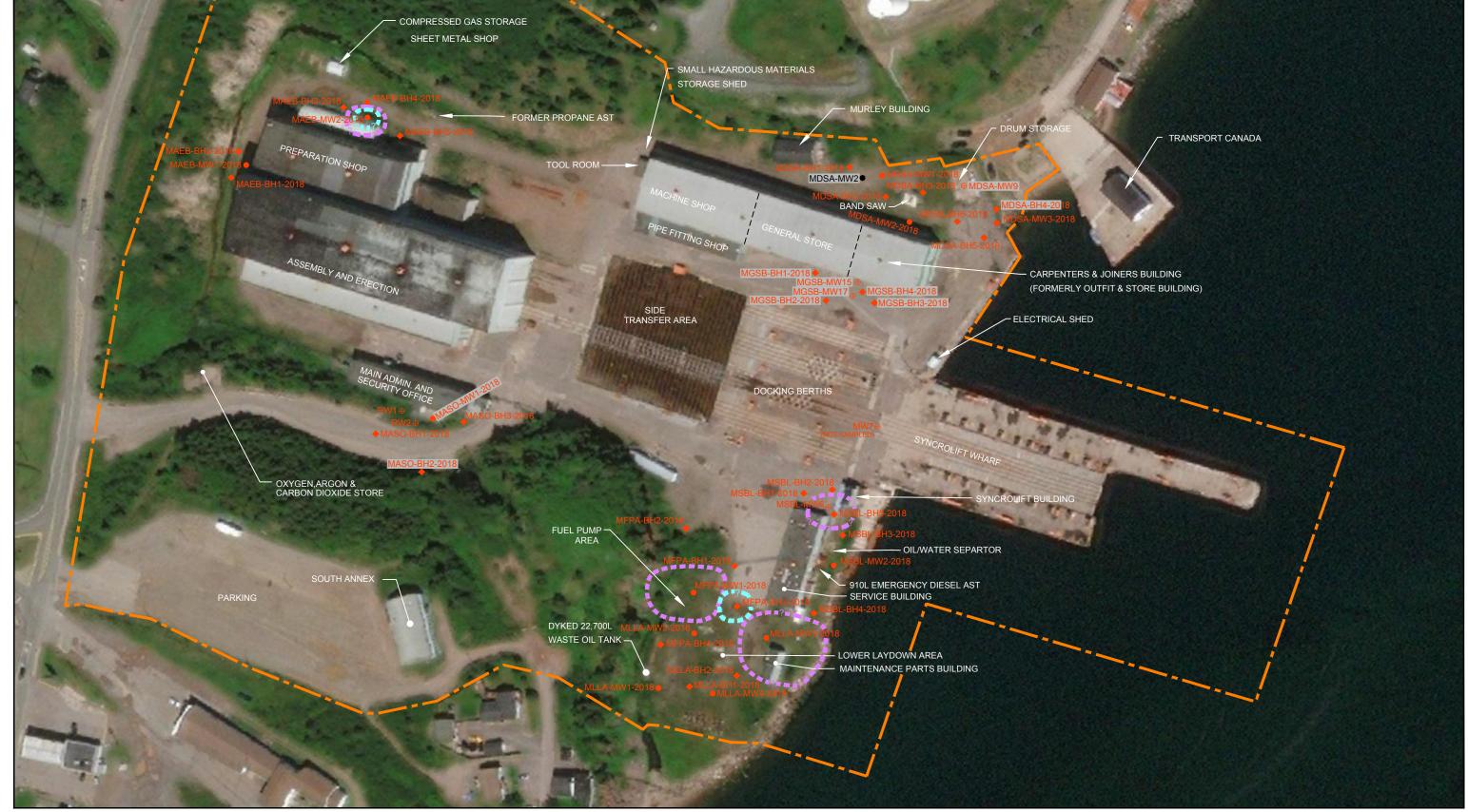


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

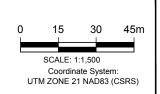
11178792-02 Feb 4, 2019

SITE PLAN WITH SAMPLE LOCATIONS - REFERENCE

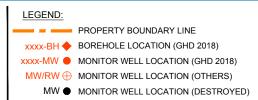
FIGURE 4B



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS







==?====?== AREA OF mTPH EXCEEDING ATLANTIC RBCA
TIER I RBSLs FOR COMMERCIAL (NON-POTABLE)

=?= = ?= = AREA OF CHROMIMUM EXCEEDING CCME SQGs - COMMERCIAL



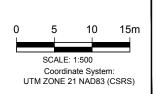
NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

11178792-02 Feb 5, 2019

SITE PLAN WITH SOIL EXCEEDANCES



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS





LEGEND:

PROPERTY BOUNDARY LINE

XXXX-BH BOREHOLE LOCATION (GHD 2018)

XXXX-MW MONITOR WELL LOCATION (GHD 2018)

AREA OF mTPH EXCEEDING ATLANTIC RBCA TIER I RBSLs FOR COMMERCIAL (NON-POTABLE)

=?=== AREA OF CHROMIMUM EXCEEDING CCME SQGs - COMMERCIAL



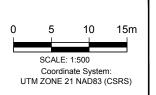
NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

11178792-02 Mar 8, 2019

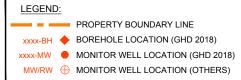
SITE PLAN WITH SOIL EXCEEDANCES - MAEB

FIGURE 5A









AREA OF mTPH EXCEEDING ATLANTIC RBCA TIER I RBSLs FOR COMMERCIAL (NON-POTABLE)

■?■■=?■■ AREA OF CHROMIMUM EXCEEDING CCME SQGs - COMMERCIAL



NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

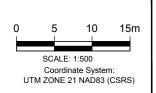
11178792-02 Mar 8, 2019

SITE PLAN WITH SOIL EXCEEDANCES - MSBL

FIGURE 5B



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS







==?== AREA OF mTPH EXCEEDING ATLANTIC RBCA
TIER I RBSLs FOR COMMERCIAL (NON-POTABLE)

REA OF CHROMIMUM EXCEEDING CCME SQGs - COMMERCIAL

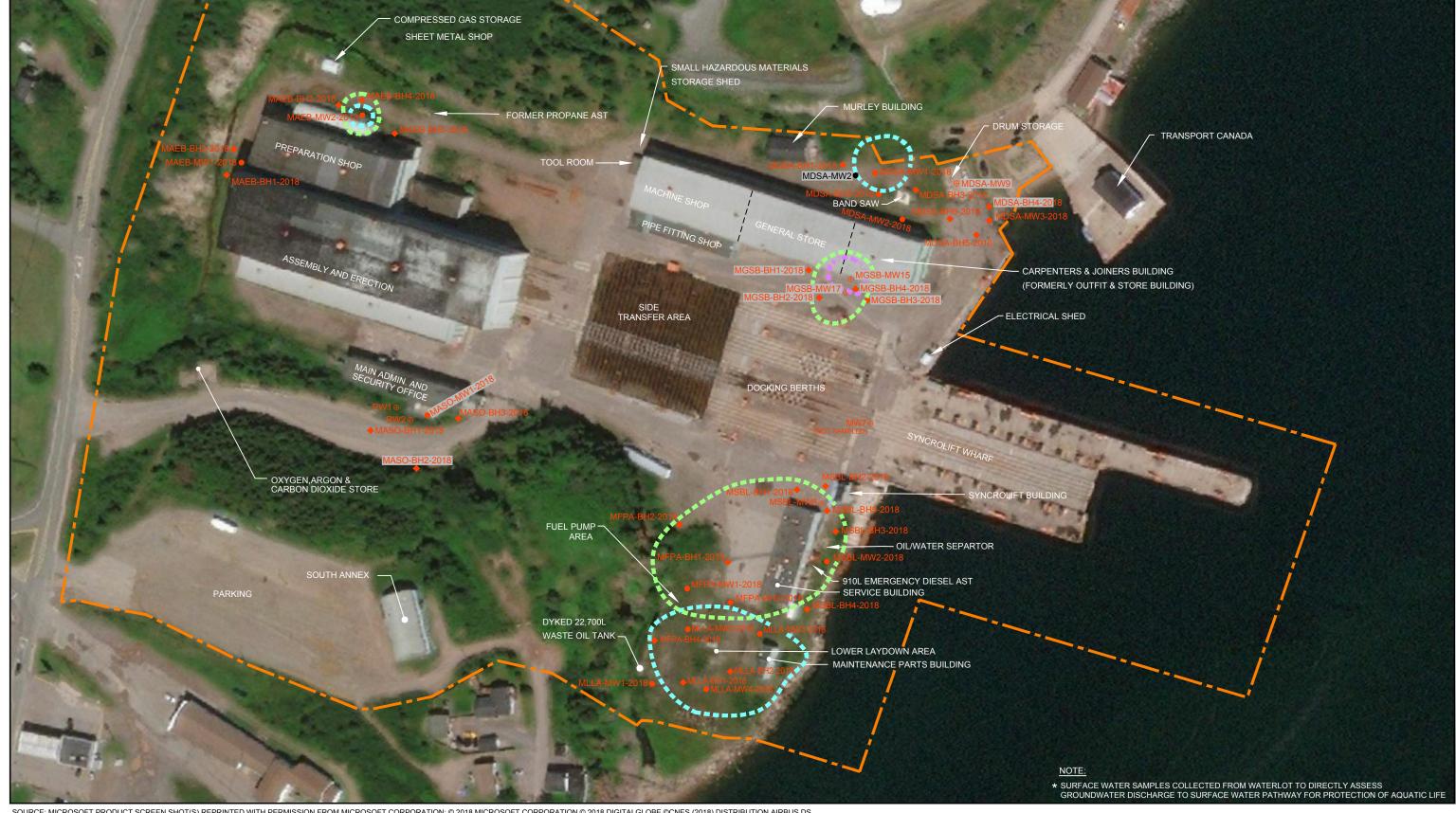


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

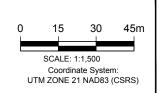
11178792-02 Mar 8, 2019

SITE PLAN WITH SOIL EXCEEDANCES - MLLA/MFPA

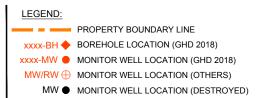
FIGURE 5C



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS







AREA OF mTPH EXCEEDING ATLANTIC RBCA TIER I RBSLs FOR COMMERCIAL (NON-POTABLE) AREA OF mTPH + F2 EXCEEDING ATLANTIC RBCA TIER I GROUNDWATER ESLs * AREA OF METALS (ARSENIC, COPPER, SELENIUM, ZINC) EXCEEDING THE FIGQG FOR COMMERCIAL

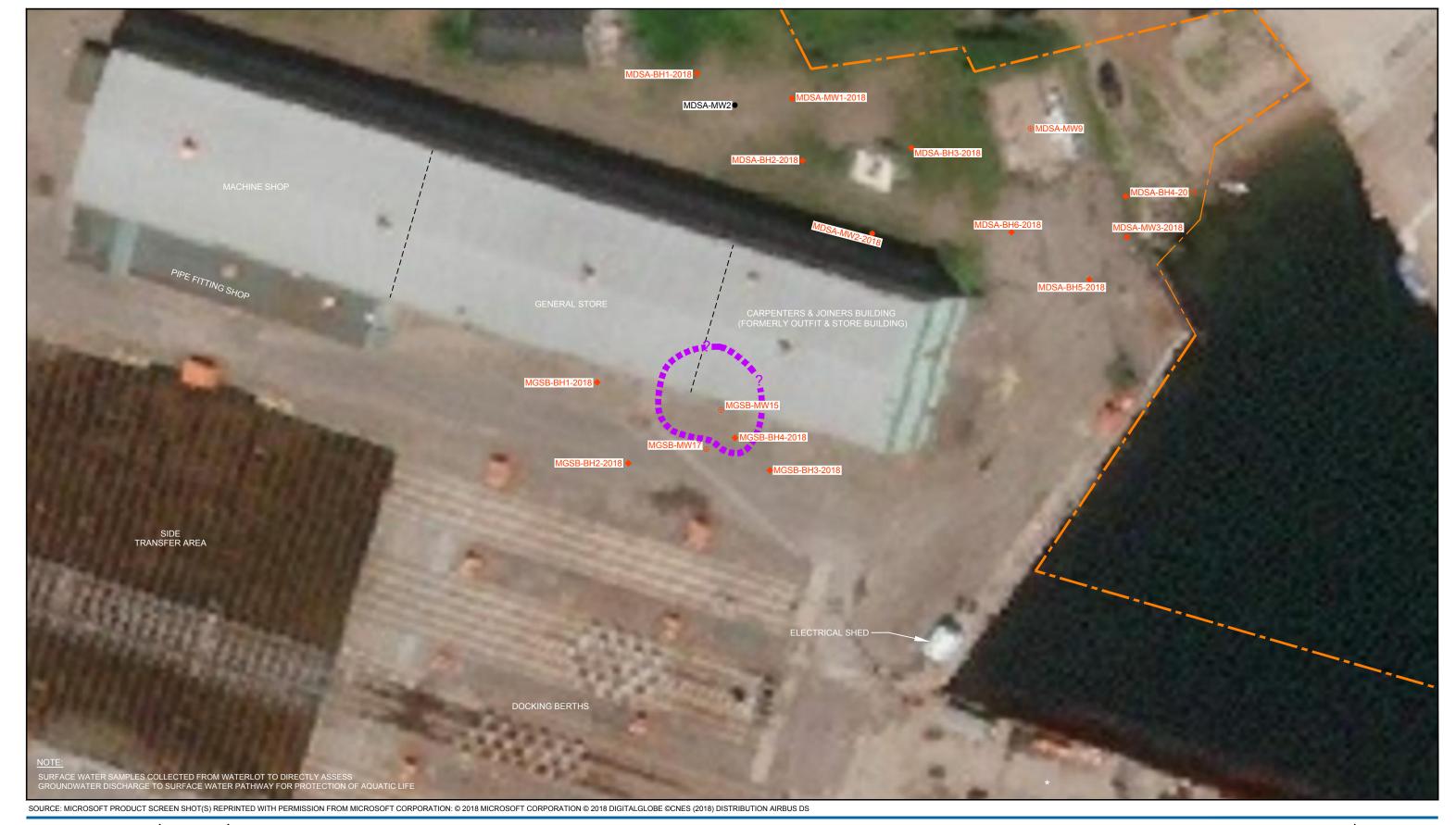
MARINE EXPOSURE *

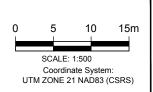


NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

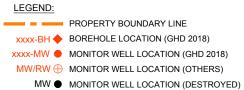
11178792-02 Feb 4, 2019

SITE PLAN WITH GROUNDWATER EXCEEDANCES









? AREA OF MTPH EXCEEDING ATLANTIC RBCA
TIER I RBSLs FOR COMMERCIAL (NON-POTABLE)

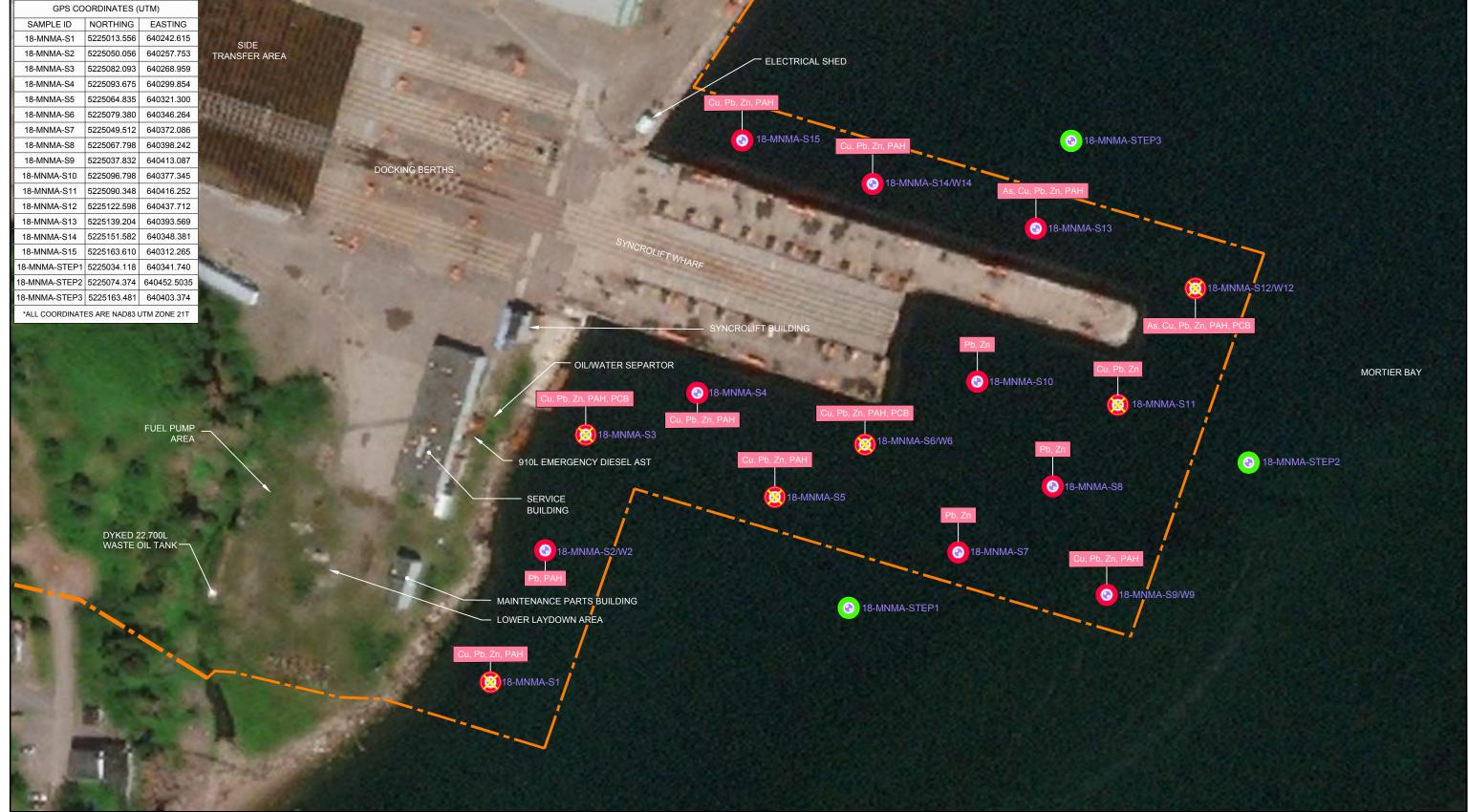
GHD

NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

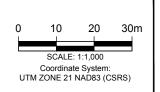
11178792-02 Mar 8, 2019

SITE PLAN WITH GROUNDWATER EXCEEDANCES - MGSB

FIGURE 6A



SOURCE: MICROSOFT PRODUCT SCREEN SHOT(S) REPRINTED WITH PERMISSION FROM MICROSOFT CORPORATION: © 2018 MICROSOFT CORPORATION © 2018 DIGITALGLOBE ©CNES (2018) DISTRIBUTION AIRBUS DS









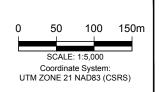
NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

11178792-02 Feb 4, 2019

CONTAMINANT DISTRIBUTION - WATERLOT

FIGURE 7A











PCBs/METALS/PAHs > CCME PELS

PARAMETERS EXCEEDING CCME PELS

OR ATLANTIC RBCA ESLS



NL DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT MARYSTOWN SHIPYARD, MARYSTOWN, NEWFOUNDLAND AND LABRADOR SUPPLEMENTAL PHASE II ENVIRONMENTAL SITE ASSESSMENT & HHERA

11178792-02 Feb 4, 2019

CONTAMINANT DISTRIBUTION - REFERENCE

FIGURE 7B

Table 1
Groundwater Monitoring Results
Supplemental Phase II ESA and HHERA
Marystown Shipyard
Marystown, NL

Well ID	Top of Riser	Ground Surface	Date	Free Product	Depth to Water	Groundwater Elevation ¹	GPS Coordinate (Collected	•
	Elevation ¹ (m)	Elevation ¹ (m)	(d/m/yyyy)	Thicknesses (mm)	Table (mbtr)	(mard)	Northing	Easting
MSBL-MW6		2.69		nd	2.62		5225359.931	369274.236
MSBL-MW2-2018	3.43	2.51		nd	2.18	1.25	5225335.675	369279.318
MLLA-MW1-2018	2.49	2.61		nd	1.71	0.78	5225285.392	369202.54
MLLA-MW2-2018	2.53	2.65		nd	1.69	0.83	5225308.019	369217.751
MLLA-MW3-2018	2.69	2.81		nd	1.75	0.94	5225305.741	369247.87
MLLA-MW4-2018	2.62	2.84		nd	1.90	0.73	5225282.84	369225.11
MFPA-MW1-2018	2.58	2.70		nd	1.85	0.73	5225325.048	369217.7
MASO-MW1-2018	2.54	2.66		nd	0.82	1.71	5225399.054	369109.861
MASO-RW1		4.24	11/10/2018	nd	0.95		5225397.134	369102.617
MASO-RW2		3.43	11/10/2010	nd	1.80		5225402.456	369096.878
MAEB-MW1-2018	2.76	2.88		nd	0.57	2.19	5225504.026	369038.542
MAEB-MW2-2018	2.79	2.91		nd	0.91	1.88	5225525.081	369084.257
MDSA-MW1-2018	2.51	2.63		nd	2.54	-0.03	5225498.048	369298.578
MDSA-MW2-2018	2.60	2.80		nd	2.24	0.36	5225478.602	369309.777
MDSA-MW3-2018	2.57	2.69		nd	2.95	-0.38	5225477.641	369346.153
MDSA-MW9		2.40		nd	1.40		5225492.069	369334.016
MGSB-MW15		2.73		nd	2.22		5225453.704	369287.86
MGSB-MW17		2.72		nd	2.28		5225448.101	369285.692

Notes:

1 - Relative elevations were determined using a control monument (95G5004, 5226240.659, 369103.381), having an assigned elevation of 26.737 metres above relative datum (mard)

m - metres

mm - millimeters

mbtr - metres below top of riser

mard - metres above relative datum

nd - not detected

'---' - not available

				Sample II	MSBL-MW2-2018 SS1	MSBL-MW2-2018 SS4	MSBL-MW2-2018 SS6	MSBL-BH1-2018 SS6	MSBL-BH1-2018 SS7	MSBL-BH2-2018 SS5	MSBL-BH2-2018 SS6	MSBL-BH3-2018 SS4	MSBL-BH3-2018 SS5	MSBL-BH4-2018 SS5	MSBL-BH4-2018 SS6	MSBL-BH5-2018 SS1	MSBL-BH5-2018 SS5	MSBL-BH5-2018 SS6
			Sample D	epth (mbgs	0 - 0.6	3.0 - 3.6	4.5 - 5.1	3.0 - 3.6	3.6 - 4.2	2.4 - 3.0	3.0 - 3.6	2.1 - 2.7	2.7 - 3.3	2.4 - 3.0	3.0 - 3.6	0 - 0.6	2.4 - 3.0	3.0 - 3.6
			Da	te Collected	10/4/2018	10/9/2018	10/9/2018	10/4/2018	10/4/2018	10/4/2018	10/4/2018	10/4/2018	10/4/2018	10/9/2018	10/9/2018	10/4/2018	10/4/2018	10/4/2018
		Guidelines																
Parameter	Criteria 1	Criteria 2	Criteria 3	Units														
Petroleum Hydrocarbons																		
Benzene	2.5	180	18	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	<0.04	< 0.04	<0.04	<0.04	< 0.04	< 0.04	< 0.04	<0.04	<0.04	< 0.04	< 0.04	< 0.04	<0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	<3	14	<3	<3	<3	<3	<3	<3	<3	70	<3	<3	<3	37
C10-C16	-	260	9800	mg/kg	26	380	<15	60	45	16	1690	47	52	1520	<15	<15	<15	3250
C16-C21	-	1700	16000	mg/kg	65	374	<15	43	34	104	1470	94	109	1200	35	<15	<15	2890
C21-C32	-	1700	10000	mg/kg	24	337	17	<15	<15	35	332	39	45	190	20	<15	<15	633
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	115	1110	<20	103	79	155	3490	180	206	2980	55	<20	<20	6810
Laboratory Resemblance					FOF	WFOF + LOF	LOF	WFOF	WFOF	WFOF	WFOF	FOF	FOF	WFOF	WFOF	NR	NR	WFOF

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact Commercial Land Use with Coarse-Grained Soil For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

		Sample ID epth (mbgs) te Collected	SS4	MLLA-MW1-2018 SS6 3.0 - 3.32 10/3/2018	MLLA-MW2-2018 SS5 2.4 - 2.5 10/3/2018	MLLA-MW2-2018 SS7 3.6 - 4.19 10/3/2018	3.0 - 3.6 10/3/2018	MLLA-MW3-2018 SS7 3.6 - 4.2 10/3/2018	MLLA-MW3-2018 SS8 4.5 - 5.1 10/3/2018	MLLA-BH1-2018 SS5 2.4 - 2.8 10/3/2018	MFPA-MW1-2018 SS5 2.4 - 3.0 10/3/2018	MFPA-MW1-2018 SS7 3.6 - 4.2 10/3/2018	MFPA-BH1-2018 SS4 2.1 - 2.7 10/4/2018	MFPA-BH2-2018 SS4 1.8 - 2.4 10/4/2018	MFPA-BH2-2018 SS6 3.0 - 3.6 10/4/2018	MFPA-BH3-2018 SS5 2.4 - 3.0 7/25/2008		
	0	Buidelines																
Parameter	Criteria 1	Criteria ²	Criteria 3	Units														
Petroleum Hydrocarbons																		
Benzene	2.5	180	18	mg/kg	< 0.03	<0.03	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	< 0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	<3	<3	<3	<3	<3	24	<3	<3	44	<3	<3	<3	62	49
C10-C16	-	260	9800	mg/kg	<15	<15	122	<15	332	2650	132	<15	3660	170	<15	64	109	<15
C16-C21	-	1700	16000	mg/kg	<15	<15	160	<15	260	1680	102	<15	2740	141	<15	39	87	<15
C21-C32	-	1700	10000	mg/kg	29	<15	695	<15	52	334	18	<15	1200	111	<15	53	102	<15
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	29	<20	977	<20	644	4690	252	<20	7640	422	<20	156	360	49
Laboratory Resemblance					LOF	NR	WFOF + LOF	NR	WFOF	WFOF	WFOF	NR	FOF	FOF + LOF	NR	FOF + LOF	FOF + LOF	GR

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact -Commercial Land Use with Coarse-Grained Soil - For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range GR - Gasoline Range

				Sample ID	MFPA-BH3-2018 SS6	MFPA-BH4-2018 SS4	MFPA-BH4-2018 SS6	MASO-MW1-20 SS2	18 MASO-MW1-2018 SS3	MASO-BH1-2018 SS2	MASO-BH1-2018 SS7	MASO-BH1-2018 SS8	MASO-BH2-2018 SS3	MASO-BH2-2018 SS4	MASO-BH3-2018 SS4	MASO-BH3-2018 SS5	MAEB-MW1-2018 SS1	MAEB-MW1-2018 SS2
			Sample D	epth (mbgs)	3.0 - 3.6	1.8 - 2.4	3.0 - 3.6	0.6 - 1.2	1.2 - 1.8	0.6 - 1.2	3.6 - 4.2	4.2 - 4.8	1.2 - 1.8	1.8 - 2.4	1.8 - 2.4	2.4 - 2.8	0 - 0.6	0.6 - 1.2
			Da	te Collected	7/25/2008	10/4/2018	10/4/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/2/2018	10/2/2018
	Guidelines																	
Parameter	Criteria ¹	Criteria 2	Criteria 3	Units														
Petroleum Hydrocarbons																		+
Benzene	2.5	180	18	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	<0.04	<0.04	< 0.04	< 0.04	< 0.04	<0.04	<0.04	< 0.04	<0.04	<0.04	< 0.04	< 0.04	<0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	<3	<3	12	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
C10-C16	-	260	9800	mg/kg	<15	<15	1320	<15	27	<15	<15	<15	<15	<15	92	21	<15	<15
C16-C21	-	1700	16000	mg/kg	<15	<15	912	<15	<15	<15	<15	<15	<15	<15	59	<15	<15	<15
C21-C32	-	1700	10000	mg/kg	<15	<15	176	67	90	<15	<15	<15	<15	<15	<15	<15	84	30
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	<20	<20	2420	67	117	<20	<20	<20	<20	<20	151	21	84	30
Laboratory Resemblance					NR	NR	FOF	LOF	FOF, LOF	NR	NR	NR	NR	NR	FOF	FOF	LOF	LOF

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact -Commercial Land Use with Coarse-Grained Soil - For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range LR - Lube Range

GR - Gasoline Range

				Sample ID	SS4	MAEB-MW2-2018 SS4	SS5	SS2	MAEB-BH1-2018 SS4	SS2	SS4	SS2	SS3	SS2	SS3	SS2	SS3	SS4
			•	epth (mbgs)	1.8 - 2.4	1.8 - 2.4	2.4 - 3.0	0.6 - 1.2	1.8 - 2.4	0.6 - 1.2	1.8 - 1.95	0.6 - 1.2	1.2 - 1.8	0.6 - 1.2	1.2 - 1.8	0.6 - 1.2	1.2 - 1.8	1.8 - 2.4
	T		Da	te Collected	10/2/2018	10/2/2018	10/2/2018	10/2/2018	10/2/2018	10/2/2018	10/2/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/2/2018
		Guidelines	•															
Parameter	Criteria ¹	Criteria ²	Criteria ³	Units														
Petroleum Hydrocarbons																		
Benzene	2.5	180	18	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	<0.04	< 0.04	<0.04	<0.04	<0.04	< 0.04	<0.04	<0.04	< 0.04	<0.04	< 0.04	< 0.04	<0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	9	4	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
C10-C16	-	260	9800	mg/kg	3910	573	<15	98	<15	<15	<15	164	<15	<15	<15	<15	<15	<15
C16-C21	-	1700	16000	mg/kg	2010	490	<15	122	<15	<15	<15	248	<15	<15	<15	<15	<15	<15
C21-C32	-	1700	10000	mg/kg	305	140	<15	74	15	<15	<15	103	<15	<15	<15	<15	21	15
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	5230	1180	<20	294	<20	<20	<20	515	<20	<20	<20	<20	21	<20
Laboratory Resemblance					FOF	FOF	NR	FOF & LOF	LOF	NR	NR	FOF	NR	NR	NR	NR	UC	LR

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact Commercial Land Use with Coarse-Grained Soil For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

	Sample Depth (i					0.6 - 1.2	1.8 - 2.4	1.8 - 2.4	2.4 - 2.92	1.8 - 2.4	2.4 - 3.0	1.8 - 2.4	2.4 - 2.85	SS3 1.2 - 1.8	1.8 - 2.4	MDSA-BH6-2018 SS3 1.2 - 1.8	1.8 - 2.4	1.65 - 1.8
		Guidelines	Da	ate Collected	10/2/2018	10/10/2018	10/10/2018	10/9/2018	10/9/2018	10/10/2018	10/10/2018	10/2/2018	10/2/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/3/2018
Parameter	Criteria ¹	Criteria ²	Criteria ³	Units														
Petroleum Hydrocarbons																		
Benzene	2.5	180	18	mg/kg	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
C10-C16	-	260	9800	mg/kg	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
C16-C21	-	1700	16000	mg/kg	<15	<15	<15	<15	<15	<15	20	<15	<15	<15	<15	<15	<15	<15
C21-C32	-	1700	10000	mg/kg	22	106	79	25	27	26	163	24	36	21	25	17	73	<15
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	22	106	79	25	27	26	183	24	36	21	25	17	73	<20
Laboratory Resemblance					LR	LOF	LOF	LOF	LOF	LOF	LOF	LR	LR	LOF	LOF	LOF	LOF	NR

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact Commercial Land Use with Coarse-Grained Soil For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

				Sample ID	MGSB-BH2-2018 SS3	MGSB-BH2-2018 SS4	MGSB-BH3-2018 SS1	MGSB-BH3-2018 SS4	MGSB-BH4-2018 SS4	MGSB-BH4-2018 SS6
			Sample D	epth (mbgs)	1.2 - 1.75	1.8 - 2.75	0.15 - 0.6	1.8 - 1.97	1.8 - 2.4	3.6 -4.2
				te Collected		10/3/2018	10/3/2018	10/3/2018	10/2/2018	10/2/2018
	(Guidelines								
Parameter	Criteria 1	Criteria 2	Criteria ³	Units						
Petroleum Hydrocarbons										
Benzene	2.5	180	18	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	10000	250	980	mg/kg	<0.04	< 0.04	<0.04	<0.04	<0.04	<0.04
Ethyl Benzene	10000	300	640	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	110	350	2600	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	320	11000	mg/kg	4	<3	<3	29	22	22
C10-C16	-	260	9800	mg/kg	<15	62	<15	302	776	695
C16-C21	-	1700	16000	mg/kg	<15	69	<15	228	514	447
C21-C32	-	1700	16000	mg/kg	<15	17	<15	48	82	73
Modified TPH	870 - Gas 4000 - Diesel / #2 10000 - # 6 oil / Lube	-	-	mg/kg	<20	148	<20	607	1390	1240
Laboratory Resemblance		1			GR	WFOF	NR	FOF	FOF	FOF

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I ESLs for the Protection of Plants and Soil Invertebrates; Direct Soil Contact Commercial Land Use with Coarse-Grained Soil For samples collected at depths shallower than 1.5 m
- 3 Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds) and Livestock; Soil & Food Ingestion
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

Table 3 Metals in Soil Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

							Mai ystown, NE							
			MAEB-MW2-2018	MAEB-MW2-2018	MAEB-BH3-2018	MAEB-BH3-2018	MAEB-BH4-2018	MAEB-BH4-2018	MAEB-BH5-2018	MAEB-BH5-2018	MDSA-MW1-2018	MDSA-MW1-2018	MDSA-BH1-2018	MDSA-BH1-2018
		Sample ID	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2	SS1	SS2
	Sar	nple Depth (mbgs)	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0-0.6	0.6 - 1.2
		Date Collected	10/2/2018	10/2/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/9/2018	10/2/2018	10/2/2018	10/9/2018	10/9/2018
	Guidelines													
Parameter	Criteria 1	Units												
Metals														
Aluminum	-	mg/kg	27300	31600	8940	8890	10500	12500	10700	8520	23100	19900	19600	9840
Antimony	40	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	26	mg/kg	6	8	14	15	13	19	13	11	9	9	12	11
Barium	2000	mg/kg	30	34	38	75	44	111	44	36	53	63	48	37
Beryllium	8	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	-	mg/kg	2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Cadmium	22	mg/kg	<0.3	<0.3	< 0.3	<0.3	<0.3	<0.3	< 0.3	<0.3	<0.3	<0.3	<0.3	< 0.3
Chromium	87	mg/kg	76	89	11	17	15	19	13	14	64	52	37	13
Cobalt	300	mg/kg	27	30	6	10	9	11	8	9	25	20	17	9
Copper	91	mg/kg	66	87	18	18	20	25	18	18	63	58	40	17
Iron	-	mg/kg	34800	36700	16800	13900	17700	23700	18200	13300	26300	25600	23600	12700
Lead	260	mg/kg	33.6	38.6	23.8	12.1	18.3	22.5	16.1	8.6	11.9	15.6	19.6	6.4
Lithium	-	mg/kg	11	13	11	9	12	10	11	8	12	11	14	12
Manganese	-	mg/kg	1210	1370	1030	1060	1100	1810	828	553	1110	1160	1060	671
Mercury	24	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	40	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	89	mg/kg	59	59	6	12	10	14	8	10	40	31	23	11
Selenium	2.9	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	=	mg/kg	42	62	12	21	16	15	13	20	78	49	29	20
Thallium	1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	300	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	4	3	<2	<2
Uranium	33	mg/kg	0.3	0.3	0.5	0.3	0.6	0.4	0.5	0.3	0.2	0.2	0.3	0.4
Vanadium	130	mg/kg	92	100	33	47	44	50	37	46	87	77	73	45
Zinc	410	mg/kg	329	311	75	59	110	97	78	47	116	121	83	50

Notes:

1 - CCME Soil Quality Guidelines (SQGs) - Commercial Land Use, accessed online October 2018

"-" - No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds guidelines

Table 3 Metals in Soil Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Marystown, NE													
			MDSA-BH2-2018	MDSA-BH2-2018	MDSA-BH3-2018	MDSA-BH3-2018	MLLA-MW2-2018	MLLA-MW2-2018	MLLA-MW3-2018	MLLA-MW3-2018	MLLA-MW4-2018	MLLA-MW4-2018	MLLA-BH1-2018	MLLA-BH1-2018
		Sample ID	SS1	SS2										
	Sar	nple Depth (mbgs)	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6-1.2	0 - 0.6	0.6 - 1.2
		Date Collected	10/9/2018	10/9/2018	10/10/2018	10/10/2018	10/3/2018	10/3/2018	10/3/2018	10/3/2018	10/3/2018	10/3/2018	10/3/2018	10/3/2018
	Guidelines													
Parameter	Criteria 1	Units												
Metals														
Aluminum	-	mg/kg	15900	8920	10000	7190	4900	2600	7260	5750	5490	2000	6240	5120
Antimony	40	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	26	mg/kg	11	11	11	11	16	7	8	12	13	23	11	9
Barium	2000	mg/kg	39	52	37	56	343	84	124	80	219	155	56	76
Beryllium	8	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	-	mg/kg	<2	<2	<2	<2	2	<2	<2	<2	<2	2	<2	<2
Cadmium	22	mg/kg	<0.3	<0.3	0.3	<0.3	0.3	<0.3	0.7	<0.3	0.3	< 0.3	<0.3	<0.3
Chromium	87	mg/kg	33	12	20	13	21	11	33	20	35	26	15	11
Cobalt	300	mg/kg	15	7	11	7	16	6	15	16	23	30	13	9
Copper	91	mg/kg	33	14	78	19	75	18	70	28	68	69	22	18
Iron	-	mg/kg	18500	12900	12100	10000	25000	7650	29900	27100	38600	23600	22400	12700
Lead	260	mg/kg	7.3	14.2	6.7	16.1	72.8	15.3	77	10.2	29.4	6.3	11	7.6
Lithium	-	mg/kg	13	7	11	7	6	<5	10	9	10	<5	9	7
Manganese	-	mg/kg	865	812	721	752	1520	1150	1290	1680	2400	2940	811	1740
Mercury	24	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.06	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Molybdenum	40	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	89	mg/kg	22	9	27	9	25	7	23	17	26	29	14	11
Selenium	2.9	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	40	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	-	mg/kg	26	17	19	18	21	25	13	15	15	28	14	19
Thallium	1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	300	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	33	mg/kg	0.4	0.4	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.2	0.3	0.3
Vanadium	130	mg/kg	66	36	51	37	34	21	45	52	80	80	44	28
Zinc	410	mg/kg	62	50	87	51	236	48	231	81	154	84	63	55

Notes:

1 - CCME Soil Quality Guidelines (SQGs) - Commercial Land Use, accessed online October 2018

"-" - No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds guidelines

					marystown, NL						
			MLLA-BH2-2018	MLLA-BH2-2018	MFPA-BH3-2018	MFPA-BH3-2018	MFPA-BH4-2018	MFPA-BH4-2018	MSBL-MW2-2018	MSBL-BH4-2018	
		Sample ID		SS2	SS1	SS2	SS1	SS3	SS1	SS1	
	Sa	mple Depth (mbgs)	0 - 0.6	0.6 - 1.2	0 - 0.6	0.6 - 1.2	0 - 0.6	1.2 - 1.8	0 - 0.6	0 - 0.6	
		Date Collected	10/3/2018	10/3/2018	10/4/2018	10/4/2018	10/4/2018	10/4/2018	10/4/2018	10/9/2018	
	Guidelines										
Parameter	Criteria 1	Units									
Metals											
Aluminum	-	mg/kg	7240	2390	32000	19600	11200	5400	10800	11400	
Antimony	40	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	
Arsenic	26	mg/kg	18	9	5	14	11	6	8	9	
Barium	2000	mg/kg	152	50	20	79	238	35	40	35	
Beryllium	8	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	
Boron	-	mg/kg	2	<2	<2	<2	2	<2	<2	<2	
Cadmium	22	mg/kg	0.5	<0.3	< 0.3	<0.3	0.4	< 0.3	<0.3	<0.3	
Chromium	87	mg/kg	14	8	107	33	43	46	13	9	
Cobalt	300	mg/kg	9	7	34	23	18	6	7	6	
Copper	91	mg/kg	16	11	54	29	66	22	13	13	
Iron	=	mg/kg	17900	7800	22600	43400	32100	13300	8310	12100	
Lead	260	mg/kg	13.3	7.5	5.9	7.6	96.7	8.5	8.7	12.5	
Lithium	-	mg/kg	9	<5	15	14	9	7	8	13	
Manganese	-	mg/kg	1130	992	1240	1700	1840	642	714	451	
Mercury	24	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	
Molybdenum	40	mg/kg	<2	<2	<2	<2	<2	7	<2	<2	
Nickel	89	mg/kg	12	7	69	24	23	11	9	6	
Selenium	2.9	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	
Silver	40	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Strontium	=	mg/kg	19	19	67	26	29	22	14	9	
Thallium	1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Tin	300	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2	
Uranium	33	mg/kg	0.5	0.2	0.1	0.2	0.3	0.3	0.3	0.4	
Vanadium	130	mg/kg	37	21	84	79	60	28	26	26	
Zinc	410	mg/kg	79	32	101	96	152	43	39	101	

Notes:

1 - CCME Soil Quality Guidelines (SQGs) - Commercial Land Use, accessed online October 2018

"-" - No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds guidelines

Table 4 Petroleum Hydrocarbons in Groundwater Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

						Sample ID	MSBL-MW2- 2018	MW0 Field Duplicate MSBL-MW2-2018	IMSRI_MW6	MLLA-MW1- 2018	MFPA-MW1- 2018	MASO-MW1- 20108	RW1	RW2	MAEB-MW1- 2018	MAEB-MW2- 2018
						Date Collected	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/26/2018	10/26/2018	10/12/2018	10/12/2018
			Guidelines													
Parameter	Criteria 1	Criteria ²	Criteria ³	Criteria ⁴	Criteria ⁵	Units										
Petroleum Hydrocarbons																
Benzene	20	350	4.6	5	97	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	20	200	4.2	4.6	88	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethyl Benzene	20	110	3.2	3.5	67	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Xylenes	20	120	2.8	3	59	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.001	<0.002	<0.002
C6-C10 (less BTEX)	-	11	-	-		mg/L	<0.01	<0.01	0.04	<0.01	0.24	0.04	<0.01	<0.01	<0.01	0.22
C10-C16	-	3.1	-	-		mg/L	0.16	0.44	1.99	<0.05	0.4	1.28	0.16	0.06	<0.05	<u>6.51</u>
C16-C21	-					mg/L	0.15	0.51	2.72	<0.10	0.46	0.64	0.27	<0.05	<0.10	4.88
C21-C32	-	1 -	-	-		mg/L	<0.1	0.2	0.76	<0.1	0.32	1.29	0.03	0.02	<0.1	0.68
Modified TPH	20	-	13 - Gas 0.84 - Diesel 0.48 - Lube Oil	13 - Gas 0.85 - Diesel 1.3 - Lube Oil	750 - Gas >SOL - Diesel >SOL - Lube Oil	mg/L	0.3	1.2	<u>5.5</u>	<0.1	1.4	3.3	0.5	<0.1	<0.1	12.3
Laboratory Resemblance							WFOF	WFOF	WFOF	NR	WFOF	FOF,LOF	WFOF	FR, UC	NR	FOF

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I Groundwater ESLs for Plants and Invertebrates; Direct Contact With Shallow Groundwater -Commercial Land Use with Coarse-Grained Soil
- 3 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 10 m to receiving aquatic environment with coarse-grained soil MSBL-MW2-2018, MDSA-MW3-2018
- 4 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 20 m to receiving aquatic environment with coarse-grained soil MSBL-MW6, MLLA-MW1-2018, MGPA-MW1-2018, MDSA-MW9, MGSB-MW15, MGSB-MW17
- 5 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 150 m to receiving aquatic environment with coarse-grained soil MASO-MW1-2018, RW1, RW2, MAEB-MW1-2018, MAEG-MW2-2018
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs

<u>Underline/Bold</u> - Exceeds Tier 1 ESLs

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

UC - Unidentified Compounds

Table 4 Petroleum Hydrocarbons in Groundwater Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

						Sample ID	MDSA-MW2- 2018	MDSA-MW3- 2018	MDSA-MW9	MGSB-MW15	MW00 Field Duplicate MGSB-MW15	MGSB-MW17
						Date Collected	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018
			Guidelines									
Parameter	Criteria 1	Criteria ²	Criteria ³	Criteria ⁴	Criteria ⁵	Units						
Petroleum Hydrocarbons												
Benzene	20	350	4.6	5	97	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	20	200	4.2	4.6	88	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethyl Benzene	20	110	3.2	3.5	67	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Xylenes	20	120	2.8	3	59	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	-	11	-	-		mg/L	<0.01	0.01	<0.01	1.08	1.09	<0.01
C10-C16	-	3.1	-	-		mg/L	0.12	<0.05	<0.05	230	<u>88.6</u>	1.87
C16-C21	-					mg/L	0.17	<0.10	<0.10	190	71.2	3.23
C21-C32	-	1 -	-	-		mg/L	<0.1	<0.1	<0.1	26	10.9	0.92
Modified TPH	20	-	13 - Gas 0.84 - Diesel 0.48 - Lube Oil	13 - Gas 0.85 - Diesel 1.3 - Lube Oil	750 - Gas >SOL - Diesel >SOL - Lube Oil	mg/L	0.3	<0.1	<0.1	<u>447</u>	<u>172</u>	<u>6</u>
Laboratory Resemblance							WFOF	GR	NR	FOF	FOF	WFOF

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I Groundwater ESLs for Plants and Invertebrates; Direct Contact With Shallow Groundwater -Commercial Land Use with Coarse-Grained Soil
- 3 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 10 m to receiving aquatic environment with coarse-grained soil MSBL-MW2-2018, MDSA-MW3-2018
- 4 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 20 m to receiving aquatic environment with coarse-grained soil MSBL-MW6, MLLA-MW1-2018, MGPA-MW1-2018, MDSA-MW9, MGSB-MW15, MGSB-MW17
- 5 Atlantic RBCA Tier I Groundwater ESLs for the Protection of Freshwater and Marine Aquatic Life, adjusted for distance to receiving aquatic environment and soil type 150 m to receiving aquatic environment with coarse-grained soil MASO-MW1-2018, RW1, RW2, MAEB-MW1-2018, MAEG-MW2-2018
- "-" No established guideline

mbgs - metres below ground surface

mg/kg - milligrams per kilogram

Shading - Exceeds Tier I RBSLs

<u>Underline/Bold</u> - Exceeds Tier 1 ESLs

FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

FR - Fuel Range

LR - Lube Range

GR - Gasoline Range

UC - Unidentified Compounds

		Sample ID	MAEB-MW2-2018	MDSA-MW1-2018	MW000 Field Duplicate MDSA-MW1-2018	MLLA-MW2-2018	MLLA-MW3-2018	MLLA-MW4-2018
		Date Collected	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018	10/12/2018
	Guidelines							
Parameter	Criteria 1	Units						
Metals								
Aluminum	-	μg/L	39	13	<5	110	14	14
Antimony	-	μg/L	<2	<2	<2	<2	<2	<2
Arsenic	12.5	μg/L	19	27	36	87	240	362
Barium	500	μg/L	97	87	82	483	55	76
Beryllium	100	μg/L	<2	<2	<2	<2	<2	<2
Bismuth	-	μg/L	<2	<2	<2	<2	<2	<2
Boron	-	μg/L	20	1930	1720	387	2370	2960
Cadmium	-	μg/L	< 0.09	0.11	0.11	< 0.09	0.13	0.16
Chromium	56	μg/L	2	3	3	4	6	7
Cobalt	-	μg/L	<1	<1	<1	1	1	2
Copper	2	μg/L	3	5	4	3	4	7
Iron	-	μg/L	149	<50	<50	2780	<50	<50
Lead	2	μg/L	<0.5	0.5	<0.5	0.5	<0.5	<0.5
Manganese	-	μg/L	320	20	18	4790	176	33
Molybdenum	-	μg/L	4	2	2	<2	4	5
Nickel	83	μg/L	<2	7	8	4	8	10
Selenium	54	μg/L	3	97	96	43	109	156
Silver	-	μg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Strontium	-	μg/L	139	3860	3630	969	4040	5290
Thallium	-	μg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	-	μg/L	<2	<2	<2	<2	<2	<2
Titanium	-	μg/L	4	2	2	6	2	6
Uranium	-	μg/L	0.1	0.8	0.8	0.4	0.1	1.9
Vanadium	-	μg/L	18	25	32	152	2	494
Zinc	10	μg/L	9	17	15	12	5	32

Notes:

1 - FCSAP, Federal Interim Groundwater Quality Guidelines Generic Guidelines for Commercial and Industrial Land Uses - Tier 2 for Marine Life Exposure Pathway

μg/L - Micrograms per litre

Shading - Exceeds Guideline

[&]quot;-" - No established guideline

Table 6 Petroleum Hydrocarbons in Sediments Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

						,									
		Sample ID	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6	18-MNMA-S7	18-MNMA-S8	18-MNMA-S9	18-MNMA- \$10	18-MNMA- S11	18-MNMA-DUP2 Field Duplicate 18-MNMA-S11
		Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
		Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
	Guideline			•					Waterlat Avec						
Parameter	Criteria ¹	Units		1			T		Waterlot Area	1		· · · · · · · · · · · · · · · · · · ·			1
Hydrocarbons															
Benzene	5.4	mg/kg	<0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	6.1	mg/kg	<0.04	< 0.04	<0.04	<0.04	< 0.04	<0.04	<0.04	<0.04	< 0.04	< 0.04	< 0.04	<0.04	<0.04
Ethyl Benzene	5	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	5.5	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
C10-C16	-	mg/kg	<15	<15	<15	<15	<15	<15	<15	<15	<15	19	<15	<15	<15
C16-C21	<u>_</u>	mg/kg	76	54	56	66	76	103	48	19	<15	77	51	28	75
C21-C32		mg/kg	203	139	179	187	226	316	129	81	63	178	149	70	182
Modified TPH- Tier 1	67 - Gas 110 - Diesel / #2 190 - #6 Oil / Lube 500 - Max	mg/kg	279	193	235	253	302	419	177	100	63	274	200	98	257
Laboratory Resemblance			FR,LR	FR,LR	FR,LR	FR,LR	FR,LR	FR,LR	FR,LR						

Notes:

1 - Atlantic RBCA Tier I Sediment ESLs for the Protection of Freshwater and Marine Aquatic Life - Other Sediment, based on FOC of 0.01, the average FOC is 0.1 for waterlot sediments and 0.038 for the reference samples. The screening levels for mTPH can change proportionally with the Site FOC, but cannot exceed 500 mg/kg regardless of the FOC.

m - metres

mg/kg - milligrams per kilogram

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance FR - Fuel Range LR - Lube Range

GR - Gasoline Range

UC - Unidentified Compounds Shading - Exceeds Guidelines

Table 6 Petroleum Hydrocarbons in Sediments Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

		Sample ID	18-MNMA- S12	18-MNMA- S13	18-MNMA- S14	18-MNMA- S15	18-MNMA- STEP1	18-MNMA- STEP2	18-MNMA- STEP3	18-MNMA-DUP3 Field Duplicate 18-MNMA-STEP3	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3
		Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
		Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	12/13/2018	12/13/2018	12/13/2018	12/13/2018	10/19/2018	10/19/2018	10/19/2018
	Guideline			\M/-1I	-1 4			01 01 6	W-1I-1 A			Deference Area	
Parameter	Criteria ¹	Units		Waterl	ot Area	1		Step Out fro	m Waterlot Are	a		Reference Area	
Hydrocarbons													
Benzene	5.4	mg/kg	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	<0.03
Toluene	6.1	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Ethyl Benzene	5	mg/kg	< 0.03	< 0.03	<0.03	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylenes	5.5	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	-	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
C10-C16	-	mg/kg	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
C16-C21	_	mg/kg	<15	55	<15	24	<15	<15	<15	40	<15	<15	<15
C21-C32	-	mg/kg	38	51	54	41	<15	<15	25	33	22	<15	<15
Modified TPH- Tier 1	67 - Gas 110 - Diesel / #2 190 - #6 Oil / Lube 500 - Max	mg/kg	38	106	54	65	<20	<20	25	73	22	<20	<20
Laboratory Resemblance			FR,LR	FR,LR	FR,LR	FR,LR	NR	NR	LR	FR,LR	LR	NR	NR

Notes:

1 - Atlantic RBCA Tier I Sediment ESLs for the Protection of Freshwater and Marine Aquatic Life - Other Sediment, based on FOC of 0.01, the average FOC is 0.1 for waterlot sediments and 0.038 for the reference samples. The screening levels for mTPH can change proportionally with the Site FOC, but cannot exceed 500 mg/kg regardless of the FOC.

m - metres

mg/kg - milligrams per kilogram

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

NR - No Resemblance

LR - Lube Range

FR - Fuel Range

GR - Gasoline Range

UC - Unidentified Compounds Shading - Exceeds Guidelines

			Sample ID	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6	18-MNMA-S7
			Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
	T		Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
		leline					Wat	erlot Area			
Parameter	Criteria 1	Criteria ²	Units						T		
Aluminum	_	_	mg/kg	10900	10500	11900	14300	11700	11900	9980	9140
Antimony		_	mg/kg	<1	28	<1	<1	1	2	1	1
-	7.24	41.6		22	17	19	19	24	19	22	20
Arsenic	7.24	41.6	mg/kg	250	83	79	97	148	92	73	58
Barium	+		mg/kg								
Beryllium	-	-	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Boron	-	-	mg/kg	38	30	32	38	53	40	32	45
Cadmium	0.7	4.2	mg/kg	0.3	<0.3	<0.3	0.3	0.4	<0.3	<0.3	0.3
Chromium	52.3	160	mg/kg	71	32	31	26	35	38	19	39
Cobalt	-	-	mg/kg	13	13	13	13	14	12	10	10
Copper	18.7	108	mg/kg	<u>147</u>	98	<u>171</u>	<u>161</u>	<u>207</u>	<u>170</u>	99	63
Iron	-	-	mg/kg	27600	23800	30900	37900	31300	30900	36200	22400
Lead	30.2	112	mg/kg	<u>358</u>	<u>135</u>	<u>284</u>	<u>381</u>	<u>125</u>	<u>252</u>	<u>143</u>	<u>222</u>
Lithium	-	-	mg/kg	18	17	22	19	22	18	16	13
Manganese	-	-	mg/kg	326	288	351	397	321	338	390	387
Mercury	0.13	0.7	mg/kg	0.14	0.08	0.1	0.64	0.09	0.11	0.06	0.06
Molybdenum	-	-	mg/kg	4	4	4	5	6	5	2	3
Nickel	-	-	mg/kg	22	24	24	22	27	24	14	17
Selenium	-	-	mg/kg	1	1	1	1	2	1	1	1
Silver	-	-	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	-	-	mg/kg	92	77	47	38	70	40	30	50
Thallium	-	-	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	=	-	mg/kg	14	8	8	10	15	12	13	20
Uranium	-	-	mg/kg	1	1	1	1.2	1.1	0.9	0.8	1
Vanadium	-	-	mg/kg	47	42	46	42	53	47	25	40
Zinc	124	271	mg/kg	<u>799</u>	267	<u>282</u>	<u>329</u>	<u>397</u>	<u>297</u>	<u>629</u>	<u>868</u>

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed online October 2018
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October 2018
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

<u>Underline/Bold</u> - Exceeds CCME PEL

			Sample ID	18-MNMA-S8	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-DUP2 Field Duplicate 18-MNMA-S11	18-MNMA-S12		
			Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10		
			Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018		
_		leline		Waterlot Area							
Parameter	Criteria 1	Criteria ²	Units			T					
A1 .				7100	2052	2010	11100	10000	40000		
Aluminum	-	-	mg/kg	7190	9350	8010	11400	10900	12600		
Antimony	-	-	mg/kg	2	2	<1	<1	<1	1		
Arsenic	7.24	41.6	mg/kg	22	34	28	29	31	<u>78</u>		
Barium	-	-	mg/kg	106	149	48	120	66	122		
Beryllium	-	-	mg/kg	<2	<2	<2	<2	<2	<2		
Boron	-	-	mg/kg	26	50	104	60	152	65		
Cadmium	0.7	4.2	mg/kg	0.3	0.5	0.5	0.4	1	0.4		
Chromium	52.3	160	mg/kg	15	24	26	20	27	11		
Cobalt	=	=	mg/kg	8	12	9	12	10	18		
Copper	18.7	108	mg/kg	98	<u>122</u>	77	<u>144</u>	<u>111</u>	<u>159</u>		
Iron	-	-	mg/kg	19400	28100	48700	29900	34600	50000		
Lead	30.2	112	mg/kg	<u>343</u>	332	54.4	<u>252</u>	67	<u>728</u>		
Lithium	-	-	mg/kg	13	16	15	20	17	17		
Manganese	-	-	mg/kg	316	343	274	559	283	115		
Mercury	0.13	0.7	mg/kg	0.07	0.07	0.05	0.05	0.05	0.05		
Molybdenum	-	-	mg/kg	2	4	9	5	9	<2		
Nickel	-	-	mg/kg	9	17	16	14	17	14		
Selenium	-	-	mg/kg	1	2	<1	<1	<1	2		
Silver	-	-	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		
Strontium	-	-	mg/kg	31	73	345	61	200	15		
Thallium	=	-	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		
Tin	-	-	mg/kg	22	26	7	13	8	17		
Uranium	-	-	mg/kg	0.7	1.2	2.4	1.4	2.5	1.5		
Vanadium	-	-	mg/kg	22	39	45	39	63	14		
Zinc	124	271	mg/kg	1450	1660	334	<u>585</u>	379	5020		

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed online October 2018
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October 2018 $\,$
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

<u>Underline/Bold</u> - Exceeds CCME PEL

		Sample ID	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA- STEP1	18-MNMA- STEP2	18-MNMA- STEP3	18-MNMA-DUP3 Field Duplicate 18-MNMA-STEP3	
		5	Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
			Date Collected	10/19/2018	10/19/2018	10/19/2018	12/13/2018	12/13/2018	12/13/2018	12/13/2018
		deline			Waterlot Area			Step Out fro	m Waterlot Area	ı
Parameter	Criteria 1	Criteria ²	Units		Γ			Γ	T	T
Al-			/I	0040	40000	44000	4000	7550	0000	0000
Aluminum	-	-	mg/kg	9940	10900	11900	4060	7550	8330	9800
Antimony		-	mg/kg	<1	<1	3	<1	<1	<1	<1
Arsenic	7.24	41.6	mg/kg	<u>65</u>	25	41	26	13	19	22
Barium	-	-	mg/kg	135	214	167	14	139	68	74
Beryllium	-	-	mg/kg	<2	<2	<2	<2	<2	<2	<2
Boron	-	-	mg/kg	86	51	100	14	12	61	82
Cadmium	0.7	4.2	mg/kg	0.5	0.4	0.6	<0.3	<0.3	<0.3	0.4
Chromium	52.3	160	mg/kg	12	31	98	11	23	24	30
Cobalt	-	-	mg/kg	19	15	22	7	12	11	13
Copper	18.7	108	mg/kg	<u>158</u>	<u>260</u>	<u>145</u>	7	13	62	77
Iron	-	-	mg/kg	43100	27400	41200	2100	17600	21400	24600
Lead	30.2	112	mg/kg	<u>236</u>	<u>135</u>	<u>466</u>	7.8	12.6	38.1	48.3
Lithium	-	-	mg/kg	16	20	17	10	19	19	22
Manganese	-	-	mg/kg	116	332	279	320	350	242	300
Mercury	0.13	0.7	mg/kg	0.07	0.14	0.05	<0.05	<0.05	0.09	0.22
Molybdenum	-	-	mg/kg	2	6	9	<2	<2	5	7
Nickel	-	-	mg/kg	23	25	45	10	19	22	24
Selenium	-	-	mg/kg	1	<1	3	<1	<1	<1	<1
Silver	-	-	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Strontium	-	-	mg/kg	24	48	120	55	187	71	76
Thallium	-	-	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	-	-	mg/kg	10	10	28	3	4	11	7
Uranium	-	-	mg/kg	1.8	1.3	2	0.2	0.2	1.6	1.9
Vanadium	-	-	mg/kg	16	50	48	34	41	56	76
Zinc	124	271	mg/kg	<u>662</u>	<u>375</u>	<u>1730</u>	45	51	179	190

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed online October 2018
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October 2018
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

<u>Underline/Bold</u> - Exceeds CCME PEL

			Sample ID	18-MNMA- REF1		18-MNMA-REF3
			Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10
	1 0.		Date Collected	10/19/2018	10/19/2018	10/19/2018
_		leline			Reference Area	
Parameter	Criteria 1	Criteria ²	Units			
Aluminum	-	-	mg/kg	8770	8780	9750
Antimony	-	-	mg/kg	<1	<1	<1
Arsenic	7.24	41.6	mg/kg	9	11	13
Barium	-	-	mg/kg	37	34	53
Beryllium	-	-	mg/kg	<2	<2	<2
Boron	-	-	mg/kg	15	16	20
Cadmium	0.7	4.2	mg/kg	<0.3	<0.3	<0.3
Chromium	52.3	160	mg/kg	11	16	22
Cobalt	-	-	mg/kg	7	8	10
Copper	18.7	108	mg/kg	6	8	14
Iron	-	-	mg/kg	6990	7390	9550
Lead	30.2	112	mg/kg	5.9	6.5	7.4
Lithium	-	-	mg/kg	13	17	17
Manganese	-	-	mg/kg	197	211	183
Mercury	0.13	0.7	mg/kg	<0.05	0.05	0.05
Molybdenum	-	-	mg/kg	<2	3	2
Nickel	-	-	mg/kg	11	13	18
Selenium	-	-	mg/kg	<1	<1	<1
Silver	-	-	mg/kg	<0.5	<0.5	<0.5
Strontium	-	-	mg/kg	17	22	27
Thallium	-	-	mg/kg	<0.1	0.1	0.1
Tin	-	-	mg/kg	3	3	4
Uranium	-	-	mg/kg	1.1	1.4	1.4
Vanadium	-	-	mg/kg	26	33	40
Zinc	124	271	mg/kg	30	34	38

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed online October 2018
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October 2018
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

<u>Underline/Bold</u> - Exceeds CCME PEL

			Sample ID	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6
		Sa	ample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
			Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
	Guid	elines					Waterlot Are	22		
Parameter	Criteria 1	Criteria 2	Units				Wateriot Air	za		
1-Methylnaphthalene	-	-	mg/kg	< 0.05	0.06	0.20	0.05	0.27	0.06	< 0.05
2-Methylnaphthalene	0.0202	0.2010	mg/kg	0.05	0.07	<u>0.24</u>	0.06	<u>0.38</u>	0.07	0.03
Acenaphthene	0.00671	0.0889	mg/kg	<u>0.122</u>	<u>0.146</u>	<u>0.279</u>	<u>0.168</u>	<u>0.728</u>	<u>0.179</u>	<u>0.101</u>
Acenaphthylene	0.00587	0.1280	mg/kg	0.039	<0.004	0.045	0.043	0.076	0.063	0.034
Acridine	-	ı	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	0.11	< 0.05	< 0.05
Anthracene	0.0469	0.2450	mg/kg	0.19	0.22	<u>0.31</u>	0.24	<u>1.01</u>	<u>0.27</u>	0.17
Benz[a]anthracene	0.0748	0.6930	mg/kg	0.36	0.42	0.58	0.43	1.55	0.59	0.29
Benzo[a]pyrene	0.0888	0.7630	mg/kg	0.37	0.42	0.60	0.44	1.34	0.57	0.29
Benzo[b]fluoranthene					0.39	0.55	0.41	1.23	0.56	0.27
Benzo(b+j)fluoranthene	-	•	mg/kg	0.57	0.60	0.90	0.64	1.96	0.80	0.39
Benzo(e)pyrene	-	ı	mg/kg	0.30	0.32	0.42	0.32	0.93	0.43	0.21
Benzo[ghi]perylene	-	•	mg/kg	<0.01	0.28	0.41	0.29	0.86	0.38	<0.01
Benzo[k]fluoranthene	-	ı	mg/kg	0.19	0.23	0.31	0.26	0.72	0.29	0.19
Chrysene	0.1080	0.8460	mg/kg	0.47	0.51	0.67	0.53	<u>1.70</u>	0.70	0.33
Dibenz[a,h]anthracene	0.00622	0.1350	mg/kg	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Fluoranthene	0.1130	1.4940	mg/kg	0.92	0.99	<u>1.59</u>	1.16	<u>3.62</u>	1.37	0.80
Fluorene	0.0212	0.1440	mg/kg	<u>0.15</u>	<u>0.17</u>	<u>0.32</u>	<u>0.19</u>	<u>0.94</u>	<u>0.20</u>	0.12
Indeno[1,2,3-cd]pyrene	-	-	mg/kg	<0.01	0.29	0.51	0.38	1.09	<0.01	<0.01
Naphthalene	0.0346	0.3910	mg/kg	<0.01	<0.01	0.32	<0.01	<u>0.62</u>	<0.01	<0.01
Perylene	-	-	mg/kg	< 0.05	0.11	0.15	0.12	0.33	0.15	< 0.05
Phenanthrene	0.0867	0.5440	mg/kg	<u>0.91</u>	<u>0.94</u>	<u>1.67</u>	<u>1.12</u>	<u>4.05</u>	<u>1.26</u>	<u>0.74</u>
Pyrene	0.1530	1.3980	mg/kg	0.87	0.80	1.19	0.90	<u>2.61</u>	1.13	0.57
Quinoline	-	-	mg/kg	< 0.05	<0.05	<0.05	< 0.05	< 0.05	<0.05	< 0.05
PAH High Molecular Wt	-		mg/kg	3.13	3.87	5.59	4.19	12.76	4.89	2.27
PAH Low Molecular Wt	-		mg/kg	2.38	2.71	5.12	3.15	12.13	3.62	2.00

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

			Sample ID	18-MNMA-S7	18-MNMA-S8	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-DUP2 Field Duplicate 18-MNMA-S11	18-MNMA-S12
		S	ample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
			Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
	Guid	elines					Waterlot Area			
Parameter	Criteria 1	Criteria 2	Units				Wateriot Area			
1-Methylnaphthalene	-	-	mg/kg	<0.05	< 0.05	0.20	0.07	< 0.05	<0.05	< 0.05
2-Methylnaphthalene	0.0202	0.2010	mg/kg	<0.01	0.04	0.20	0.09	0.02	0.02	0.02
Acenaphthene	0.00671	0.0889	mg/kg	<0.00671	0.0831	<u>0.226</u>	<u>0.269</u>	<0.00671	<0.00671	<0.00671
Acenaphthylene	0.00587	0.1280	mg/kg	0.020	0.058	0.060	0.095	0.049	<u>0.465</u>	0.030
Acridine	-	-	mg/kg	<0.05	< 0.05	<0.05	<0.05	< 0.05	<0.05	<0.05
Anthracene	0.0469	0.2450	mg/kg	0.05	0.17	<u>0.33</u>	<u>0.49</u>	0.12	<u>0.56</u>	<u>0.28</u>
Benz[a]anthracene	0.0748	0.6930	mg/kg	0.11	0.35	0.59	<u>1.26</u>	0.28	<u>1.45</u>	0.34
Benzo[a]pyrene	0.0888	0.7630	mg/kg	0.10	0.35	0.52	<u>1.06</u>	0.22	<u>1.42</u>	0.25
Benzo[b]fluoranthene	-	-	mg/kg	0.11	0.35	0.49	1.00	0.23	1.20	0.26
Benzo(b+j)fluoranthene	-	-	mg/kg	0.17	0.35	0.81	1.41	0.38	1.80	0.39
Benzo(e)pyrene	-	-	mg/kg	0.08	0.35	0.37	0.74	0.18	0.89	0.18
Benzo[ghi]perylene	-	-	mg/kg	<0.01	<0.01	0.32	0.64	<0.01	0.76	<0.01
Benzo[k]fluoranthene	-	-	mg/kg	0.05	0.43	0.25	0.53	0.11	0.59	0.19
Chrysene	0.1080	0.8460	mg/kg	0.14	0.41	0.66	<u>1.63</u>	0.33	<u>1.37</u>	0.39
Dibenz[a,h]anthracene	0.00622	0.1350	mg/kg	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Fluoranthene	0.1130	1.4940	mg/kg	0.30	0.92	<u>1.67</u>	<u>2.76</u>	1.08	<u>3.93</u>	0.49
Fluorene	0.0212	0.1440	mg/kg	0.03	0.11	<u>0.26</u>	<u>0.35</u>	0.04	0.13	0.06
Indeno[1,2,3-cd]pyrene	-	-	mg/kg	<0.01	<0.01	0.42	0.65	<0.01	1.13	<0.01
Naphthalene	0.0346	0.3910	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Perylene	-	-	mg/kg	<0.05	< 0.05	0.13	0.25	< 0.05	0.41	<0.05
Phenanthrene	0.0867	0.5440	mg/kg	0.22	<u>0.78</u>	<u>1.50</u>	<u>2.41</u>	0.32	<u>1.42</u>	0.33
Pyrene	0.1530	1.3980	mg/kg	0.24	0.76	1.27	<u>2.13</u>	0.83	<u>2.98</u>	0.41
Quinoline	-	-	mg/kg	<0.05	< 0.05	<0.05	<0.05	<0.05	<0.05	< 0.05
PAH High Molecular Wt	-		mg/kg	0.89	3.00	5.21	10.05	2.33	12.39	2.15
PAH Low Molecular Wt	-		mg/kg	0.62	2.16	4.58	6.78	1.63	6.94	1.23

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

			Sample ID	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA- STEP1	18-MNMA- STEP2	18-MNMA- STEP3	18-MNMA-DUP3 Field Duplicate 18-MNMA-STEP3	
		S	ample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	
			Date Collected	10/19/2018	10/19/2018	10/19/2018	12/13/2018	12/13/2018	12/13/2018	12/13/2018	
	Guid	elines			Waterlot Area			Stop Out fr	om Waterlot Are		
Parameter	Criteria 1	Criteria 2	Units		Wateriot Area			Step Out II	om wateriot Are	ŧa	
1-Methylnaphthalene	-	-	mg/kg	<0.05	0.11	0.08	< 0.05	< 0.05	<0.05	< 0.05	
2-Methylnaphthalene	0.0202	0.2010	mg/kg	0.01	0.13	0.09	<0.01	<0.01	<0.01	<0.01	
Acenaphthene	0.00671	0.0889	mg/kg	<u>0.0478</u>	<u>0.480</u>	<u>0.209</u>	<0.00671	<0.00671	0.0176	0.0469	
Acenaphthylene	0.00587	0.1280	mg/kg	0.039	0.084	0.081	< 0.004	< 0.004	0.025	0.024	
Acridine	-	-	mg/kg	<0.05	<0.05	< 0.05	< 0.05	< 0.05	<0.05	< 0.05	
Anthracene	0.0469	0.2450	mg/kg	0.16	<u>0.72</u>	<u>0.44</u>	< 0.03	< 0.03	0.05	0.13	
Benz[a]anthracene	0.0748	0.6930	mg/kg	0.30	<u>1.08</u>	<u>0.72</u>	<0.01 <0.01 0.13 0				
Benzo[a]pyrene	0.0888	0.7630	mg/kg	0.24	<u>1.04</u>	0.66	<0.01	<0.01	0.13	0.31	
Benzo[b]fluoranthene	-	-	mg/kg	0.24	1.00	0.66	< 0.05	< 0.05	0.14	0.36	
Benzo(b+j)fluoranthene	-	-	mg/kg	0.38	1.39	0.94	<0.1	<0.1	0.20	0.56	
Benzo(e)pyrene	-	-	mg/kg	0.19	0.74	0.49	< 0.05	< 0.05	0.11	0.26	
Benzo[ghi]perylene	-	-	mg/kg	<0.01	0.68	0.40	<0.01	<0.01	0.08	0.20	
Benzo[k]fluoranthene	-	-	mg/kg	0.11	0.38	0.35	<0.01	<0.01	0.09	0.24	
Chrysene	0.1080	0.8460	mg/kg	0.33	<u>1.19</u>	0.83	<0.01	<0.01	0.14	0.38	
Dibenz[a,h]anthracene	0.00622	0.1350	mg/kg	<0.006	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	<0.006	
Fluoranthene	0.1130	1.4940	mg/kg	0.56	<u>2.91</u>	<u>1.84</u>	<0.05	< 0.05	0.31	0.84	
Fluorene	0.0212	0.1440	mg/kg	0.07	<u>0.52</u>	<u>0.26</u>	<0.01	<0.01	0.03	0.01	
Indeno[1,2,3-cd]pyrene	-	-	mg/kg	<0.01	0.87	0.53	<0.01	<0.01	<0.01	<0.01	
Naphthalene	0.0346	0.3910	mg/kg	<0.01	0.32	<0.01	<0.01	<0.01	<0.01	<0.01	
Perylene	-	-	mg/kg	<0.05	0.29	0.18	<0.05	<0.05	<0.05	0.09	
Phenanthrene	0.0867	0.5440	mg/kg	0.42	2.82	<u>1.51</u>	< 0.03	<0.03	0.21	<u>0.57</u>	
Pyrene	0.1530	1.3980	mg/kg	0.50	2.27	<u>1.54</u>	<0.05	<0.05	0.28	0.61	
Quinoline	-	-	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
PAH High Molecular Wt	-		mg/kg	2.05	9.64	6.46	0.00	0.00	1.16	2.89	
PAH Low Molecular Wt	-		mg/kg	1.31	8.38	4.69	0.00	0.00	0.64	1.71	

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

			Sample ID	18-MNMA-REF1	18-MNMA-REF2	
		S	ample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10
			Date Collected	10/19/2018	10/19/2018	10/19/2018
	Guid	elines			Reference Area	
Parameter	Criteria 1	Criteria 2	Units		Reference Area	
1-Methylnaphthalene	-	-	mg/kg	< 0.05	< 0.05	<0.05
2-Methylnaphthalene	0.0202	0.2010	mg/kg	<0.01	<0.01	<0.01
Acenaphthene	0.00671	0.0889	mg/kg	<0.00671	<0.00671	<0.00671
Acenaphthylene	0.00587	0.1280	mg/kg	<0.004	<0.004	<0.004
Acridine	-	-	mg/kg	< 0.05	< 0.05	<0.05
Anthracene	0.0469	0.2450	mg/kg	< 0.03	< 0.03	< 0.03
Benz[a]anthracene	0.0748	0.6930	mg/kg	0.03	0.02	<0.01
Benzo[a]pyrene	0.0888	0.7630	mg/kg	<0.01	<0.01	<0.01
Benzo[b]fluoranthene	-	-	mg/kg	< 0.05	< 0.05	<0.05
Benzo(b+j)fluoranthene	-	-	mg/kg	<0.1	<0.1	<0.1
Benzo(e)pyrene	-	-	mg/kg	< 0.05	< 0.05	<0.05
Benzo[ghi]perylene	-	-	mg/kg	<0.01	<0.01	<0.01
Benzo[k]fluoranthene	-	-	mg/kg	0.02	<0.01	<0.01
Chrysene	0.1080	0.8460	mg/kg	0.03	0.03	<0.01
Dibenz[a,h]anthracene	0.00622	0.1350	mg/kg	<0.006	<0.006	<0.006
Fluoranthene	0.1130	1.4940	mg/kg	0.07	0.07	<0.05
Fluorene	0.0212	0.1440	mg/kg	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	-	-	mg/kg	<0.01	<0.01	<0.01
Naphthalene	0.0346	0.3910	mg/kg	<0.01	<0.01	<0.01
Perylene	-	-	mg/kg	<0.05	<0.05	<0.05
Phenanthrene	0.0867	0.5440	mg/kg	0.06	0.04	< 0.03
Pyrene	0.1530	1.3980	mg/kg	0.05	0.06	<0.05
Quinoline	-	-	mg/kg	<0.05	<0.05	<0.05
PAH High Molecular Wt	-		mg/kg	0.13	0.11	0.00
PAH Low Molecular Wt	=		mg/kg	0.13	0.11	0.00

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

									-											
Sample ID	18-MNMA- S1	18-MNMA- S2	18-MNMA- S3	18-MNMA- S4	18-MNMA- S5	18-MNMA- S6	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6	18-MNMA- S7	18-MNMA- S8	18-MNMA- S9	18-MNMA- S10	18-MNMA- S11	18-MNMA-DUP2 Field Duplicate 18-MNMA-S11	18-MNMA- S12	18-MNMA- S13	18-MNMA- S14	18-MNMA- S15	18-MNMA- REF1	18-MNMA- REF2	18-MNMA- REF3
Sample Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
Date Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
Parameter								1	Naterlot Are	a								R	eference Are	ea
Fraction Organic Carbon-1	0.018	0.062	0.058	0.054	0.049	0.079	0.082	0.112	0.107	0.088	0.098	0.109	0.159	0.198	0.371	0.075	0.100	0.034	0.050	0.029
Fraction Organic Carbon-2	0.019	0.062	0.057	0.058	0.051	0.080	0.080	0.113	0.106	0.088	0.099	0.108	0.160	0.198	0.371	0.075	0.102	0.034	0.052	0.029
Fraction Organic Carbon-3	0.019	0.062	0.055	0.059	0.049	0.082	0.083	0.113	0.105	0.089	0.099	0.109	0.159	0.198	0.369	0.075	0.100	0.034	0.051	0.030
Fraction Organic Carbon-Avg	0.019	0.062	0.057	0.057	0.049	0.080	0.083	0.113	0.106	0.088	0.099	0.109	0.159	0.198	0.370	0.075	0.101	0.034	0.051	0.029

Mean FOC 0.1074 Mean FOC 0.0380

Notes:

Samples were analyzed and are reported in triplicate.

FOC was calculated from the Total Organic Matter, which was determined using the Loss on Ignition procedure.

			Sample ID	18-MNMA- S1	18-MNMA- S2	18-MNMA- S3	18-MNMA- S4	18-MNMA- S5	18-MNMA- S6	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6	18-MNMA- S7	18-MNMA- S8	18-MNMA- S9	18-MNMA- \$10	18-MNMA- S11	18-MNMA-DUP2 Field Duplicate 18-MNMA-S11	18-MNMA- \$12	18-MNMA- \$13	18-MNMA- S14	18-MNMA- S15
		Samp	le Depth (m)	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
		Da	te Collected	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018	10/19/2018
	Guide	elines									VA	aterlot Area								
Parameter	Criteria 1	Criteria 2	Units								V	aleriol Area								
Total PCBs	0.0215	0.189	mg/kg	0.10	0.17	<u>0.65</u>	0.05	0.10	0.53	<0.02	<0.02	0.13	0.03	0.08	<0.02	<0.02	0.27	<0.02	0.07	0.05

Notes:

- 1 CCME Interim Sediment Quality Guidelines (ISQGs) for marine sediment, accessed online October 2018
- 2 CCME Probable Effects Levels (PELs) for marine sediment, accessed online October 2018
- "-" Indicates value is not available or does not apply

Shading - Exceeds CCME ISQG

			18-MNMA- STEP1	18-MNMA- STEP2	18-MNMA- STEP3	18-MNMA-DUP3 Field Duplicate 18-MNMA-STEP3	18-MNMA- REF1	18-MNMA- REF2	18-MNMA- REF3
		Samp	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10	0 - 0.10
		Da	12/13/2018	12/13/2018	12/13/2018	12/13/2018	10/19/2018	10/19/2018	10/19/2018
	Guidelines			Stop Out fi	om Waterlot	Reference Area			
Parameter Criteria 1 Criteria 2		Criteria 2		Step Out II	om waterior	Alea	K	elerence Are	;a
Total PCBs	0.0215	0.189	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Notes:

- 1 CCME Interim Sediment Quality Guidel
- 2 CCME Probable Effects Levels (PELs)
- "-" Indicates value is not available or does

Shading - Exceeds CCME ISQG

Table 11

Metals in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Sample ID	18-MNMA-TIS- COMP1	18-MNMA-TIS- COMP2	18-MNMA-TIS- COMP3	18-MNMA-TIS- COMP4	18-MNMA-TIS- REF1B	18-MNMA-TIS- REF3B	18-MNMA- TIS1A	18-MNMA-TIS3
		S1, S2, S4	S5-S10	S12-S15	S8, S9	-	-	-	-
		Rock Crabs	Rock Crabs	Rock Crabs	Mussels	Rock Crab	Mussel	Scallops	Scallops
	Date Collected	12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018
Danamatan	Units								
Parameter	Units								
Metals	,								4.0
Aluminum	mg/kg	15	<10	<10	<10	<10	29	<10	<10
Antimony	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg	3	4	4	3	5	4	2	3
Barium	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg	<5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg	<2	<2	<2	6	2	6	4	5
Cadmium	mg/kg	2.9	1.3	2.3	4.8	< 0.3	3.5	2.7	6
Chromium	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg	20	14	18	9	19	<2	<2	<2
Iron	mg/kg	125	63	132	<50	52	95	<50	146
Lead	mg/kg	<0.4	<0.4	<0.4	0.7	<0.4	1.1	<0.4	<0.4
Manganese	mg/kg	4	<2	<2	43	2	23	<2	<2
Mercury	mg/kg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg	<1	<1	<1	<1	1	<1	<1	<1
Silver	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg	113	49	36	33	210	8	5	5
Thallium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg	2	4	3	5	4	6	4	6
Zinc	mg/kg	25	28	27	108	27	74	10	10

Notes:

mg/kg - milligrams per litre

Table 11

Metals in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Sample ID	18-MNMA- TIS5A	18-MNMA- TIS6A	18-MNMA- TIS10A	18-MNMA- TIS11	18-MNMA- TIS12A	18-MNMA- TIS14A	18-MNMA-TIS- REF3A
		-	-	-	-	-	-	-
		Scallops	Scallops	Scallops	Scallops	Scallops	Scallops	Scallops
	Date Collected	12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018
Parameter	Units							
Metals								
Aluminum	mg/kg	<10	<10	<10	<10	<10	14	<10
Antimony	mg/kg	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg	3	2	3	3	3	3	2
Barium	mg/kg	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg	5	4	5	5	5	5	4
Cadmium	mg/kg	5.6	6.3	17.8	6.6	10.2	8.7	4.9
Chromium	mg/kg	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg	<2	<2	<2	<2	<2	<2	<2
Iron	mg/kg	70	115	142	66	58	74	<50
Lead	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Manganese	mg/kg	<2	<2	<2	<2	<2	<2	<2
Mercury	mg/kg	<0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	mg/kg	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg	<1	<1	<1	<1	<1	<1	<1
Silver	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	< 0.5	<0.5
Strontium	mg/kg	6	<5	5	<5	5	6	5
Thallium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg	5	3	6	4	4	5	4
Zinc	mg/kg	12	7	12	10	9	10	9

Notes:

mg/kg - milligrams per litre

Table 12 PAHs in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

					Sample Identifi	ication and Date			
Parameter	Units	18-MNMA-TIS- COMP1	18-MNMA-TIS- COMP2	18-MNMA-TIS- COMP3	18-MNMA-TIS- COMP4	18-MNMA-TIS- REF1B	18-MNMA-TIS- REF3B	18-MNMA-TIS1A	18-MNMA-TIS3
		S1, S2, S4	S5-S10	S12-S15	S8, S9	-	-	-	-
		Rock Crabs	Rock Crabs	Rock Crabs	Mussels	Rock Crab	Mussel	Scallops	Scallops
		12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018
Polyaromatic Hydrocarbons (PAHs)									
1-Methylnaphthalene	ng/g	20	13.3	12.9	14.1	12.2	15	28	16.4
2-Methylnaphthalene	ng/g	34	23.7	25	26.5	21.4	27	51	30.2
Acenaphthylene	ng/g	1.6	1.6	0.9	1.3	1.8	1.7	2.1	1.2
Acenaphthene	ng/g	5.3	12.7	6.3	10.7	18.4	12.1	16.4	10.5
Acridine	ng/g	<0.3	<0.1	<0.1	<0.1	<0.3	<0.2	<0.1	<0.2
Anthracene	ng/g	1.3	0.3	0.3	1.8	0.9	0.5	1.1	1.1
Benzo(a)anthracene	ng/g	4.30	0.20	0.1	0.4	15.6	0.6	5	5.6
Benzo(a)pyrene	ng/g	1.2	0.6	0.8	0.8	3.4	0.3	2.9	1.1
Benzo(b+j)fluoranthene	ng/g	0.9	0.2	0.2	0.6	2.3	0.4	2.6	1.7
Benzo(e)pyrene	ng/g	3.6	1.4	1.6	2.7	10.6	1.9	7.1	2.5
Benzo(ghi)perylene	ng/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	4	<0.5
Benzo(k)fluoranthene	ng/g	0.8	<0.1	0.2	0.7	3.9	0.4	3.1	1.7
Chrysene	ng/g	4.9	0.3	0.3	0.4	37.8	1.5	5.3	3.8
Dibenzo(a,h)anthracene	ng/g	<0.1	<01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	ng/g	22	1.3	1.2	10.7	14.6	5.8	14.9	12.3
Fluorene	ng/g	3.5	1.8	1.3	1.8	2.9	2.1	2.3	1.8
Indeno(1,2,3)pyrene	ng/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.9	<0.1
Naphthalene	ng/g	22.1	15.3	14	16.4	14	17.4	31.6	19.3
Perylene	ng/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.7	<0.1
Phenanthrene	ng/g	17.8	2.3	2.4	4.1	7.7	5.2	6.1	5.1
Pyrene	ng/g	43.3	1.3	1.1	7.4	11.7	7.2	8	6.8
Quinoline	ng/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B(a)P TPE	ng/g	1.9	0.6	0.9	1.0	6.0	0.5	4.2	2.0
B(a)P TPE x 3 (creosote)	ng/g	5.6	1.9	2.6	2.9	17.9	1.4	12.5	6.1
PAH High Molecular Wt	ng/g	58.10	3.80	4.10	12.40	83.00	11.90	36.30	21.50
PAH Low Molecular Wt	ng/g	127.6	72.3	64.3	87.4	93.9	86.8	155.2	97.9

Notes:

ng/g - nanograms/gram

B(a)P TPE - Benzo(a)pyrene total potency equivalents

Table 12 PAHs in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

				Samp	ole Identification and	I Date		
Parameter	Units	18-MNMA-TIS5A	18-MNMA-TIS6A	18-MNMA-TIS10A	18-MNMA-TIS11	18-MNMA-TIS12A	18-MNMA-TIS14A	18-MNMA-TIS- REF3A
		-	-	-	-		-	-
		Scallops	Scallops	Scallops	Scallops	Scallops	Scallops	Scallops
		12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018
Polyaromatic Hydrocarbons (PAHs)								
1-Methylnaphthalene	ng/g	20	17	12.2	12	12	19.7	8
2-Methylnaphthalene	ng/g	35	32	23.3	23	22	35.4	15
Acenaphthylene	ng/g	1.3	1.3	1.1	1.5	1.3	1.4	0.9
Acenaphthene	ng/g	16.3	14.7	14.6	9.8	8.7	6.1	13.7
Acridine	ng/g	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.1
Anthracene	ng/g	0.5	0.9	0.5	0.7	0.4	1.3	0.4
Benzo(a)anthracene	ng/g	1.7	3.3	6.2	3.4	2	5.1	1.6
Benzo(a)pyrene	ng/g	1.2	2.2	1.2	1.2	1	1.2	1.4
Benzo(b+j)fluoranthene	ng/g	0.8	1.6	1.2	1.5	1.4	2.1	0.7
Benzo(e)pyrene	ng/g	2.9	4.1	4.4	3.7	4.2	4.1	3.5
Benzo(ghi)perylene	ng/g	<0.1	2.6	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	ng/g	1.2	1.8	1.4	1.4	1	1.9	0.5
Chrysene	ng/g	0.9	2.4	3.9	2.6	1.8	20.4	1.1
Dibenzo(a,h)anthracene	ng/g	<0.1	<0.1	<0.1	<0.1	<0.6	<0.1	<0.1
Fluoranthene	ng/g	5.3	12	7.6	11.3	7	9.1	3.2
Fluorene	ng/g	1.7	1.9	1.6	2.2	1.5	1.9	1.6
Indeno(1,2,3)pyrene	ng/g	<0.1	0.5	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	ng/g	26.1	19.5	17.1	13	13.3	24.6	10.2
Perylene	ng/g	0.7	2.1	1.4	<0.1	1	1.1	1.4
Phenanthrene	ng/g	3.8	4.8	4.2	6	3.3	6.2	3.1
Pyrene	ng/g	3	8	4.5	10.7	4	3.8	2.1
Quinoline	ng/g	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B(a)P TPE	ng/g	1.6	3.0	2.1	1.9	1.5	2.3	1.7
B(a)P TPE x 3 (creosote)	ng/g	4.8	8.9	6.4	5.6	4.4	7.0	5.1
PAH High Molecular Wt	ng/g	10.90	24.90	21.60	23.00	14.00	36.50	10.20
PAH Low Molecular Wt	ng/g	110.7	106.2	83.6	79.5	70.5	106.8	57.5

Notes:

ng/g - nanograms/gram

B(a)P TPE - Benzo(a)pyrene total potency equivalents

Table 13 PCBs in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Sample ID	18-MNMA-TIS- COMP1	18-MNMA-TIS- COMP2	18-MNMA-TIS- COMP3	18-MNMA-TIS- COMP4	18-MNMA-TIS- REF1B	18-MNMA-TIS- REF3B	18-MNMA- TIS1A	18-MNMA-TIS3
		S1, S2, S4	S5-S10	S12-S15	S8, S9		•	-	-
		Rock Crabs	Rock Crabs	Rock Crabs	Mussels	Rock Crab	Mussel	Scallops	Scallops
	Date Collected	12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018	12/14/2018	12/13/2018	12/13/2018
Parameter	Units								
Metals		_						_	
PCBs	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

mg/kg - milligrams per litre

Table 13 PCBs in Benthic Invertebrate Tissue Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Sample ID	18-MNMA- TIS5A	18-MNMA- TIS6A	18-MNMA- TIS10A	18-MNMA- TIS11	18-MNMA- TIS12A	18-MNMA- TIS14A	18-MNMA-TIS- REF3A
		-	-	-	-	-	-	-
		Scallops	Scallops	Scallops	Scallops	Scallops	Scallops	Scallops
	Date Collected	12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018
Parameter	Units							
Metals								
PCBs	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

mg/kg - milligrams per litre

Table 14 Petroleum Hydrocarbons in Surface Water Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

			Sample ID	18-MNMA-W2	18-MNMA-W6	18-MNMA-W-DUP1 Field Duplicate 18-MNMA-W6	18-MNMA-W9	18-MNMA- W12	18-MNMA- W14	18-MNMA-W- REF2	18-MNMA-W- REF3
			Date Collected	12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018	12/13/2018
	Guid	elines									
Parameter	Criteria ¹	Criteria ²	Units								
Petroleum Hydrocarbons											
Benzene	20	2.1	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	20	0.77	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ethyl Benzene	20	0.32	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Xylenes	20	0.33	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
C6-C10 (less BTEX)	-	-	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
C10-C16	-	-	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C16-C21	-	-	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
C21-C32	-	-	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Modified TPH	20	1.5 - Gas 0.10 - Diesel 0.10 - Lube Oil	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Laboratory Resemblance				NR	NR	NR	NR	NR	NR	NR	NR

Notes:

- 1 Atlantic RBCA Tier I RBSL Commercial, Non-Potable Water Use with Coarse-Grained Soil
- 2 Atlantic RBCA Tier I Surface Water ESLs for the Protection of Freshwater and Marine
- "-" No established guideline

mg/L - milligrams per litre

Shading - Exceeds Tier I RBSLs <u>Underline/Bold</u> - Exceeds Tier 1 ESLs

NR - No Resemblance

		18-MNMA-W2	18-MNMA-W6	18-MNMA-W-DUP1 Field Duplicate 18-MNMA-W6	18-MNMA-W9	18-MNMA-W12	18-MNMA-W14	18-MNMA-W-REF2	18-MNMA-W-REF3		
Date Collected				12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018	12/13/2018
	Guideline			12,10,2010	12,70,2010	12,10,2010	12112010	121112010	127 0200	12.10.2010	,.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Parameter	Criteria 1	Criteria 2	Units								
Aluminum	-	-	μg/L	23	21	22	30	31	27	21	12
Antimony	-	-	μg/L	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	12.5	5	μg/L	<2	<2	<2	<2	<2	<2	<2	<2
Barium	-	-	μg/L	9	8	8	9	9	8	7	7
Beryllium	-	-	μg/L	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	-	-	μg/L	<2	<2	<2	<2	<2	<2	<2	<2
Boron	-	1,500	μg/L	3,020	3,570	3,470	2,970	3,050	<u>3,210</u>	<u>3,410</u>	<u>3,950</u>
Cadmium	0.12	0.09	μg/L	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
Chromium	1.5 ³	1 ³	μg/L	<u>6</u>	<u>8</u>	<u>8</u>	<u>8</u>	<u>9</u>	<u>8</u>	<u>8</u>	<u>8</u>
Cobalt	-	-	μg/L	3	3	3	3	3	3	3	3
Copper	-	2-44	μg/L	<u>6</u>	<u>8</u>	<u>11</u>	<u>8</u>	<u>8</u>	<u>11</u>	<u>11</u>	<u>13</u>
Iron	-	300	μg/L	179	180	174	200	202	210	177	157
Lead	-	1-7 ⁵	μg/L	<0.05	<0.5	<0.5	<0.05	<0.05	<0.5	<0.5	<0.5
Manganese	-	-	μg/L	13	9	9	15	14	13	9	5
Mercury	0.016	0.026	μg/L	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶	<0.026 ⁶
Molybdenum	-	73	μg/L	7	8	8	6	7	7	7	9
Nickel	-	25-150 ⁷	μg/L	17	18	19	15	16	16	20	24
Phosphorous	-	-		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Selenium	-	1	μg/L	<1	1	1	<1	<1	<u>2</u>	<1	<1
Silver	-	0.25	μg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	-	-	μg/L	4,210	5,080	5,040	4,200	4,410	4,270	4,620	5,690
Thallium	-	0.8	μg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	-	-	μg/L	<2	<2	<2	<2	<2	<2	<2	<2
Titanium	-	-		4	5	10	4	6	6	14	25
Uranium	-	15	μg/L	1.8	2.0	2.1	1.7	1.9	1.8	2.0	2.4
Vanadium	-	-	μg/L	1,140	1,180	1,040	1,120	1,120	1,060	944	930
Zinc	-	7.0	μg/L	<5	<5	<5	<5	<5	<5	<5	<5

Notes:

- 1 CCME Water Quality Guidelines (CWQG) for the Protection of Marine Aquatic Life (Long Term), accessed online January 2019
- 2 CCME Water Quality Guidelines (CWQG) for the Protection of Freshwater Aquatic Life (Long Term), accessed online January 2019
- 3 Chromium, hexavalent (Cr(VI))
- 4 The CWQG for copper is related to water hardness (as CaCO₃):

When the harness is 0 to <82 mg/L, the CWQG is 2 μ g/L.

At hardness \ge 82 to \le 180 mg/L the CWQG is calculated using this equation: CWQG (μ g/L) = 0.2*e^{(0.8545[in(hardness)]-1.465)}. At hardness >180 mg/L, the CWQG is 4 μ g/L.

5 - The CWQG for lead is related to water hardness (as CaCO₃):

When the harness is 0 to ≤60 mg/L, the CWQG is 1 µg/L.

At hardness >60 to ≤180 mg/L the CWQG is calculated using this equation: CWQG (μ g/L) = $e^{\{1.273[\ln(hardness)]\cdot 4.705\}}$

At hardness >180 mg/L, the CWQG is 7 μg/L.

If hardness is unknown, the CWQG is 1 µg/L.

- 6 Reportable Detection Limit (RDL) is greater than the guideline.
- 7 The CWQG for nickel is related to water hardness (as CaCO₃):

When the harness is 0 to ≤60 mg/L, the CWQG is 25 $\mu\text{g/L}.$

At hardness >60 to ≤180 mg/L the CWQG is calculated using this equation: CWQG (μ g/L) = $e^{(0.76[ln(hardness)]+1.06)}$. At hardness >180 mg/L, the CWQG is 150 μ g/L.

If hardness is unknown, the CWQG is 25 μg/L.

"-" - Indicates value is not available or does not apply

Shading - Exceeds CWQG for Marine Aquatic Life

Underline/Bold - Exceeds CWQG for Freshwater Aquatic Life

Table 16 PAHs in Surface Water Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

			Sample ID	18-MNMA-W2	18-MNMA-W6	18-MNMA-W-DUP1 Field Duplicate 18-MNMA-W6	18-MNMA-W9	18-MNMA-W12	18-MNMA-W14	18-MNMA-W- REF2	18-MNMA-W- REF3
		12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018	12/13/2018		
	Guidelines										
Parameter	Criteria 1	Criteria 2	Units								
1-Methylnaphthalene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	-	-	μg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	-	5.8	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	-	4.4	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	-	0.012	μg/L	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
Benz[a]anthracene	-	0.018	μg/L	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018
Benzo[a]pyrene	-	0.015	μg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo[b]fluoranthene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b+j)fluoranthene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[ghi]perylene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo[k]fluoranthene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz[a,h]anthracene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	-	0.04	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	-	3	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno[1,2,3-cd]pyrene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	1.4	1.1	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	-	-	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	-	0.4	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	-	0.025	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	-	3.4	μg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

- 1 CCME Water Quality Guidelines (CWQG) for the Protection of Marine Aquatic Life, accessed online January 2019
- 2 CCME Water Quality Guidelines (CWQG) for the Protection of Freshwater Aquatic Life, accessed online January 2019
- "-" Indicates value is not available or does not apply

Shading - Exceeds CWQG for Marine Aquatic Life

<u>Underline/Bold</u> - Exceeds CWQG for Freshwater Aquatic Life

Table 17 General Chemistry in Surface Water Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

			18-MNMA-W2	18-MNMA-W6	18-MNMA-W-DUP1 Field Duplicate 18-MNMA-W6	18-MNMA-W9		18-MNMA-W14	18-MNMA-W-REF2	18-MNMA-W-REF3	
	12/13/2018	12/13/2018	12/13/2018	12/14/2018	12/14/2018	12/14/2018	12/13/2018	12/13/2018			
_	Guideline										
Parameter	Criteria 1	Criteria ²	Units								
pH	7.0-8.7	6.5-9.0	ma/l	7.79	7.87	7.93	7.89	7.90	7.91	7.92	7.96
Reactive Silica as SiO ₂	7.0-0.7	6.5-9.0	mg/L	1.1	0.5	0.6	0.8	0.8	0.7	0.6	<0.5
Chloride		120	mg/L	9,390	11,200	11,600	9,540		9,940		12,900
	-		mg/L					<u>9,520</u>		11,400	
Fluoride	-	120	mg/L	<24 1,230	<24 1,460	<24 1,500	<24 1,250	<24 1,240	<24 1,290	<24 1,480	<24 1,690
Sulphate Alkalinity	-	-	mg/L	77	89	91	75	79	79	88	1,690
True Color	-	-	mg/L TCU	22	13	12	22	8	10	10	
Turbidity	-	-	NTU	0.8	0.7	1.5	1.3	0.6	0.9	0.8	<5 1.4
Electrical Conductivity	-	-	umho/cm	34,100	38,800	38,300	32,700	33,700	33,900	37,900	43,500
Nitrate + Nitrite as N	-	-	mg/L	<10	<10	<10	<10	<10	<10	<10	43,300 <10
Nitrate as N	200	13	mg/L	<10	<10	<10	<10	<10	<10	<10	<10
Nitrite as N	-	60 NO ₂ -N	mg/L	<10	<10	<10	<10	<10	<10	<10	<10
Ammonia as N	<u> </u>	0.021-231 ³	mg/L	0.31	0.11	0.09	0.1	0.11	0.13	0.09	0.1
Total Organic Carbon		0.021-231	mg/L	3.2	2.2	2.2	3	2.8	2.9	2.2	1.4
Ortho-Phosphate as P		_	mg/L	0.06	0.06	0.06	0.05	0.06	0.005	0.05	0.07
Total Sodium			mg/L	6,820	7,930	7,630	6,530	6,900	6,570	7,140	8,350
Total Potassium		_	mg/L	257	295	282	247	259	245	267	324
Total Calcium		_	mg/L	247	303	275	228	243	244	274	330
Total Magnesium		_	mg/L	789	955	897	800	806	773	855	1,040
Bicarb. Alkalinity (as CaCO ₃)		_	mg/L	77	89	91	75	79	79	88	103
Carb. Alkalinity (as CaCO ₃)	-	-	mg/L	<10	<10	<10	<10	<10	<10	<10	<10
Hydroxide	-	-	mg/L	<5	<5	<5	<5	<5	<5	<5	<5
Calculated TDS	-	-	mg/L	18,800	22,200	22,200	18,600	19,000	19,100	21,500	24,700
Hardness	-	-	mg/L	3,870	4,690	4,380	3,860	3,930	3,790	4,210	5,110
Langelier Index (@20C)	-	-	NA	0.25	0.48	0.51	0.31	0.37	0.38	0.48	0.66
Langelier Index (@4C)	-	-	NA	-0.07	0.16	0.19	-0.01	0.05	0.06	0.16	0.34
Saturation pH (@20C)	-	-	NA	7.54	7.39	7.42	7.58	7.53	7.53	7.44	7.3
Saturation pH (@4C)	-	-	NA	7.86	7.71	7.74	7.9	7.85	7.85	7.76	7.62
Anion Sum	-	-	me/L	292	348	360	297	296	309	354	401
Cation sum	-	-	me/L	380	446	426	367	385	367	401	473
% Difference/ Ion Balance	-	-	%	13	12	8	11	13	9	6	8

Notes:

- 1 CCME Water Quality Guidelines (CWQG) for the Protection of Marine Aquatic Life (Long Term), accessed online January 2019
- 2 CCME Water Quality Guidelines (CWQG) for the Protection of Freshwater Aquatic Life (Long Term), accessed online January 2019
- 3 CWQG for total ammonia is related to temperature (see table on CCME factsheet)
- "-" Indicates value is not available or does not apply

Shading - Exceeds CWQG for Marine Aquatic Life

<u>Underline/Bold</u> - Exceeds CWQG for Freshwater Aquatic Life

Appendix A Photographic Record



Photo 1 – View, looking northeast of the main Site entrance at the Marystown Shipyard Main Administration and Security Office (MASO) with the Machine Shop and General Stores Building in the background.



Photo 2 – View, looking southwest, of the Marystown Shipyard Drum Storage Area (MDSA) with existing monitor well MDSA-MW9 in the foreground.





Photo 3 – View, looking north, of the Marystown Shipyard Drum Storage Area (MDSA).



Photo 4- View, looking southwest, of the former Maintenance Service & Maintenance Parts Buildings.





Photo 5 – View, looking north, of the former Marystown Shipyard Lower Laydown Area (MLLA).



Photo 6-View, looking west, of the Marystown Shipyard Assembly and Erection Building (MAEB) while drilling MAEB-MW1-2018.





Photo 7 – View of existing wells near the Marystown Shipyard General Stores Building (MGSB).



Photo 8 –View, looking north, of RW1 along the west side of the Main Administration and Security Office (MASO).





Photo 9 - View, looking west, of RW2 along the south side of the Main Administration and Security Office (MASO).



Photo 10 - View, looking southwest, of the Marystown Shipyard Assembly and Erection Building (MAEB) while drilling MAEB-MW2-2018.





Photo 11 - View, looking southeast, of the Marystown Shipyard Drum Storage Area (MDSA), while drilling MDSA-MW3-2018.



Photo 12 – View, looking north, of the Marystown Shipyard Fuel Pump Area (MFPA), while drilling MFPA-BH2-2018.





Photo 13 – View, looking north, of the Marystown Shipyard Fuel Pump Area (MFPA), while drilling MFPA-MW1-2018.



Photo 14 – View, looking northwest, of the Marystown Shipyard General Stores Building (MGSB), while drilling MGSB-BH4-2018.





Photo 15 – View, looking west, of the Marystown Shipyard Lower Laydown Area (MLLA), while drilling MLLA-MW1-2018.



Photo 16 – View, looking west, of the Marystown Shipyard Lower Laydown Area (MLLA), while drilling MLLA-MW2-2018.





Photo 17 - View, looking east, of the Marystown Shipyard Lower Laydown Area (MLLA), while drilling MLLA-MW3-2018.



Photo 18 - View looking west, of the Marystown Shipyard Lower Laydown Area (MLLA), while drilling MLLA-MW4-2018.





Photo 19 - View, looking south, of the Marystown Shipyard Service Building (MSBL), while drilling MSBL-BH1-2018.



Photo 20 – View, looking northeast, while drilling MSBL-MW2-2018 in the Marystown Shipyard Service Building (MBSL) area. Note the waterlot to the right of the photograph.





Photo 21 - View, looking northwest, of the Marystown Shipyard General Stores Building (MSGB), while drilling MSGB-BH1-2018.



Photo 22 - View of Reference Sediment Sample 1 (MNMA-REF1-2018) collected northeast of the waterlot property.





Photo 23 - View of Sediment Sample 1 (MNMA-S1-2018) collected from the south portion of the waterlot property.



Appendix B Borehole/Monitor Well Logs

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369032.297

UTM Northing: 5225498.870

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.752 metres

Final Depth: 2.40 metres

Depth to Water Strike: 0.90 metres

Depth to Bedrock: 2.40 metres



Borehole: MAEB-BH1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.8						
- - - -			Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles, compact, moist to wet at approximately 0.90 mbgs, odourless.		SS1	SS	21	50	10	
- - - 1.0 —				2.0 — - - - -	SS2	SS	25	50	25	ВТЕХ/ТРН
- - -			Sand Brown sand, compact, wet, odourless.	- - - -	SS3	SS	15	63	15	
- - 2.0 — - -			Silty Gravel Grey silty gravel, some fractured rock, compact, wet, odourless.	1.0 — - - - -	SS4	SS	21	25	15	BTEX/TPH
			Borehole terminated at 2.40 mbgs on probable bedrock.	0.0 —						
- - -	-			- - - -						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369035.425

UTM Northing: 5225509.687

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.738 metres

Final Depth: 2.00 metres

Depth to Water Strike: 0.60 metres Borehole: MAEB-BH2-2018

Depth to Bedrock: 2.00 metres Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
- - - -			Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles, compact, moist, odourless.	- - - - -	SS1	SS	26	42	20	
1.0—			Silty Gravel Light brown to grey silty gravel, some fractured rock, dense to very dense, wet at approximately 0.60 mbgs, odourless.	2.0 —	SS2	SS	41	25	20	BTEX/TPH
- - - -				- - - - 1.0	SS3	SS	10	0	NR	
				_	SS4	SS	50\50	100	25	BTEX/TPH
3.0 —			Borehole terminated at 2.00 mbgs on probable bedrock.	-1.0						

Drilling Contractor: Logan Drilling Group Client: NLMAE

Project No: 11178792-02 Drill Type: CME 75

Civic Address: Marystown Shipyard

Drill Method: Hollow Stem Auger

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369074.327 GL Elevation: 2.905 metres UTM Northing: 5225529.443 Final Depth: 1.80 metres

Borehole: MAEB-BH3-2018 Date Started: October 9, 2018 Depth to Water Strike: 1.00 metres

Logged By: Robert Perry

Page: 1 of 1 Date Finished: October 9, 2018 Depth to Bedrock: 1.80 metres



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.9						
			Silty Sand and Gravel Brown to reddish brown silty sand and gravel, dense to very dense, wet at approximately 1.00 mbgs, odourless.	- - - -	SS1	SS	31	83	20	Metals
- - - 1.0 – -				2.0 — - - -	SS2	SS	39	75	55	BTEX/TPH + Metals
- - - -				- - - -	SS3	SS	59	83	20	ВТЕХ/ТРН
2.0 — - - - - - -			Borehole terminated at 1.80 mbgs on probable bedrock.	1.0 —						
3.0 —				0.0						
4.0 — - - - - - -				-1.0 — -1.0 — - - - -						

Client: NLMAE Drilling Contractor: Logan Drilling Group

Project No: 11178792-02 Drill Type: CME 75

Civic Address: Marystown Shipyard Drill Method: Hollow Stem Auger

City & Province: Marystown, NL Logged By: Robert Perry

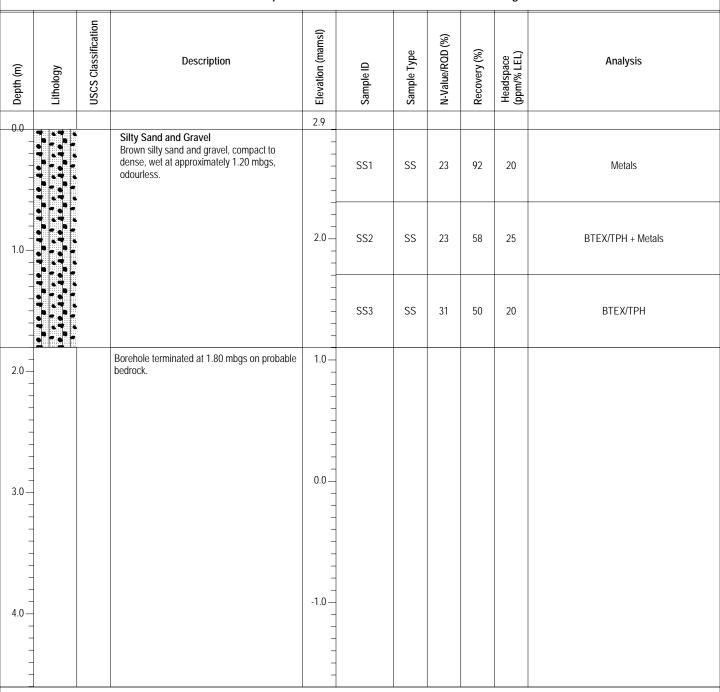
PID Number: N/A

 UTM Easting: 369084.225
 GL Elevation: 2.844 metres

 UTM Northing: 5225531.411
 Final Depth: 1.80 metres

Date Started: October 9, 2018 Depth to Water Strike: 1.20 metres Borehole: MAEB-BH4-2018

Date Finished: October 9, 2018 Depth to Bedrock: 1.80 metres Page: 1 of 1





Client: NLMAE Drilling Contractor: Logan Drilling Group

Project No: 11178792-02 Drill Type: CME 75

Civic Address: Marystown Shipyard Drill Method: Hollow Stem Auger

City & Province: Marystown, NL Logged By: Robert Perry

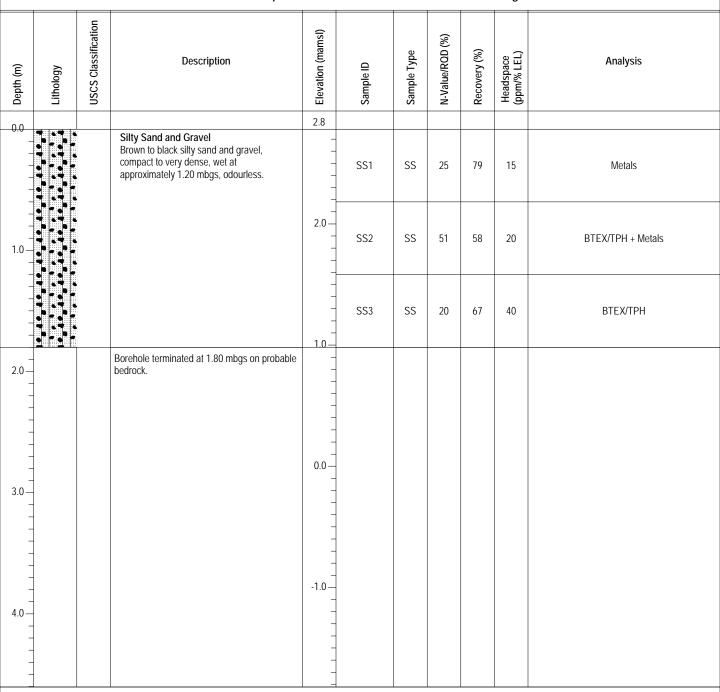
PID Number: N/A

 UTM Easting: 369097.701
 GL Elevation: 2.782 metres

 UTM Northing: 5225517.277
 Final Depth: 1.80 metres

Date Started: October 9, 2018 Depth to Water Strike: 1.20 metres Borehole: MAEB-BH5-2018

Date Finished: October 9, 2018 Depth to Bedrock: 1.80 metres Page: 1 of 1





Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369038.542

UTM Northing: 5225504.026

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Hubert Anderson

TOC Elevation: 2.760 metres

GL Elevation: 2.880 metres

Final Depth: 3.050 metres

Depth to Water Strike: 0.690 metres

Depth to Bedrock 1.200 metres



Monitor Well: MAEB-MW1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.9								
			Gravel Topsoil Black topsoil, some rootmat and gravel,	-	SS1	SS	29	17	20	BTEX/TPH		Bentonite seal
- - -			compact, moist to very moist, odourless. Silty Sand and Gravel	2.0	SS2	SS	86\175	38	40	BTEX/TPH	V	Groundwater at approx. 0.690 mbgs
1.0			Brown silty sand and gravel, some fractured rock, very dense, wet at approximately 0.60 mbgs,	-								"No. 10" slot
2.0			odourless. Bedrock Fractured to very sound sedimentary rock.	1.0	RC1	RC	71	71	NA			PVC screen "No. 3" silica
				-	RC2	RC	100	100	NA			sand pack
3.0 –				0.0							∇	End point
4.0			Monitor well terminated at 3.05 mbgs in very sound bedrock.	-1.0								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369084.257

UTM Northing: 5225525.081

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.789 metres

GL Elevation: 2.909 metres

Final Depth: 3.150 metres

Depth to Water Strike: 1.032 metres

Depth to Bedrock 3.150 metres



Monitor Well: MAEB-MW2-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.9								- Floribus sout
-			Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles, some organics, compact to loose, moist, slight organic	- - - - -	SS1	SS	30	33	30			Flushmount Bentonite seal
1.0 —			odour.	2.0	SS2	SS	19	33	25			Groundwater at approx. 1.032 mbgs
- - - -				- - - - -	SS3	SS	5	33	25			"No. 10" slot
2.0 - - - -			Silty Gravel Brown to dark brown silty gravel, loose to very dense, wet at approximately 1.80 mbgs, moderate to faint	1.0	SS4	SS	4	21	NHS	BTEX/TPH + DUP01		PVC screen "No. 3" silica
- - - 3.0 —			petroleum hydrocarbon odour.	0.0	SS5	SS	16	42	75	BTEX/TPH		sand pack End point
	33:33:				SS6	SS	50\0	0	NR			Cave-in material
4.0			Monitor well terminated at 3.150 mbgs on probable bedrock.	-1.0								

1 VL IVI/ \L

Project No: 11178792-02

...,......

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369085.977

UTM Northing: 5225393.005

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

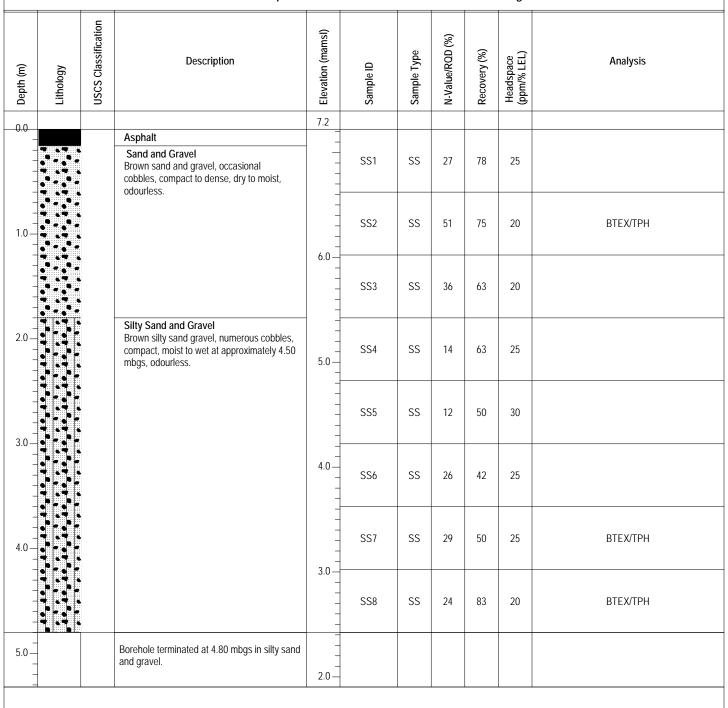
Logged By: Robert Perry

GL Elevation: 7.223 metres

Final Depth: 4.80 metres

Depth to Water Strike: 4.50 metres Borehole: MASO-BH1-2018

Depth to Bedrock: Not encountered Page: 1 of 1





NLMAE DI

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369104.945

UTM Northing: 5225376.867

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Robert Perry

GL Elevation: 5.970 metres

Final Depth: 2.40 metres

Depth to Water Strike: 2.10 metres Borehole: MASO-BH2-2018

Depth to Bedrock: Not encountered Page: 1 of 1

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				6.0						
0.0	?{} ?{}		Grassmat/Topsoil	_						
- - -			Sand and Gravel Brown sand and gravel, occasional cobbles, compact, dry, odourless.	- - - -	SS1	SS	19	75	20	
1.0—				5.0 —	SS2	SS	15	58	25	
- - - -				- - - -	SS3	SS	16	71	10	ВТЕХ/ТРН
2.0 —			Silty Sand and Gravel Brown to grey silty sand gravel, some clay, numerous cobbles, dense, wet at approximately 2.10 mbgs, odourless.	4.0 — - - -	SS4	SS	36	63	10	BTEX/TPH
-			Borehole terminated at 2.40 mbgs in silty sand and gravel.	- - -						
3.0 —				3.0 —						
4.0 —				2.0 —						



Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369122.782

UTM Northing: 5225397.515

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Robert Perry

GL Elevation: 3.176 metres

Final Depth: 2.95 metres

Depth to Water Strike: 2.40 metres

Depth to Bedrock: 2.95 metres



Borehole: MASO-BH3-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				3.2						
-	~~~		Grassmat/Topsoil	_						
-			Sand and Gravel Brown to grey sand and gravel, occasional cobbles, loose to dense, dry, odourless.	- - -	SS1	SS	5	25	15	
1.0 -				- - - - 2.0	SS2	SS	18	0	NR	
-					SS3	SS	40	0	NR	
2.0 -			Silty Sand and Gravel Brown to grey silty sand gravel, numerous cobbles and boulders, very dense, wet at approximately 2.40 mbgs, slight petroleum hydrocarbon odour.	- - 1.0 — -	SS4	SS	58	100	40	ВТЕХ/ТРН
-				- - -	SS5	SS	97\225	100	55	ВТЕХ/ТРН
3.0 -				_	SS6	SS	50\25	0	NR	
3.0 — — — — — — — — — — — — — — — — — — —			Borehole terminated at 2.95 mbgs on probable bedrock.	-1.0 —						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369109.861

UTM Northing: 5225399.054

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Robert Perry

TOC Elevation: 2.535 metres

GL Elevation: 2.655 metres

Final Depth: 3.600 metres

Depth to Water Strike: 0.703 metres Monitor Well: MASO-MW1-2018

Depth to Bedrock Not encountered Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.7								
-	~~~		Grassmat/Topsoil]]								Flushmount
-			Brown sandy gravel, compact, moist to wet at	-	SS1	SS	24	33	25			Bentonite seal
1.0			approximately 1.00 mbgs, some sheen, slight petoleum hydrocarbon odour.	2.0	SS2	SS	18	42	55	BTEX/TPH		Groundwater at approx. 0.703 mbg
- - - -			Sandy Gravel Brown sandy gravel, compact, wet, odoulress.	1.0	SS3	SS	17	54	40	BTEX/TPH		"No. 10" slot PVC screen
2.0 —				0.0								"No. 3" silica sand pack End point
	••••										\Box	Епа рош
4.0 —			Monitor well terminated at 3.600 mbgs in sandy gravel.	-1.0								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369285.098

UTM Northing: 5225501.769

Date Started: October 9, 2018

Date Finished: October 9, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Robert Perry

GL Elevation: 2.620 metres

Final Depth: 3.00 metres

Borehole: MDSA-BH1-2018 Depth to Water Strike: 2.25 metres

Page: 1 of 1 Depth to Bedrock: Not encountered

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.6						
- 0.0	} } }		Grassmat/Topsoil	_						
- - -			Sand and Gravel Brown to reddish brown sand and gravel, occasional cobbles, compact to very dense, dry to wet at approximately 2.25	- - - 2.0	SS1	SS	26	83	25	Metals
- - 1.0 —			mbgs, odourless.	- - - - -	SS2	SS	58	75	20	Metals
- - - -				1.0 —	SS3	SS	19	67	20	
2.0 —				- - - -	SS4	SS	92	92	10	
- - - - -3.0				0.0 —	SS5	SS	75	83	10	
- - - -			Borehole terminated at 3.00 mbgs in sand and gravel.	- - -						
4.0 —				-1.0 — 						



Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369299.994

UTM Northing: 5225489.158

Date Started: October 9, 2018

Date Finished: October 9, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Robert Perry

GL Elevation: 2.711 metres

Final Depth: 2.95 metres

Depth to Water Strike: 2.40 metres **Borehole:** MDSA-BH2-2018

Depth to Bedrock: Not encountered Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
- 0.0 			Sand and Gravel Brown sand and gravel, occasional cobbles, compact to very dense, dry to wet at approximately 2.40 mbgs, odourless.	2.7	SS1	SS	26	100	15	Metals
1.0				2.0 —	SS2	SS	52	100	20	Metals
- - - -				- - 1.0 —	SS3	SS	19	13	NHS	
2.0 —				- - - -	SS4	SS	14	63	15	ВТЕХ/ТРН
3.0—				0.0	SS5	SS	57	42	30	BTEX/TPH
- - - -			Borehole terminated at 2.95 mbgs in sand and gravel.	- - - -						
4.0 —				-1.0 — - - - - -						
				_						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369315.576

UTM Northing: 5225490.768

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

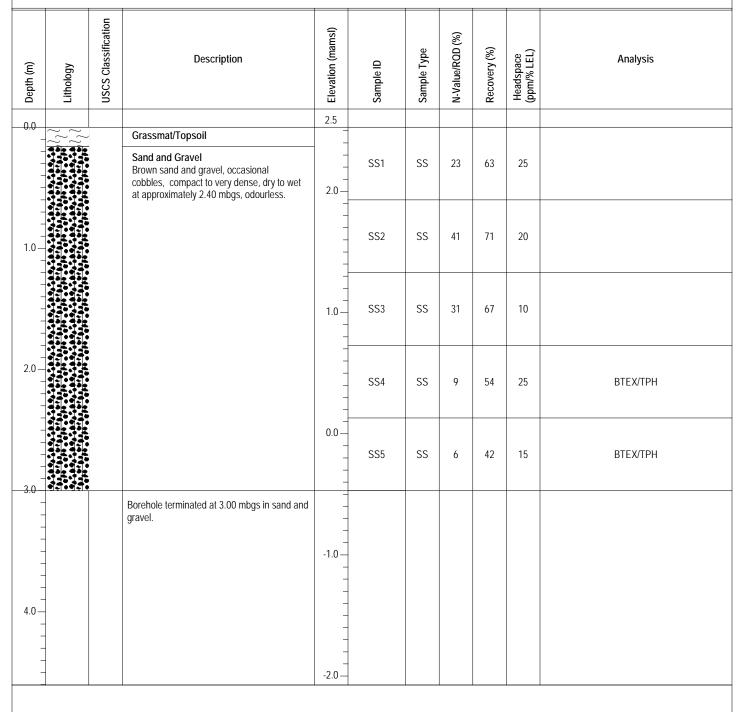
Logged By: Robert Perry

GL Elevation: 2.530 metres

Final Depth: 3.00 metres

Depth to Water Strike: 2.40 metres Borehole: MDSA-BH3-2018

Depth to Bedrock: Not encountered Page: 1 of 1





Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369346.074

UTM Northing: 5225483.463

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.492 metres

Final Depth: 2.85 metres

Depth to Water Strike: 2.10 metres

Depth to Bedrock: 2.85 metres



Borehole: MDSA-BH4-2018

Date	, i iiiisiict	<i></i>	Depti 10	Deare	CK. 2.00 I	1101100			Tage.	1011
Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.5						
			Gravelly Sand Dark brown gravelly sand, occasional to numerous cobbles, loose to compact, very moist to wet at approximately 2.10 mbgs, odourless.	2.0—	SS1	SS	7	25	10	
- - - 1.0 – -				- - - - -	SS2	SS	42	33	10	
- - - -				1.0— 	SS3	SS	19	13	NHS	
2.0				- - - - -	SS4	SS	7	13	NHS	ВТЕХ/ТРН
- - -	- - - -		Sand Brown sand, some wood debris, wet, odourless.	0.0—	SS5	SS	22	44	20	BTEX/TPH
3.0			Borehole terminated at 2.85 mbgs on probable bedrock.	-1.0 —						
-				-2.0 <u> </u>						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369340.739

UTM Northing: 5225471.644

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

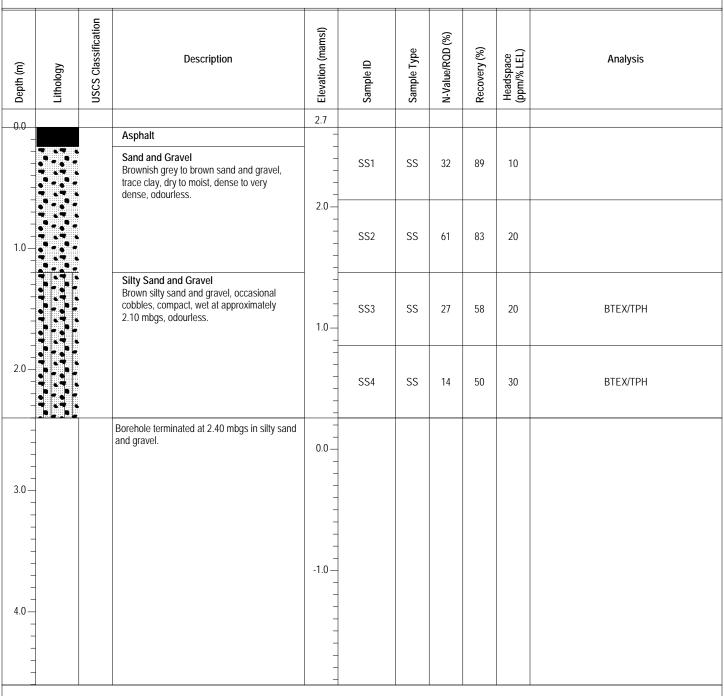
Logged By: Hubert Anderson

GL Elevation: 2.658 metres

Final Depth: 2.40 metres

Depth to Water Strike: 2.10 metres Borehole: MDSA-BH5-2018

Depth to Bedrock: Not encountered Page: 1 of 1



Project No: 11178792-02 Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369329.693

UTM Northing: 5225478.548

Date Started: October 10, 2018

Date Finished: October 10, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

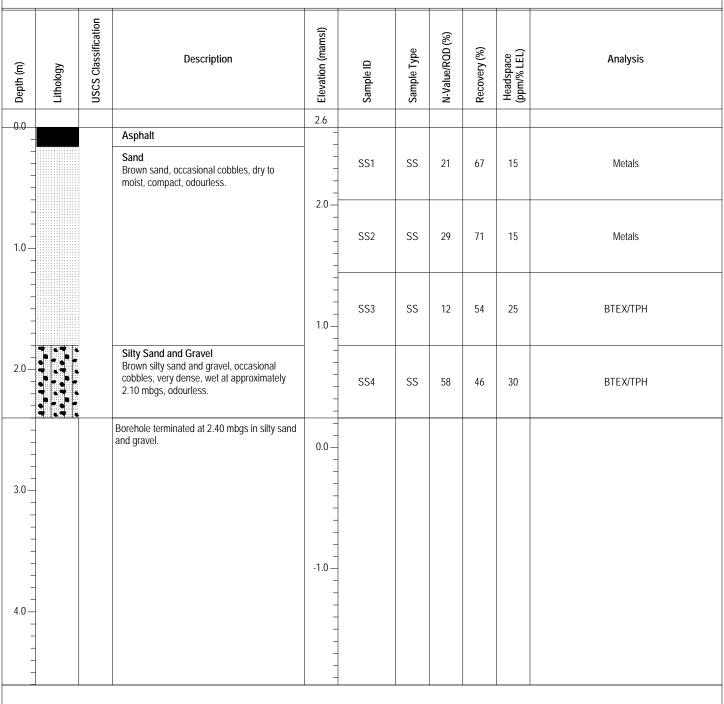
Logged By: Hubert Anderson

GL Elevation: 2.643 metres

Final Depth: 2.40 metres

Borehole: MDSA-BH6-2018 Depth to Water Strike: 2.10 metres

Page: 1 of 1 Depth to Bedrock: Not encountered





Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369298.578

UTM Northing: 5225498.048

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.511 metres

GL Elevation: 2.631 metres

Final Depth: 3.900 metres

Depth to Water Strike: 2.660 metres

Depth to Bedrock Not encountered Page: 1 of 1



Monitor Well: MDSA-MW1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.6								
- - - -			Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles, some wood debris between 1.80 to 2.40	2.0	SS1	SS	19	33	15	Metals		Flushmount Bentonite seal
1.0			mbgs, compact, wet at approximately 2.40 mbgs, odourless.	2.0 —	SS2	SS	25	33	20	Metals		"No. 10" slot PVC screen
- - - -				1.0	SS3	SS	9	29	20			"No. 3" silica
2.0 —				- - - -	SS4	SS	11	33	25			sand pack
3.0				0.0	SS5	SS	11	17	NHS		<u>.</u>	Groundwater at approx. 2.660 mbgs
- - -			Sandy Gravel Brown sandy gravel, some silt, compact, wet, odourless.	-1.0	SS6	SS	10	50	15			
-				-1.0 —								End point
4.0 —			Monitor well terminated at 3.900 mbgs in sandy gravel.	-2.0 —								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369309.777

UTM Northing: 5225478.602

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.597 metres

GL Elevation: 2.797 metres

Final Depth: 3.600 metres

Depth to Water Strike: 2.355 metres

Depth to Bedrock 3.600 metres



Monitor Well: MDSA-MW2-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0	~~~		Grassmat	2.8								Flushmount
- - -			Silty Sand and Gravel Brown silty sand and gravel, some rootmat,	- - - -	SS1	SS	21	33	20			Bentonite seal
1.0			occasional cobbles, some fractured rock, compact to very dense, moist to wet at approximately 2.40 mbgs, odourless.	2.0	SS2	SS	51	29	20			"No. 10" slot PVC screen
- - - -				1.0	SS3	SS	29	25	20			"No. 3" silica
2.0 —				1.0	SS4	SS	14	21	35	ВТЕХ/ТРН		sand pack Groundwater at approx. 2.355 mbg
3.0				0.0	SS5	SS	12	25	20	ВТЕХ/ТРН		
- - - - -				- - - -	SS6	SS	53	0	NR			End point
4.0 - 4.0			Monitor well terminated at 3.600 mbgs on probable bedrock.	-1.0 -								
- - -												
5.0 —				-2.0								
- - -												

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369346.153

UTM Northing: 5225477.641

Date Started: October 9, 2018

Date Finished: October 9, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Robert Perry

TOC Elevation: 2.565 metres

GL Elevation: 2.685 metres

Final Depth: 3.600 metres

Depth to Water Strike: 3.068 metres

Depth to Bedrock 3.600 metres



Monitor Well: MDSA-MW3-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.7								Elizaber a vert
- - - -			Asphalt Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles,		SS1	SS	21	72	10			Flushmount Bentonite seal
1.0			compact to dense, moist to wet at approximately 2.10 mbgs, odourless.	2.0	SS2	SS	31	50	15	ВТЕХ/ТРН		"No. 10" slot PVC screen
- - - -				1.0	SS3	SS	35	75	15			"No. 3" silica
2.0 —					SS4	SS	24	42	25	BTEX/TPH		sand pack
3.0 —	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		Cobbles and Boulders Numerous cobbles and boulders, very dense, wet, odourless.	0.0	RC1	RC	NA	NA	NA			Groundwater at approx. 3.068 mbg
4.0	<u>ૹ૾ઌ૾ૺૼૹ૽ઌ૽ૼ</u>		Monitor well terminated at 3.600 mbgs on probable bedrock.	-1.0 —								End point
5.0 —				-2.0 —								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369231.165

UTM Northing: 5225341.043

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.591 metres

Final Depth: 3.50 metres

Borehole: MFPA-BH1-2018 Depth to Water Strike: 2.40 metres

Page: 1 of 1 Depth to Bedrock: 3.50 metres



	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0			Sand and Gravel Greyish brown sand and gravel, trace silt, compact, dry, odourless.	2.6	SS1	SS	30	25	20	
0-				2.0 — - - - - -	SS2	SS	21	17	NHS	
				1.0—	SS3	SS	22	33	NHS	
_				0.0—	SS4	SS	10	33	20	ВТЕХ/ТРН
_ _ _ _ _			Sandy Gravel Brown sandy gravel, some fractured rock, compact, wet at approximately 2.40 mbgs, odourless.	- - - - -	SS5	SS	11	17	NHS	
)—	···		Borehole terminated at 3.50 mbgs on probable bedrock.	-1.0 — - - - - - - -						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369245.085

UTM Northing: 5225331.202

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.736 metres

Final Depth: 3.70 metres

Depth to Water Strike: 2.10 metres Borehole: MFPA-BH2-2018

Depth to Bedrock: 3.70 metres Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
-	\sim		Grassmat/Topsoil	_						
- - -			Sand and Gravel Brown to greyish brown sand and gravel, trace silt, compact, damp to wet at approximately 2.10 mbgs, odourless.	- - -	SS1	SS	24	42	15	
1.0 —				2.0 —	SS2	SS	14	46	25	
- - - -				1.0	SS3	SS	31	42	30	
2.0 —				- - - -	SS4	SS	25	25	30	BTEX/TPH
- - - 3.0 —				0.0	SS5	SS	9	0	NR	
- - - - -			Sandy Gravel Brown sandy gravel, some fractured rock, compact, wet, faint petroleum hydrocarbon odour.	- - - -	SS6	SS	11	25	135	BTEX/TPH
4.0 —			Borehole terminated at 3.70 mbgs on probable bedrock.	-1.0 — - - - - - -						
				_						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369235.786

UTM Northing: 5225319.069

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.658 metres

Final Depth: 3.60 metres

Borehole: MFPA-BH3-2018 Depth to Water Strike: 2.40 metres

Page: 1 of 1 Depth to Bedrock: Not encountered

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
- - - - -			Silty Sand and Gravel Brown to dark brown silty sand and gravel, occasional cobbles, compact to loose, moist to wet at approximately 2.40 mbgs, odourless.	- - - - -	SS1	SS	17	58	15	Metals
- - - 1.0 -				2.0	SS2	SS	73	50	15	Metals
- - -				- - - 1.0 —	SS3	SS	41	46	20	
- - 0. - - -				- - - - -	SS4	SS	29	42	30	
- - - - - -0.				0.0 — - - - -	SS5	SS	6	13	NHS	ВТЕХ/ТРН
- - - -				- - - -	SS6	SS	11	42	30	BTEX/TPH
- - - - - - -			Borehole terminated at 3.60 mbgs in silty sand and gravel.	-1.0 — - - - - - -						



Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369203.708

UTM Northing: 5225303.489

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.426 metres

Final Depth: 3.60 metres

Borehole: MFPA-BH4-2018 Depth to Water Strike: 2.40 metres

Page: 1 of 1 Depth to Bedrock: Not encountered



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.4						
			Grassmat/Topsoil	_						
			Silty Sand and Gravel Brown to dark brown silty sand and gravel, occasional to numerous cobbles, some fractured rock, compact to loose, moist to	2.0—	SS1	SS	12	21	<5	Metals
1.0-			wet at approximately 2.40 mbgs, odourless.	- - - -	SS2	SS	16	0	NR	
				1.0 —	SS3	SS	18	17	NHS	Metals
2.0 -				- - - -	SS4	SS	18	33	25	BTEX/TPH
3.0-				0.0—	SS5	SS	5	0	NR	
3.0 -				-1.0 —	SS6	SS	9	25	15	BTEX/TPH
4.0 -			Borehole terminated at 3.60 mbgs in silty sand and gravel.	- - - -						
				-2.0 -2.0						
					<u> </u>			<u> </u>		

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369217.700

UTM Northing: 5225325.048

Date Started: October 3, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.580 metres

GL Elevation: 2.700 metres

Final Depth: 4.200 metres

Depth to Water Strike: 1.972 metres

Depth to Bedrock 4.200 metres



Monitor Well: MFPA-MW1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.7								
			Silty Sand and Gravel Greyish brown silty sand and gravel, occasional cobbles, compact, moist, odourless.	-	SS1	SS	19	37	20			Flushmount
1.0—			ododiess.	2.0	SS2	SS	25	13	20			Bentonite seal
- - - -				1.0	SS3	SS	13	0	NR			"No. 10" slot PVC screen
2.0 —			Sandy Gravel Brown to dark grey sandy gravel, numerous cobbles, compact to loose, moist to wet at approximately 2.70		SS4	SS	20	42	110			Groundwater at approx. 1.972 mbg
3.0			mbgs, some sheen, faint to moderate petroleum hydrocarbon odours.	0.0	SS5	SS	6	33	345	втех/трн		"No. 3" silica
- - - -				-	SS6	SS	5	21	385			sand pack
4.0				-1.0 — - - - -	SS7	SS	6	33	270	втех/трн		End point
- - - -			Monitor well terminated at 4.200 mbgs on probable bedrock.	-2.0								
5.0 —												

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369270.245

UTM Northing: 5225457.857

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

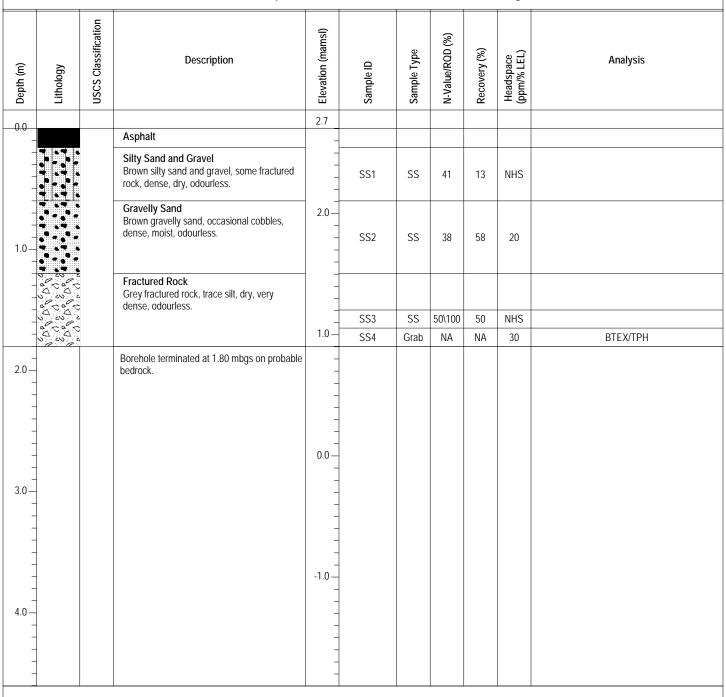
Logged By: Hubert Anderson

GL Elevation: 2.705 metres

Final Depth: 1.80 metres

Depth to Water Strike: Not encountered **Borehole:** MGSB-BH1-2018

Depth to Bedrock: 1.80 metres Page: 1 of 1





Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369274.546

UTM Northing: 5225446.236

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.729 metres

Final Depth: 2.75 metres

Depth to Water Strike: 2.10 metres

Depth to Bedrock: 2.75 metres



Borehole: MGSB-BH2-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
-			Asphalt							
- - -			Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless.	- - - - -	SS1	SS	39	50	15	
- - 1.0 —				2.0 —	SS2	SS	46	0	NR	
- - - - -			Silty Sand and Gravel Brown silty sand and gravel, some fractured rock, moist to wet at approximately 2.10 mbgs, odourless.	1.0	SS3	SS	113	81	25	BTEX/TPH
- 2.0 — - - - - -				- - - - - - 0.0	SS4	Grab	NA	NA	25	ВТЕХ/ТРН
3.0 — - - - - -			Borehole terminated at 2.75 mbgs on probable bedrock.	- - - - -						
4.0 — — — — — — —				-1.0 — 						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369295.015

UTM Northing: 5225445.087

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.685 metres

Final Depth: 2.75 metres

Borehole: MGSB-BH3-2018 Depth to Water Strike: 2.10 metres

Page: 1 of 1 Depth to Bedrock: 2.75 metres



Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
			2.7						
		Asphalt	}						
		Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour.	_ _ _	SS1	SS	39	56	55	BTEX/TPH
		Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless.	2.0	SS2	SS	43	42	30	
			1.0	SS3	SS	48	13	20	
		Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at	-	SS4	SS	50\50	25	85	BTEX/TPH
		approximately 2.10 mbgs, faint petroleum hydrocarbon odour.	0.0	SS5	Grab	NA	NA	100	
		Borehole terminated at 2.75 mbgs on probable bedrock.							
			-1.0 — -1.0 — - -						
	Lithology	Lithology USCS Classificatio	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. Borehole terminated at 2.75 mbgs on probable	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. 2.0— Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. Borehole terminated at 2.75 mbgs on probable bedrock.	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. Sist SS3 1.0 SS4 SS4 Borehole terminated at 2.75 mbgs on probable bedrock.	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. SS2 SS SS3 SS 1.0 SS4 SS SS4 SS Borehole terminated at 2.75 mbgs on probable bedrock.	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. SS2 SS 43 SS3 SS 48 1.0— Silty Sand and Gravel Dark Brown silty sand and gravel, some fraction frock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. Borehole terminated at 2.75 mbgs on probable bedrock.	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. SS2 SS 43 42 SS3 SS 48 13 1.0— Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. SS5 Grab NA NA Borehole terminated at 2.75 mbgs on probable bedrock.	Asphalt Gravelly Sand Brown gravelly sand, dense, moist, faint musty odour. Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. SS1 SS 39 56 55 Gravelly Sand Brown gravelly sand, occasional cobbles, dense, moist, odourless. SS2 SS 43 42 30 Silty Sand and Gravel Dark Brown silty sand and gravel, some fractured rock, very moist to wet at approximately 2.10 mbgs, faint petroleum hydrocarbon odour. SS5 Grab NA NA 100 Borehole terminated at 2.75 mbgs on probable bedrock.

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369289.817

UTM Northing: 5225449.664

Date Started: October 2, 2018

Date Finished: October 2, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.683 metres

Final Depth: 4.20 metres

Depth to Water Strike: 2.10 metres Borehole: MGSB-BH4-2018

Depth to Bedrock: 4.20 metres Page: 1 of 1



Deptn (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
.0				2.7						
1			Asphalt	-						
-			Silty Sand and Gravel Brown silty sand and gravel, trace cobbles, dense to compact, moist to very moist, odourless.	- - - -	SS1	SS	31	56	20	
- - - - -				2.0 —	SS2	SS	17	42	20	
-				1.0	SS3	SS	10	13	NHS	
_ _ _ _ _ _			Sandy Gravel Brown to grey sandy gravel sand, some fractured rock, compact to dense, very moist to wet at approximately 2.10 mbgs, slight to moderate petroleum hydrocarbon odour.	- - - -	SS4	SS	20	25	175	ВТЕХ/ТРН
			oddi.	0.0	SS5	SS	30	50	525	
) — - - - -	\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$		Cobbles and Boulders Numerous cobbles and boulders, very dense, wet, moderate petroleum hydrocarbon odour.	- - - -						
- - - - - -			Gravel Grey gravel, trace sand, compact, wet, moderate to slight petroleum hydrocarbon odour.	-1.0 — - - -	SS6	SS	29	33	510	втех/трн
			Borehole terminated at 4.20 mbgs on probable bedrock.	-						

Drilling Contractor: Logan Drilling Group

Project No: 11178792-02

Drill Type: CME 75

Civic Address: Marystown Shipyard Drill Method: Hollow Stem Auger

City & Province: Marystown, NL

Logged By: Hubert Anderson

PID Number: N/A

UTM Easting: 369215.542

GL Elevation: 2.745 metres

UTM Northing: 5225285.764

Final Depth: 2.80 metres

Date Started: October 4, 2018

Depth to Water Strike: 2.40 metres

Borehole: MLLA-BH1-2018

Date Finished: October 4, 2018

Depth to Bedrock: 2.80 metres

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
- 0.0	? ² ?		Grassmat/Topsoil	-						
- - -			Silty Sand and Gravel Brown to dark brown silty sand and gravel, compact, moist to very moist, odourless.	- - - -	SS1	SS	15	50	10	Metals
1.0 —				2.0	SS2	SS	19	29	15	Metals
- - - -				1.0	SS3	SS	16	13	NHS	
2.0 —	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		Cobbles and Boulders Numerous cobbles and boulders, trace sandy silt, compact to very dense, very moist to wet at approximately 2.40 mbgs, odourless.	- - - - -	SS4	SS	10	0	NR	
- - -	~ \$7; \$5; E \$2; \$5; E \$7; \$5; E \$2; \$2; E			0.0	SS5	SS	53\250	13	NHS	BTEX/TPH
3.0 —			Borehole terminated at 2.80 mbgs on probable bedrock.	- - - - - -						
4.0				-1.0 — 						

. ._...

Project No: 11178792-02

CLIVO. 11110132-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369235.294

UTM Northing: 5225290.124

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.799 metres

Final Depth: 2.10 metres

Depth to Water Strike: Not encountered **Borehole:** MLLA-BH2-2018

Depth to Bedrock: 2.10 metres



Page: 1 of 1

USCS Classification Elevation (mamsl) N-Value/RQD (%) Headspace (ppm/% LEL) Recovery (%) Sample Type Description **Analysis** Depth (m) Sample ID 2.8 0.0 Grassmat/Topsoil Silty Sand and Gravel SS1 SS 43 54 <5 Metals Brown to dark brown silty sand and gravel, some fractured rock, dense to very dense, moist to very moist, odourless. 2.0 -SS2 SS 90 67 Metals <5 1.0 SS3 SS 54 25 10 1.0 -SS4 Grab NA NA 25 Borehole terminated at 2.10 mbgs on probable bedrock. 0.0 3.0 -1.0 -4.0

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369202.540

UTM Northing: 5225285.392

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Hubert Anderson

TOC Elevation: 2.494 metres

GL Elevation: 2.614 metres

Final Depth: 4.500 metres

Depth to Water Strike: 1.834 metres

Depth to Bedrock 3.400 metres Page: 1 of 1



Monitor Well: MLLA-MW1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction		Well Details
0.0				2.6									
	{} {}		Grassmat/Topsoil Silty Sand Brown silty sand, some topsoil, some fractured rock, dense to compact,	2.0—	SS1	SS	43	67	15				Flushmount
1.0—			moist to wet at approximately 2.40 mbgs, odourless.	- - - -	SS2	SS	21	50	15				Bentonite seal
- - - -				1.0—	SS3	SS	35	13	NHS				Groundwater at
2.0 —					SS4	SS	11	13	40	ВТЕХ/ТРН			approx. 1.834 mbgs "No. 10" slot
3.0—			Sandy Gravel Reddish brown sandy gravel, compact to very dense, wet, odourless.	0.0	SS5	SS	11	42	35				PVC screen
=				- - -	SS6	SS	100\175	42	20	BTEX/TPH			"No. 3" silica sand pack
4.0 —			Bedrock Fractured sedimentary rock.	-1.0 — 	RC1	RC	65	75	NA				End point Cave-in material
5.0 —			Monitor well terminated at 4.500 mbgs in fractured bedrock.	-2.0 —							## #	· ==	Seve in material

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369217.751

UTM Northing: 5225308.019

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.525 metres

GL Elevation: 2.645 metres

Final Depth: 4.200 metres

Depth to Water Strike: 1.814 metres

Depth to Bedrock 4.200 metres



Monitor Well: MLLA-MW2-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.6								
- U.U - - - - -	~~~		Grassmat/Topsoil Sand and Gravel Brown sand and gravel, occasional cobbles,	-	SS1	SS	28	42	<5	Metals		Flushmount
1.0 —			compact, moist, odourless.	2.0	SS2	SS	24	42	<5	Metals		Bentonite seal
- - - -			Silty Sand and Gravel Dark brown to black silty sand and gravel, loose to compact, moist, odourless	1.0	SS3	SS	8	13	NHS			Groundwater at
2.0 — - - -				- - - - - -	SS4	SS	20	0	NR			approx. 1.814 mbgs
3.0			Sandy Gravel Brown sandy gravel, wet at approximately 2.65 mbgs, some sheen, moderate petroleum	0.0	SS5	SS	9	25	395	ВТЕХ/ТРН		PVC screen
- - - -			hydrocarbon odour.	-1.0	SS6	SS	8	33	415			"No. 3" silica sand pack
4.0					SS7	SS	12	33	440	BTEX/TPH		End point
- - - - - 5.0 —			Monitor well terminated at 4.200 mbgs on probable bedrock.	-2.0								
- - - -				- - - - -								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369247.870

UTM Northing: 5225305.741

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

TOC Elevation: 2.689 metres

GL Elevation: 2.809 metres

Final Depth: 5.100 metres

Depth to Water Strike: 1.874 metres

Depth to Bedrock Not encountered Page:



Monitor Well: MLLA-MW3-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0.0				2.8								
- - - - -			Grassmat/Topsoil Silty Sand and Gravel Brown silty sand and gravel, some fractured	- - - - -	SS1	SS	27	42	10	Metals		Flushmount
- - 1.0 —			rock, compact, moist, odourless.	2.0	SS2	SS	14	29	<5	Metals		
- - - -				-	SS3	SS	10	13	NHS			Bentonite seal
2.0 —			Sand and Gravel Light brown sand and gravel, occasional cobbles, compact, very moist, odourless.	1.0	SS4	SS	22	33	35			Groundwater at approx. 1.874 mbg
- - - -				0.0	SS5	SS	11	33	45			"No. 10" slot PVC screen
3.0 —			Gravel Light brown gravel, some sand, compact to loose, wet at approximately 3.00 mbgs, faint to slight		SS6	SS	13	25	175	BTEX/TPH		TVO SCICCII
4.0 —			petroleum hydrocarbon odour.	-1.0	SS7	SS	7	25	310	ВТЕХ/ТРН		"No. 3" silica sand pack
- - - - - 5.0			Sand Brown sand, loose, wet, odourless.	-2.0	SS8	SS	7	21	NHS	BTEX/TPH		End point
			Monitor well terminated at 5.100 mbgs in sand.	-							V	

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369225.110

UTM Northing: 5225282.840

Date Started: October 3, 2018

Date Finished: October 3, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Hubert Anderson

TOC Elevation: 2.620 metres

GL Elevation: 2.840 metres

Final Depth: 5.100 metres

Depth to Water Strike: 2.015 metres

Depth to Bedrock 4.800 metres



Monitor Well: MLLA-MW4-2018

()do.	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis	Well Construction	Well Details
0				2.8								
	{ } } }		Grassmat/Topsoil Sand and Gravel Dark brown sand and gravel, numerous cobbles,		SS1	SS	39	50	<5	Metals		Flushmount
- - - - -			occasional boulders, dense to very dense, moist to very moist, odourless.	2.0	SS2	SS	51	46	15	Metals		
-				=								Bentonite seal
- - - - - - 0.				1.0	SS3	SS	9	0	NR		<u></u>	Groundwater at
				+	SS4	SS	50\75	44	NHS			approx. 2.015 mb
	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		Boulders Numerous boulders, some cobbles, trace to some reddish brown sandy gravel, very dense, wet at	0.0	RC1	RC	NA	NA				"No. 10" slot PVC screen
.	\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		approximately 2.40 mbgs, odourless.		RC2	RC	NA	NA				
- 0 — - -				-1.0 — - - - - -	NO2							"No. 3" silica sand pack
-	\$\$\$\$\$\$\$\$ \$20\\$20			-	SS5	SS	56\150	17	NHS			
- 0-			Bedrock Sound sedimnetary rock.	-2.0	RC3	RC	100	100	NA			End point
-			Monitor well terminated at 5.100 mbgs in sound bedrock.	-								

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369264.213

UTM Northing: 5225365.891

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.720 metres

Final Depth: 4.35 metres

Depth to Water Strike: 3.30 metres

Depth to Bedrock: 4.35 metres



Borehole: MSBL-BH1-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
-			Asphalt	_						
- - -			Gravelly Sand Brown gravelly sand, compact to dense, damp to moist, odourless.	- - -	SS1	SS	18	67	15	
1.0—				2.0 — - - - -	SS2	SS	40	0	NR	
- - - -			Silty Gravel Brown silty gravel, occasional cobbles, compact to dense, dry to very moist, odourless.	- - - - 1.0	SS3	SS	23	13	NHS	
2.0 — - - - -				- - - -	SS4	SS	45	75	40	
- - - - 3.0 —				0.0	SS5	SS	42	75	45	
- - - - -			Sand and Gravel Brown to dark brown sand and gravel, numerous cobbles, some fractured rock, compact to very dense, very moist to wet at approximately 3.30 mbgs, faint petroleum hydrocarbon odour.	- - - - -	SS6	SS	20	33	95	ВТЕХ/ТРН
- - 4.0 —				-1.0 — -1.0 — - -	SS7	SS	17	25	60	BTEX/TPH
_	: [:: [-	SS8	SS	50\0	0	NR	
-			Borehole terminated at 4.35 mbgs on bedrock.	-						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369276.165

UTM Northing: 5225367.251

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.685 metres

Final Depth: 3.60 metres

Depth to Water Strike: 2.70 metres **Borehole:** MSBL-BH2-2018

Depth to Bedrock: 3.60 metres Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
).0				2.7						
-			Asphalt	-						
- - -			Gravelly Sand Brown gravelly sand, occasional cobbles, dense to compact, damp to wet at approximately 2.70 mbgs, odourless.	-	SS1	SS	33	44	5	
- - - - - -				2.0 —	SS2	SS	31	13	NHS	
- - - -				1.0	SS3	SS	15	29	25	
- - - - - -				- - - - -	SS4	SS	17	33	40	
- - - - - 0.				0.0	SS5	SS	31	58	65	ВТЕХ/ТРН
- - - -				- - - -	SS6	SS	13	25	NHS	ВТЕХ/ТРН
- - - 0- - -			Borehole terminated at 3.60 mbgs on bedrock.	-1.0 — - - - - - -						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369280.231

UTM Northing: 5225348.213

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.595 metres

Final Depth: 3.45 metres

Depth to Water Strike: 2.70 metres

Depth to Bedrock: 3.45 metres Page: 1 of 1



Borehole: MSBL-BH3-2018

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.6						
_	~~		Grassmat/Topsoil	-						
- - - -			Silty Sand and Gravel Brown silty sand and gravel, occasional cobbles and boulders, loose to very dense, moist to wet at approximately 2.70 mbgs,	2.0	SS1	SS	9	50	55	
1.0—			odourless.	- - - -	SS2	SS	13	42	50	
- - -				- - -	SS3	SS	98\150	0	NR	
2.0				1.0 — - - - -						
- - - -				0.0	SS4	SS	33	33	55	BTEX/TPH
3.0 —				- - - -	SS5	SS	60	33	40	BTEX/TPH
_				_	SS6	SS	50\0	0	NR	
4.0			Borehole terminated at 3.45 mbgs on probable bedrock.	-1.0 — -1.0 — - - - - - -						

INLIVIAL

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: ,369267.940

UTM Northing: 5225315.665

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.649 metres

Final Depth: 3.60 metres

Depth to Water Strike: 2.70 metres **Borehole:** MSBL-BH4-2018

Depth to Bedrock: 3.60 metres Page: 1 of 1



Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.6						
-	~~~		Grassmat/Topsoil	_						
- - -			Sand and Gravel Brown sand and gravel, some organics, occasional cobbles, compact to dense, moist, odourless.	- - -	SS1	SS	23	75	15	Metals
- - 1.0 —				2.0 —	SS2	SS	36	58	10	
- - - -				- - - 1.0 —	SS3	SS	39	75	15	
2.0 —			Silty Sand and Gravel Brown to black silty sand and gravel, occasional cobbles, very dense to compact, moist to wet at approximately 2.70 mbgs, slight petroleum hydrocarbon odour.	- - - - -	SS4	SS	47	63	20	
- - - -				0.0 — - - -	SS5	SS	27	54	40	BTEX/TPH
3.0 —			Silty Sand and Gravel Brown to black silty sand and gravel, dense, wet, odourless.	- - - - -	SS6	SS	50	71	30	BTEX/TPH
4.0 —			Borehole terminated at 3.60 mbgs on probable bedrock.	-1.0 — - - - - - -						
				_						

NLIVIAE I

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369274.236

UTM Northing: 5225359.931

Date Started: October 4, 2018

Date Finished: October 4, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger

Logged By: Hubert Anderson

GL Elevation: 2.685 metres

Final Depth: 3.60 metres

Depth to Water Strike: 3.00 metres

Depth to Bedrock: 3.60 metres Page: 1 of 1



Borehole	MSBL-BH5-2018	

Depth (m)	Lithology	USCS Classification	Description	Elevation (mamsl)	Sample ID	Sample Type	N-Value/ROD (%)	Recovery (%)	Headspace (ppm/% LEL)	Analysis
0.0				2.7						
-			Asphalt	-						
- - -			Silty Sand and Gravel Brownish grey to dark grey silty sand and gravel, some fractured rock, compact to dense, very moist, odourless.	- - -	SS1	SS	18	33	<5	втех/трн
1.0—				2.0 —	SS2	SS	15	17	<5	
- - - -				1.0—	SS3	SS	46	33	NHS	
2.0				- - - -	SS4	SS	12	33	20	
3.0—			Sandy Gravel Brown sandy gravel, some fractured rock, compact, wet at approximately 3.00 mbgs, faint musty odour.	0.0 —	SS5	SS	14	17	NHS	ВТЕХ/ТРН
-				- - - -	SS6	SS	12	33	150	ВТЕХ/ТРН
4.0 —			Borehole terminated at 3.60 mbgs on probable bedrock.	-1.0 — — — — —						
				_						

Project No: 11178792-02

Civic Address: Marystown Shipyard

City & Province: Marystown, NL

PID Number: N/A

UTM Easting: 369276.318

UTM Northing: 5225335.675

Date Started: October 4, 2018

Date Finished: October 9, 2018

Drilling Contractor: Logan Drilling Group

Drill Type: CME 75

Drill Method: Hollow Stem Auger/Coring

Logged By: Hubert Anderson/Robert Perry

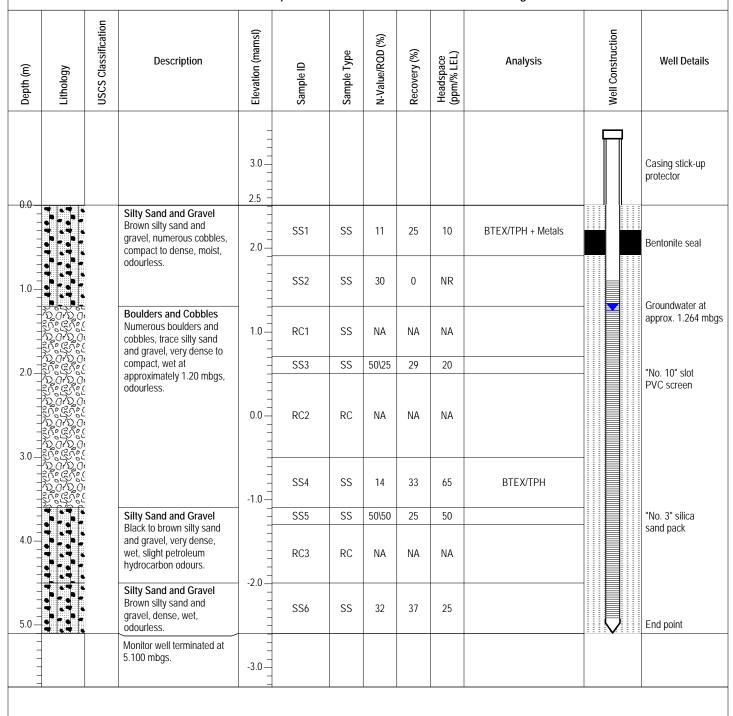
TOC Elevation: 3.425 metres

GL Elevation: 2.509 metres

Final Depth: 5.100 metres

Depth to Water Strike: 1.264 metres Monitor Well: MSBL-MW2-2018

Depth to Bedrock Not encountered Page: 1 of 1



Appendix C Laboratory Certificates of Analysis



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395328

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 18, 2018

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 7

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395328

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-10 **DATE REPORTED: 2018-10-18** MSBL-BH1-2018 MSBL-BH1-2018 MSBL-BH2-2018 MSBL-BH2-2018 MSBL-BH3-2018 MSBL-BH3-2018 MSBL-BH5-2018 MSBL-BH5-2018 SAMPLE DESCRIPTION: -SS6 -SS7 **-SS5 -SS6** -SS4 **-SS5** -SS1 **-SS5 SAMPLE TYPE:** Soil Soil Soil Soil Soil Soil Soil Soil DATE SAMPLED: 2018-10-04 2018-10-04 2018-10-04 2018-10-04 2018-10-04 2018-10-04 2018-10-04 2018-10-04 G/S 9612887 9612892 9612893 9612894 9612895 9612897 9612898 **Parameter** Unit **RDL** 9612896 Benzene 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 mg/kg Toluene 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 mg/kg Ethylbenzene mg/kg 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 0.05 < 0.05 Xylene (Total) mg/kg < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 C6-C10 (less BTEX) 3 <3 <3 <3 <3 <3 <3 <3 <3 mg/kg >C10-C16 Hydrocarbons 15 60 45 16 1690 47 52 <15 mg/kg <15 >C16-C21 Hydrocarbons 15 43 34 104 1470 94 <15 mg/kg 109 <15 >C21-C32 Hydrocarbons mg/kg 15 <15 <15 35 332 39 45 <15 <15 Modified TPH (Tier 1) 20 103 79 155 3490 180 206 <20 mg/kg <20 WFOF WFOF WFOF WFOF FOF FOF NR NR Resemblance Comment Return to Baseline at C32 Υ Υ Υ Υ Υ Υ Υ Unit **Acceptable Limits** Surrogate Isobutylbenzene - EPH % 60-140 89 91 93 109 92 91 93 94 Isobutylbenzene - VPH % 60-140 91 93 89 88 86 91 86 88 % 92 96 96 n-Dotriacontane - EPH 60-140 96 88 95 96 98

Certified By:

any Mus

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395328

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-10 **DATE REPORTED: 2018-10-18**

			MSBL-BH5-2018	MSBL-MW2-
	S	AMPLE DESCRIPTION:	-SS6	2018-SS1
		SAMPLE TYPE:	Soil	Soil
		DATE SAMPLED:	2018-10-04	2018-10-04
Parameter	Unit	G/S RDL	9612899	9612900
Benzene	mg/kg	0.03	<0.03	<0.03
Toluene	mg/kg	0.04	<0.04	<0.04
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	mg/kg	3	37	<3
>C10-C16 Hydrocarbons	mg/kg	15	3250	26
>C16-C21 Hydrocarbons	mg/kg	15	2890	65
>C21-C32 Hydrocarbons	mg/kg	15	633	24
Modified TPH (Tier 1)	mg/kg	20	6810	115
Resemblance Comment			WFOF	FOF
Return to Baseline at C32			Υ	Υ
Surrogate	Unit	Acceptable Limits		
Isobutylbenzene - EPH	%	60-140	97	94
Isobutylbenzene - VPH	%	60-140	86	94
n-Dotriacontane - EPH	%	60-140	93	96

RDL - Reported Detection Limit; G / S - Guideline / Standard

9612887-9612900 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



Certificate of Analysis

AGAT WORK ORDER: 18K395328

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Moisture

DATE RECEIVED: 2018-10-10									DATE REPORT	ED: 2018-10-18	
				MSBL-BH1-2018	MSBL-BH1-2018	MSBL-BH2-2018	MSBL-BH2-2018	MSBL-BH3-2018	MSBL-BH3-2018	MSBL-BH5-2018	MSBL-BH5-201
		SAMPLE DES	CRIPTION:	-SS6	-SS7	-SS5	-SS6	-SS4	-SS 5	-SS1	-SS5
		SAM	PLE TYPE:	Soil	Soil						
		DATE	SAMPLED:	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04
Parameter	Unit	G/S	RDL	9612887	9612892	9612893	9612894	9612895	9612896	9612897	9612898
% Moisture	%		0	11	12	9	10	6	6	6	10
				MSBL-BH5-2018	MSBL-MW2-						
		SAMPLE DES	CRIPTION:	-SS6	2018-SS1						
		SAM	PLE TYPE:	Soil	Soil						
		DATE	SAMPLED:	2018-10-04	2018-10-04						
Parameter	Unit	G/S	RDL	9612899	9612900						
% Moisture	%		0	18	10						

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395328
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMI LING SITE.		SAINT LLD DT.													
			Trac	e Or	gani	cs Ar	nalys	is							
RPT Date: Oct 18, 2018				UPLICATI	E		REFERENCE MATERIAL			METHOD	BLANK	SPIKE	MATRIX SPIKE		
PARAMETER	Batch	Sample	Dup #1	Dup #2 RPD	Method Blank	Measured	Acceptable Limits		Recovery	Lie	ptable nits	Recovery	1 1 1 1 1	ptable nits	
		ld					Value	Lower	Upper			Upper			Upper
Atlantic RBCA Tier 1 Hydroca	rbons in Soil	(Version 3	3.1) - Field	Preserve	d										
Benzene	1	9614973	< 0.03	< 0.03	NA	< 0.03	87%	60%	140%	81%	60%	140%			
Toluene	1	9614973	< 0.04	< 0.04	NA	< 0.04	90%	60%	140%	70%	60%	140%			
Ethylbenzene	1	9614973	< 0.03	< 0.03	NA	< 0.03	93%	60%	140%	73%	60%	140%			
Xylene (Total)	1	9614973	< 0.05	< 0.05	NA	< 0.05	96%	60%	140%	75%	60%	140%			
C6-C10 (less BTEX)	1	9614973	< 3	< 3	NA	< 3	116%	60%	140%	103%	60%	140%	117%	30%	130%
>C10-C16 Hydrocarbons	1	9612900	26	25	NA	< 15	100%	60%	140%	100%	60%	140%	130%	30%	130%
>C16-C21 Hydrocarbons	1	9612900	65	65	NA	< 15	97%	60%	140%	100%	60%	140%	130%	30%	130%
>C21-C32 Hydrocarbons	1	9612900	24	21	NA	< 15	98%	60%	140%	100%	60%	140%	130%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

my Hus

Method Summary

CLIENT NAME: GHD LIMITED PROJECT: 11178792-02

SAMPLING SITE:

AGAT WORK ORDER: 18K395328 ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis	'		•
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, N B3B 1M

webearth.agatlabs.com · www.agatlabsco

P: 902.468.8718 * F: 902.468.892

ve	
NS	Laboratory Use Only
12 m	Arrival Condition:
	Arrival Temperature:
24_	AGAT Job Number: 18 5395 328
	Notes:

Chain of Custody Record		Report Information								Notes:													
Report Information	r							2 2 2 2	art E	orm	at	``	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,										
Company: GHD Limited			James O'Neill				Ш.	-															
Contact: James O'Neill			James.Oneill@ghd.com			_			Singl	e ole pe	ar l	E				_		_					
Address: 1118 Topsail Road		2. Name: -				_	-		oage		21	Tu	rnar	oun	id Ti	ime	Red	quire	d (TA	AT)			
St. John's NL A1B 3N7		Email:	datanl@ghd.oom				-	v !	Multi	ple oles p		Re	gula	r TA	T [o 7 v	workii	ng da	₃ys			
	700 264 5269						-]		Samp bage		oer	Ru	sh T	AT]1c	lav			2 days	s		
	709-364-5368	Regulator	Requirements (Check):						Excel							3 d	-						
Site # and/or Name: MARYSTOWN SHIPY	YARD - MSBL	List Guidelines			п Кера	rt		N.	-orm	at				-									
Project #: 11178792-02		□PIRI						ı	nclu	ded		Da	e Re	quir	ed:	_							
AGAT Quotation #: GHD Standing Offer		☑ Tier 1		☑ Coarse	!			rink	ind W	ater 9	Samr												
GHD PO #: TO FOLLOW		□ Res ☑ Com	□ Fuel □ N/Pot □ Lube	□ Fine				Reg. 1	_	alci	Jamp	ic.	<u> пе</u> .	3		NO.							
Invoice To S	ame Yes ☑ / No □					n l		Ť	┰	Ŧ	m	Ť	Ť	Ť	î	Ť	î -	T	7	7		_	T
Company		□ CCME □ Industri	□ CDWQ			TABLE																	
Company:		□ Comme				EL (PC			9	2			1	ster)			111						
Contact:		□ Res/Pa	rk ———	- N	ER 1	W LEV			7] Available) 	ette)			E E			AT						
Address:		□ Agricult	ural	,,	A I	07-1	z	ξĨ			Pipe			E 2	<u> </u>		₫						
-		☐ FWAL ☐ Sedime	ent =	NER	C RB	A TIER	IATIO	H/B	D.S.	2	e and		9				S.L		- 1			2	
Phone: Fax:		_ 000,		CONTAINERS	ANTÍ	C RBC	Į į	0 T			(Siev		i i	MERCHRY (Ha)	5		POSS. LEAHATE					AR ()	<u> </u>
		T		09. CC	- AT	LANT	FRAC	E	> 2		SIZE		1									1 YE	i S
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER (TPH/BTEX - ATLANTIC RBCA TIER	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	МТВЕ (АDDED ТО ТРН/ВТЕХ)	MTBE ONLY METALS: CITotal	FOC	PARTICLE SIZE (Sieve and Pipette)	PAHs	PCBs	OTHER. IV	OTHER	OTHER:	HOLD FOR					HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
MSBL-BH1-2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3	Ø																		
MSBL-BH1-2018-SS7	2018/04/10 00:00	Soil	VARIOUS	3																			
MSBL-BH2-2018-SS5	2018/04/10 00:00	Soil	VARIOUS	3	Ø																		
MSBL-BH2-2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3	Ø										\perp			Ш				4	
MSBL-BH3-2018-SS4	2018/04/10 00:00	Soil	VARIOUS	3	Ø													\Box			Ш		
MSBL-BH3-2018-SS5	2018/04/10 00:00	Soil	VARIOUS	3		_	_	_	_	\perp	Ш	_	4	_	-					\perp	\perp	+	\perp
MSBL-BH5-2018-SS / J 2	2018/04/10 00:00	Soil	VARIOUS	3		Ц	4	_	4		Ш	4	\perp	_	+		\vdash	\vdash	_	\perp	\perp	+	\perp
MSBL-BH5-2018-SS5	2018/04/10 00:00	Soil	VARIOUS	3			_	4	4	-	Ш	_	+	4	+	1		\vdash	-	\perp	\vdash	+	_
MSBL-BH 2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3	Ø	_	-	-	-	-		-	_	-	+	+	_	\vdash	-	+	\rightarrow	-	+
MSBL-MW2-2018-S\$1	2018/04/10 00:00	Soil	VARIOUS	3		4		+		\vdash		-1	+	+	+	1		\vdash	+	+	+	+	+
Samples Relinquished By (Print Name):	Date/Time	Isam	ples Received By (Print Name):)			_			Date	n/Time	Щ		+				누	Щ			<u> </u>		
Hubert Anderson	2016/	1-11-1	ples Received By (S)gn)						0	4	101	8						Pag ——	ge <u>1</u>	_	of _1		-
Samples Relinquiphed By (Sight)	08:00	Sam	ples Received By (Sign)						Dat	e/Time	2	The	2										



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395696

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 18, 2018

PAGES (INCLUDING COVER): 12

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*	*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 12

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

DATE RECEIVED: 2018-10-10	0							1	DATE REPORTI	ED: 2018-10-18	
				MLLA-MW3-	MLLA-MW3-	MLLA-MW4-	MLLA-MW4-	MLLA-BH2-2018	MLLA-BH2-2018	MLLA-BH1-2018	MLLA-BH1-2018
		SAMPLE DESC	RIPTION:	2018-SS1	2018-SS2	2018-SS1	2018-SS2	-SS1	-SS2	-SS1	-SS2
		SAMP	LE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE S	AMPLED:	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03
Parameter	Unit	G/S	RDL	9615869	9615873	9615880	9615882	9615883	9615884	9615885	9615886
Aluminum	mg/kg		10	7260	5750	5490	2000	7240	2390	6240	5120
Antimony	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic	mg/kg		1	8	12	13	23	18	9	11	9
Barium	mg/kg		5	124	80	219	155	152	50	56	76
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	mg/kg		2	<2	<2	<2	2	2	<2	<2	<2
Cadmium	mg/kg		0.3	0.7	<0.3	0.3	<0.3	0.5	<0.3	<0.3	<0.3
Chromium	mg/kg		2	33	20	35	26	14	8	15	11
Cobalt	mg/kg		1	15	16	23	30	9	7	13	9
Copper	mg/kg		2	70	28	68	69	16	11	22	18
Iron	mg/kg		50	29900	27100	38600	23600	17900	7800	22400	12700
Lead	mg/kg		0.5	77.0	10.2	29.4	6.3	13.3	7.5	11.0	7.6
Lithium	mg/kg		5	10	9	10	<5	9	<5	9	7
Manganese	mg/kg		2	1290	1680	2400	2940	1130	992	811	1740
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	23	17	26	29	12	7	14	11
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	13	15	15	28	19	19	14	19
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	0.3	0.3	0.3	0.2	0.5	0.2	0.3	0.3
Vanadium	mg/kg		2	45	52	80	80	37	21	44	28
Zinc	mg/kg		5	231	81	154	84	79	32	63	55

Certified By:

Joseph Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

			/\ v	allable Metal.	3 11 0011
DATE RECEIVED: 2018-10-1	0				DATE REPORTED: 2018-10-18
			MLLA-MW2-	MLLA-MW2-	
	SA	MPLE DESCRIPTION:	2018-SS1	2018-SS2	
		SAMPLE TYPE:	Soil	Soil	
		DATE SAMPLED:	2018-10-03	2018-10-03	
Parameter	Unit	G/S RDL	9615899	9615940	
Aluminum	mg/kg	10	4900	2600	
Antimony	mg/kg	1	<1	<1	
Arsenic	mg/kg	1	16	7	
Barium	mg/kg	5	343	87	
Beryllium	mg/kg	2	<2	<2	
Boron	mg/kg	2	2	<2	
Cadmium	mg/kg	0.3	0.3	<0.3	
Chromium	mg/kg	2	21	11	
Cobalt	mg/kg	1	16	6	
Copper	mg/kg	2	75	18	
ron	mg/kg	50	25000	7650	
∟ead	mg/kg	0.5	72.8	15.3	
_ithium	mg/kg	5	6	<5	
Manganese	mg/kg	2	1520	1150	
Molybdenum	mg/kg	2	<2	<2	
Nickel	mg/kg	2	25	7	
Selenium	mg/kg	1	<1	<1	
Silver	mg/kg	0.5	<0.5	<0.5	
Strontium	mg/kg	5	21	25	
Γhallium	mg/kg	0.1	<0.1	<0.1	
Γin	mg/kg	2	<2	<2	
Uranium	mg/kg	0.1	0.3	0.2	
/anadium	mg/kg	2	34	21	
Zinc	mg/kg	5	236	48	

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

9615869-9615940 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtay



Certificate of Analysis

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury	Analysis	in Soil
ivicioary	, tildiy 010	, ,,, ,

Mercury Analysis in Soil												
DATE RECEIVED: 2018-10-10								l	DATE REPORT	ED: 2018-10-18		
				MLLA-MW3-	MLLA-MW3-	MLLA-MW4-	MLLA-MW4-	MLLA-BH2-2018	MLLA-BH2-2018	MLLA-BH1-2018	MLLA-BH1-2018	
		SAMPLE DESCR	RIPTION:	2018-SS1	2018-SS2	2018-SS1	2018-SS2	-SS1	-SS2	-SS1	-SS2	
		SAMPL	E TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	
		DATE SA	AMPLED:	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	
Parameter	Unit	G/S	RDL	9615869	9615873	9615880	9615882	9615883	9615884	9615885	9615886	
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	< 0.05	< 0.05	< 0.05	<0.05	<0.05	
		SAMPLE DESC	RIPTION:	MLLA-MW2- 2018-SS1	MLLA-MW2- 2018-SS2							
			E TYPE:	Soil	Soil							
		DATE SA	AMPLED:	2018-10-03	2018-10-03							
Parameter	Unit	G/S	RDL	9615899	9615940							
Mercury	mg/kg		0.05	<0.05	0.06							

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

9615869-9615940 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Jasan Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-10 **DATE REPORTED: 2018-10-18** MLLA-MW1-MLLA-MW1-MLLA-MW2-MLLA-MW2-MLLA-MW3-MLLA-MW3-MLLA-MW3-MLLA-BH1-2018 SAMPLE DESCRIPTION: 2018-SS4 2018-SS6 2018-SS5 2018-SS7 2018-SS6 2018-SS7 2018-SS8 -SS5 SAMPLE TYPE: Soil Soil Soil Soil Soil Soil Soil Soil DATE SAMPLED: 2018-10-03 2018-10-03 2018-10-03 2018-10-03 2018-10-03 2018-10-03 2018-10-03 2018-10-03 9615898 Parameter Unit G/S **RDL** 9615862 9615864 9615865 9615866 9615875 9615876 9615877 Benzene 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 mg/kg Toluene 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 < 0.04 mg/kg Ethylbenzene 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 < 0.03 mg/kg Xylene (Total) mg/kg 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 C6-C10 (less BTEX) 3 <3 <3 <3 <3 mg/kg <3 <3 <3 24 >C10-C16 Hydrocarbons 122 mg/kg 15 <15 <15 <15 332 2650 132 <15 >C16-C21 Hydrocarbons 15 <15 <15 160 <15 260 1680 102 mg/kg <15 >C21-C32 Hydrocarbons mg/kg 15 29 <15 695 <15 52 334 18 <15 20 29 <20 977 <20 644 4690 252 Modified TPH (Tier 1) mg/kg <20 NR WFOF+LOF NR WFOF WFOF LOF WFOF NR Resemblance Comment Return to Baseline at C32 Υ Unit Acceptable Limits Surrogate Isobutylbenzene - EPH % 60-140 93 92 91 68 97 104 93 90 Isobutylbenzene - VPH % 60-140 73 70 90 108 108 76 118 105 n-Dotriacontane - EPH % 60-140 106 100 79 66 96 103 98 95

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

9615862-9615898 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Mus

57 Old Pennywell Road, Unit I

St. John's, NL

CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



Certificate of Analysis

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

				•······ === - ··										
					Moistu	ıre								
DATE RECEIVED: 2018-10-10								[DATE REPORT	ED: 2018-10-18	}			
				MLLA-MW1-	MLLA-MW1-	MLLA-MW2-	MLLA-MW2-	MLLA-MW3-	MLLA-MW3-	MLLA-MW3-	MLLA-BH1-2018			
		SAMPLE DESC	CRIPTION:	2018-SS4	2018-SS6	2018-SS5	2018-SS7	2018-SS6	2018-SS7	2018-SS8	-SS5			
		SAME	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
		DATE S	SAMPLED:	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03	2018-10-03			
Parameter	Unit	G/S	RDL	9615862	9615864	9615865	9615866	9615875	9615876	9615877	9615898			
% Moisture	%		0	13	14	8	12	19	13	19	6			

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K395696

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Soil Analysis															
RPT Date: Oct 18, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MATRIX SPIKE		KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery		ptable	Recovery	Accer Lim	
		lu lu	-				value	Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9615940	9615940	3830	3410	11.6%	< 10	118%	80%	120%	114%	80%	120%	NA	70%	130%
Antimony	9615940	9615940	<1	<1	NA	< 1	102%	80%	120%	116%	80%	120%	70%	70%	130%
Arsenic	9615940	9615940	7	6	15.4%	< 1	101%	80%	120%	102%	80%	120%	98%	70%	130%
Barium	9615940	9615940	87	73	17.5%	< 5	99%	80%	120%	101%	80%	120%	111%	70%	130%
Beryllium	9615940	9615940	<2	<2	NA	< 2	111%	80%	120%	114%	80%	120%	106%	70%	130%
Boron	9615940	9615940	<2	6	NA	< 2	116%	80%	120%	115%	80%	120%	101%	70%	130%
Cadmium	9615940	9615940	< 0.3	<0.3	NA	< 0.3	99%	80%	120%	101%	80%	120%	99%	70%	130%
Chromium	9615940	9615940	11	8	NA	< 2	103%	80%	120%	104%	80%	120%	129%	70%	130%
Cobalt	9615940	9615940	6	5	18.2%	< 1	100%	80%	120%	101%	80%	120%	107%	70%	130%
Copper	9615940	9615940	18	15	18.2%	< 2	106%	80%	120%	106%	80%	120%	100%	70%	130%
Iron	9615940	9615940	8430	7110	17.0%	< 50	102%	80%	120%	116%	80%	120%	70%	70%	130%
Lead	9615940	9615940	15.3	11.2	30.9%	< 0.5	106%	80%	120%	107%	80%	120%	93%	70%	130%
Lithium	9615940	9615940	<5	<5	NA	< 5	111%	70%	130%	115%	70%	130%	115%	70%	130%
Manganese	9615940	9615940	1150	873	27.4%	< 2	118%	80%	120%	119%	80%	120%	111%	70%	130%
Molybdenum	9615940	9615940	<2	<2	NA	< 2	100%	80%	120%	104%	80%	120%	101%	70%	130%
Nickel	9615940	9615940	7	33	NA	< 2	101%	80%	120%	104%	80%	120%	NA	70%	130%
Selenium	9615940	9615940	<1	<1	NA	< 1	100%	80%	120%	103%	80%	120%	87%	70%	130%
Silver	9615940	9615940	<0.5	<0.5	NA	< 0.5	103%	80%	120%	105%	80%	120%	98%	70%	130%
Strontium	9615940	9615940	25	22	NA	< 5	114%	80%	120%	116%	80%	120%	130%	70%	130%
Thallium	9615940	9615940	<0.1	<0.1	NA	< 0.1	103%	80%	120%	103%	80%	120%	NA	70%	130%
Tin	9615940	9615940	<2	<2	NA	< 2	101%	80%	120%	100%	80%	120%	96%	70%	130%
Uranium	9615940	9615940	0.2	0.2	NA	< 0.1	102%	80%	120%	101%	80%	120%	99%	70%	130%
Vanadium	9615940	9615940	21	18	15.4%	< 2	101%	80%	120%	102%	80%	120%	113%	70%	130%
Zinc	9615940	9615940	48	54	11.8%	< 5	101%	80%	120%	101%	80%	120%	95%	70%	130%
Mercury Analysis in Soil															
Mercury	1	9615884	<0.05	<0.05	NA	< 0.05	115%	70%	130%		70%	130%	105%	70%	130%

Certified By:

Joseph Coaght

AGAT QUALITY ASSURANCE REPORT (V1)

Page 7 of 12



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395696
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			Trac	ce Or	gani	cs Ar	nalys	is							
RPT Date: Oct 18, 2018				DUPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Lin	ptable nits	Recovery	منا أ	ptable nits
		lu lu					value	Lower	Upper		Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocark	ons in Soil	(Version 3	3.1) - Field	Preserve	d										
Benzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	100%	60%	140%	103%	60%	140%			
Toluene	1	9615862	< 0.04	< 0.04	NA	< 0.04	110%	60%	140%	108%	60%	140%			
Ethylbenzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	108%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9615862	< 0.05	< 0.05	NA	< 0.05	119%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9615862	< 3	< 3	NA	< 3	116%	60%	140%	122%	60%	140%	NA	30%	130%
>C10-C16 Hydrocarbons	1	9616181	< 15	< 15	NA	< 15	103%	60%	140%	94%	60%	140%	108%	30%	130%
>C16-C21 Hydrocarbons	1	9616181	< 15	< 15	NA	< 15	98%	60%	140%	94%	60%	140%	108%	30%	130%
>C21-C32 Hydrocarbons	1	9616181	20	18	NA	< 15	97%	60%	140%	94%	60%	140%	108%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

my Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395696
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395696 PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL SAMPLING SITE:

SAMPLED BY:

<u> </u>		O/ (IVII EED D1)	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis	·	·	
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

Laboratory Use	Only	
Arrival Condition:	Good	☐ Poor (see notes)
Arrival Temperatur	e: 2 0	1.4,33°C
AGAT Job Number:	18K	395696
Notes:		

NO. 1				P: 902.4	<u> 168.87</u>	7 <u>18 -</u>	F: 9	02.4	68.8	924	AG	AT Jo	b N	umł	oer:		181	230	15	69	6	
Chain of Custody Record		Report Info	ormation									otes:										
Report Information		1 Name:	James O'Neill				Re	port	Forn	nat												
Company: GHD Limited			James.Oneill@ghd.com					C:m-	1-													
Contact: James O'Neill		2. Name:				_		Sing Sam	ple p	er	Tu	rnar	==	d T	ime	Ra	auire	ed (TA	(T)			
Address: 1118 Topsail Road			datanl@ghd.oom			==:		page			ll .							•				
St. John's NL A1B 3N7	-	Lilian.	add.ii@gi.a.ooiii				V	Mult Sam	iple		Re	gulai	r TAI	r L	⊻ 5 t	ιο 7 ν	worki	ing da	ys			
	709-364-5368	•						page		per	Ru	sh TA	AT.		1 10	day		$\Box 2$	2 days	S		
Site # and/or Name: MARYSTOWN SHIP		Regulatory	Requirements (Check	:():			V	Exce	1						□3 c	days	1					
Project #: 11178792-02		☐ List Guideline:	s on Report 🗵 Do Not Lis	st Guidelines o	n Report		(K)	Forn														
AGAT Quotation #: GHD Standing Offer		□ PIRI	El Casa	C 0				HIGH	lucu		Dat	te Red	quire	ed:	_	_				_		_
TO FOLLOW!		☑ Tier 1 □ Res	☐ Gas ☐ Pot☐ Fuel ☐ N/Pot	☑ Coarse ☐ Fine	:		Drin	king V	Vater	Sam	ole:	□ Yes	ò	Ø	No							
GHD P0 #:		☑ Com	□Lube				Reg	. No.:											2			
Invoice To S	ame Yes ☑ / No □	□ CCME	□ CDWQ			9	П		Т	Т		Т	Т			T			П	П	Т	
Company:		□Industri	_		1 0	LOW LEVEL (POINBLE)						-	_									
Contact:		□ Comme			4 3	I AET			⊡ Available			ieter	3 2			Щ						
Address:		□ Res/Pa			TER	A.			Aya	Pipette)		i a	3			HA!						
714410551		☐ Agricult☐ FWAL	urai	_ ×			3TEX		S S	ld Pi		i i	[P	9		Ē						
Phone: Fax:		□ Sedime	ent -	- II II	ATLANTIC RBCA	NATI	PH/E		U Diss	SIZE (Sieve and		S) N	MERCURY (Ha)	2		FOR POSS. LEAHATE					\ \ \ \	
Phone: Fax:			V: ====================================	- NO	LAN	CTIO	107		<u></u>	Sie (Sie		OITA		3		PÕ					FAR	3
				- B	A - AT	FR/	DED		<u> </u>	SIZE		Į.		از		S.					2	. 2
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR CONTAINERS	TPH/BTEX - ATLANTIC RBCA	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BTEX)	MTBE ONLY	MEIALS: U lotal	PARTICLE (PAHS	PCBs TPH FRACTIONATION (Summa Canister)	OTHER:		OTHER:	HOLDF					HOLD FOR 1 YEAR (Y/N)	TOED FOR I TEAR
MLLA-MW1-2018-SS4	2018/03/10 00:00	Soil	VARIOUS	3	Ø																	T
MLLA-MW1-2018-SS6	2018/03/10 00:00	Soil	VARIOUS	3	Ø																	
MLLA-MW2-2018-SS5	2018/03/10 00:00	Soil	VARIOUS	3	Ø																	
MLLA-MW2-2018-SS7	2018/03/10 00:00	Soil	VARIOUS	3	Ø							\perp	\perp	\perp		\perp						
MLLA-MW3-2018-SS1	2018/03/10 00:00	Soil	1 X 60 ML	1				1	7				Ø	1		Ø			\perp	\Box		1
MLLA-MW3-2018-SS2	2018/03/10 00:00	Soil	1 X 60 ML	1				I	<u>a</u>			_	Ø	1		Ø				\perp	4	1
MLLA-MW3-2018-SS6	2018/03/10 00:00	Soil	VARIOUS	3	Ø						_	_	_	\perp	_	┶	Ш			\vdash		\perp
MLLA-MW3-2018-SS7	2018/03/10 00:00	Soil	VARIOUS	3									1	\perp	1	\perp	\Box			\vdash	4	\perp
MLLA-MW3-2018-SS8	2018/03/10 00:00	Soil	VARIOUS	3					_		_		_	\perp	_	┶	\perp		\perp	\vdash	4	+
MLLA-MW4-2018-SS1	2018/03/10 00:00	Soil	1 X 60 ML	1				-	7			\perp	Ø		_	Ø	Ш			\vdash	4	+
MLLA-MW4-2018-SS2	2018/03/10 00:00	Soil	1 X 60 ML	1					Z]			4	Ø	1		Ø						
Samples Relinquished By (Print Name): Hubert Anderson	2018/1		ples Received By (Print Name): No. 1 (Print Name): ples Received By (Sign):							-10	/11	3					Pa	ge <u>1</u>		of <u>2</u>		
Samples Relinquished By Sign):	Pate/Time	Sep	poles Received By (Sign)					D	ate/Time	20 1	1					U.S.						
IV. UVVICUITI	10.00									-	×											





08:00

Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

902.468.8718 = F: 902.468.8924	۸0

Laboratory Use Or	ıly	
Arrival Condition:	☑ Good	☐ Poor (see notes)
Arrival Temperature:		
AGAT Job Number:		
Notes:		

Chain of Custody Record	Ī	Report Info	ormation									Note	es:									
Report Information		1 Name	James O'Neill				R	ерог	t Fo	rmat												
Company: GHD Limited			James.Oneill@ghd.com					Ci	محام													
Contact: James O'Neill		2. Name:						- Sa		e per	ľ	Turn	aro	und	Tim	ne Re	==== riups	red (T	(AT)			
Address: 1118 Topsail Road			datanl@ghd.oom						ge 		- 11						-	` king d	•			
St. John's NL A1B 3N7							[E	∄ Mi	lqitlu Mole	e es pe	r							_	-			
Phone 1-709-364-5353 Fax:	1-709-364-5368						-		ge			Rusi	TAT	Г		1 day			2 day	S		
Site # and/or Name: MARYSTOWN SHIF	PYARD - MLLA		Requirements (Check					Ex	cel rmat							3 day	S					
Project #: 11178792-02		☐ List Guidelines	on Report	st Guidelines o	n Repo	irt			clude			Date	Regi	uirec	4							
AGAT Quotation #: GHD Standing Offer		☐ FIRI	□ Gas ☑ Pot	☑ Coarse			-								-		_	_				=
GHD PO #: TO FOLLOW		□ Res ☑ Com	□ Fuel □ N/Pot □ Lube	□Fine			1.1	inkina g. No	-	er Sa	mple	: 🗆	Yes		☑No							
Invoice To	Same Yes ☑ / No □					Ω I	1 -			T	T	T	П			T			=	П	T	T
Company:		□ CCME □ Industri	☐ CDWQ al			OTABL																
Contact:		□ Comme				YEL (P			lable				ister			— µ	u l					
Address:		□ Res/Pai			띪	OW LE			☑ Available		Sette		a Car				<u> </u>					
7.0007	-	□ Agriculti □ FWAL	urai	_	BCA	- I	No I	2	SS				mmn	(Fg)		I EAHATE	5				_	
Phone: Fax:		□ Sedime	ent ————	CONTAINERS	IS R	3CA TIE	INAT		□ Diss		sve ar		S) N	₩		0000	ġ				\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	
Thore.				CONT	TLAN.	ATIC RE	ACTIC	2	la l		1 (38		NATIC	MERCURY (Hg)		8	5	Н			VEAR	S S
	A NAME OF STREET		COMMENTS -	~ 08	X	- ATLA	E 5		15		212		CTIO	R		0	5				1 H	Sous
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER	TPH/BTEX - ATLANTIC RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE ONLY	METALS: □ Total	70C	PARTICLE SIZE (Sieve and Pipette)	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER:	٦ l				HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
MLLA-BH2-2018-SS1	2018/03/10 00:00	Soil	1 X 60 ML	1					Ø					Ø		E	7					
MLLA-BH2-2018-SS2	2018/03/10 00:00	Soil	1 X 60 ML	1					Ø					Ø		E	7	Ш				
MLLA-BH1-2018-SS1	2018/03/10 00:00	Soil	1 X 60 ML	1					Ø		4	_		Ø		_	Z _				\perp	_
MLLA-BH1-2018-SS2	2018/03/10 00:00	Soil	1 X 60 ML	1	Щ		_		Ø	4	_	-		Ø		Ø		\vdash				
MLLA-BH1-2018-SS5	2018/03/10 00:00	Soil	VARIOUS	3 -	0		_					_						\vdash		\vdash	+	
MLLA-MN2-2018-551	2018/03/10	Soll	I X 60 ML			_	_	-	×	_	_	-	-	×				\vdash	_	\vdash	+	+
MLLA-MW2-2018-552	2018/03/10	5014	1 x 60 HL	1	Ш	_	+	-	X	4	_	-		×		>	<u> </u>	\vdash	-	-	+	+
X					-		-	+		-	+	+	-		-		+	\vdash	-		+	+
X						-	+	+	H	+	+	+	-		\vdash	-		++	_	\vdash	+	+-
X							+			+	-	+	-				+	+	+	\vdash	+	+
X	Date/Time	[Ones	plee Received By (Print Nagre):						Date/1	ime			+-					Щ		Щ.		
Samples Relinquished By (Print Name): Hubert Anderson	2018/1		musikenne						Do	51	01	15					P	age <u>2</u>	<u>'</u>	of <u>2</u>		-



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395584

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 20, 2018

PAGES (INCLUDING COVER): 12

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 12

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

				A۷	ailable Metal	Is in Soil
DATE RECEIVED: 2018-10-1	10					DATE REPORTED: 2018-10-20
	S	AMPLE DESCR		MAEB-MW2- 2018-SS1	MAEB-MW2- 2018-SS2	
		SAMPL DATE SA	E TYPE: MPLED:	Soil 2018-10-02	Soil 2018-10-02	
Parameter	Unit	G/S	RDL	9614901	9614902	
Aluminum	mg/kg		10	27300	31600	
Antimony	mg/kg		1	<1	<1	
Arsenic	mg/kg		1	6	8	
Barium	mg/kg		5	30	34	
Beryllium	mg/kg		2	<2	<2	
Boron	mg/kg		2	2	2	
Cadmium	mg/kg		0.3	<0.3	<0.3	
Chromium	mg/kg		2	76	89	
Cobalt	mg/kg		1	27	30	
Copper	mg/kg		2	66	87	
Iron	mg/kg		50	34800	36700	
Lead	mg/kg		0.5	33.6	38.6	
Lithium	mg/kg		5	11	13	
Manganese	mg/kg		2	1210	1370	
Molybdenum	mg/kg		2	<2	<2	
Nickel	mg/kg		2	59	59	
Selenium	mg/kg		1	<1	<1	
Silver	mg/kg		0.5	<0.5	<0.5	
Strontium	mg/kg		5	42	62	
Thallium	mg/kg		0.1	<0.1	<0.1	
Tin	mg/kg		2	<2	<2	
Uranium	mg/kg		0.1	0.3	0.3	
Vanadium	mg/kg		2	92	100	
Zinc	mg/kg		5	329	311	

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

9614901-9614902 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Casar Coaghtry



Certificate of Analysis

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Mercury Analysis in Soil

				1410	roury / mary	
DATE RECEIVED: 2018-10-10						DATE REPORTED: 2018-10-20
				MAEB-MW2-	MAEB-MW2-	
		SAMPLE DES	CRIPTION:	2018-SS1	2018-SS2	
		SAMI	PLE TYPE:	Soil	Soil	
		DATE S	SAMPLED:	2018-10-02	2018-10-02	
Parameter	Unit	G/S	RDL	9614901	9614902	
Mercury	mg/kg		0.05	<0.05	<0.05	

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

9614901-9614902 Results are based on the dry weight of the soil. Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Jasan Coughtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-10							Ι	DATE REPORTI	ED: 2018-10-20	
			MAEB-MW1-	MAEB-MW1-	MAEB-BH1-	MAEB-BH1-	MAEB-BH2-	MAEB-BH2-	MAEB-MW2-	MAEB-MW2-
		SAMPLE DESCRIPTION	2018-SS1	2018-SS2	2018-SS2	2018-SS4	2018-SS2	2018-SS4	2018-SS4	2018-SS5
		SAMPLE TYPE	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02
Parameter	Unit	G/S RDL	9614892	9614893	9614894	9614895	9614896	9614897	9614898	9614899
Benzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Toluene	mg/kg	0.04	< 0.04	<0.04	< 0.04	<0.04	< 0.04	< 0.04	<0.04	<0.04
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	9	<3
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	98	<15	<15	<15	2910	<15
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	122	<15	<15	<15	2010	<15
>C21-C32 Hydrocarbons	mg/kg	15	84	30	74	15	<15	<15	305	<15
Modified TPH (Tier 1)	mg/kg	20	84	30	294	<20	<20	<20	5230	<20
Resemblance Comment			LOF	LOF	FOF+LOF	LOF	NR	NR	FOF	NR
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140	84	89	82	87	86	92	97	92
Isobutylbenzene - VPH	%	60-140	120	117	120	116	93	110	98	105
n-Dotriacontane - EPH	%	60-140	86	86	82	88	83	88	74	89

Certified By:

any Hu



DATE RECEIVED: 2018-10-10

SAMPLING SITE:

Resemblance Comment

Isobutylbenzene - EPH

Isobutylbenzene - VPH

n-Dotriacontane - EPH

Return to Baseline at C32

Surrogate

Certificate of Analysis

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

		MAEB-MW2-		
	S	Soil		
	DATE SAMPLED:			
Parameter	Unit	G/S	RDL	9614900
Benzene	mg/kg		0.03	<0.03
Toluene	mg/kg		0.04	<0.04
Ethylbenzene	mg/kg		0.03	< 0.03
Xylene (Total)	mg/kg		0.05	< 0.05
C6-C10 (less BTEX)	mg/kg		3	4
>C10-C16 Hydrocarbons	mg/kg		15	573
>C16-C21 Hydrocarbons	mg/kg		15	460
>C21-C32 Hydrocarbons	mg/kg		15	140
Modified TPH (Tier 1)	mg/kg		20	1180

FOF

Υ

93

108

92

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

Unit

%

%

%

Acceptable Limits

60-140

60-140

60-140

9614892-9614900 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hut

DATE REPORTED: 2018-10-20



Certificate of Analysis

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

SAMPLING SITE:			SAMPLED BY:										
Moisture													
DATE RECEIVED: 2018-10-10	DATE REPORTED: 2018-10-20												
			MAEB-MW1-	MAEB-MW1-	MAEB-BH1-	MAEB-BH1-	MAEB-BH2-	MAEB-BH2-	MAEB-MW2-	MAEB-MW2-			
	SAMPLE DESCRIPTION:		2018-SS1	2018-SS2	2018-SS2	2018-SS4	2018-SS2	2018-SS4	2018-SS4	2018-SS5			
	SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
	DATE SAMPLED:		2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02			
Parameter	Unit	G/S RDL	9614892	9614893	9614894	9614895	9614896	9614897	9614898	9614899			
% Moisture	%	0	7	12	12	13	11	9	12	12			
			MAEB-MW2-										
		SAMPLE DESCRIPTION:	2018-DUP01										
		SAMPLE TYPE:	Soil										
		DATE SAMPLED:	2018-10-02										
Parameter	Unit	G/S RDL	9614900										
% Moisture	%	0	15										

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

Certified By:



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K395584

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

				Soi	l Ana	alysis	3								
RPT Date: Oct 20, 2018			С	UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SP	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable	Recovery		ptable nits	Recovery		eptable mits
		ld	·	·			Value	Lower	Upper	,	Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9615940		3830	3410	11.7%	< 10	118%	80%	120%	114%	80%	120%	NA	70%	130%
Antimony	9615940		<1	<1	NA	< 1	102%	80%	120%	116%	80%	120%	70%	70%	130%
Arsenic	9615940		7	6	13.7%	< 1	101%	80%	120%	102%	80%	120%	98%	70%	130%
Barium	9615940		87	73	17.3%	< 5	99%	80%	120%	101%	80%	120%	111%	70%	130%
Beryllium	9615940		<2	<2	NA	< 2	111%	80%	120%	114%	80%	120%	106%	70%	130%
Boron	9615940		<2	6	NA	< 2	116%	80%	120%	115%	80%	120%	101%	70%	130%
Cadmium	9615940		< 0.3	< 0.3	NA	< 0.3	99%	80%	120%	101%	80%	120%	99%	70%	130%
Chromium	9615940		11	8	NA	< 2	103%	80%	120%	104%	80%	120%	129%	70%	130%
Cobalt	9615940		6	5	8.2%	< 1	100%	80%	120%	101%	80%	120%	107%	70%	130%
Copper	9615940		18	15	19.0%	< 2	106%	80%	120%	106%	80%	120%	100%	70%	130%
Iron	9615940		8430	7110	17.0%	< 50	102%	80%	120%	116%	80%	120%	70%	70%	130%
Lead	9615940		15.3	11.2	NA	< 0.5	106%	80%	120%	107%	80%	120%	93%	70%	130%
Lithium	9615940		<5	<5	NA	< 5	111%	70%	130%	115%	70%	130%	115%	70%	130%
Manganese	9615940		1150	873	NA	< 2	118%	80%	120%	119%	80%	120%	111%	70%	130%
Molybdenum	9615940		<2	<2	NA	< 2	100%	80%	120%	104%	80%	120%	101%	70%	130%
Nickel	9615940		7	33	NA	< 2	101%	80%	120%	104%	80%	120%	NA	70%	130%
Selenium	9615940		<1	<1	NA	< 1	100%	80%	120%	103%	80%	120%	87%	70%	130%
Silver	9615940		<0.5	<0.5	NA	< 0.5	103%	80%	120%	105%	80%	120%	98%	70%	130%
Strontium	9615940		25	22	NA	< 5	114%	80%	120%	116%	80%	120%	130%	70%	130%
Thallium	9615940		<0.1	<0.1	NA	< 0.1	103%	80%	120%	103%	80%	120%	NA	70%	130%
Tin	9615940		3	4	NA	< 2	101%	80%	120%	100%	80%	120%	96%	70%	130%
Uranium	9615940		0.2	0.2	NA	< 0.1	102%	80%	120%	101%	80%	120%	99%	70%	130%
Vanadium	9615940		21	18	17.9%	< 2	101%	80%	120%	102%	80%	120%	113%	70%	130%
Zinc	9615940		48	54	11.7%	< 5	101%	80%	120%	101%	80%	120%	95%	70%	130%
Mercury Analysis in Soil															
Mercury	1 9	9615884	<0.05	<0.05	NA	< 0.05	115%	70%	130%		70%	130%	105%	70%	130%

Certified By:

Closar C

AGAT QUALITY ASSURANCE REPORT (V1)

Page 7 of 12



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395584 PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			Trac	e Or	gani	cs Ar	alys	is							
RPT Date: Oct 20, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		eptable mits	Recovery	منا أ	ptable nits	Recovery	منا أ	ptable nits
		la la		i i			Value	Lower	Upper		l	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbo	ns in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	121%	60%	140%	109%	60%	140%			
Toluene	1	9584397	< 0.04	< 0.04	NA	< 0.04	128%	60%	140%	114%	60%	140%			
Ethylbenzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	122%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9584397	< 0.05	< 0.05	NA	< 0.05	126%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9584397	< 3	< 3	NA	< 3	127%	60%	140%	101%	60%	140%	115%	30%	130%
>C10-C16 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	126%	60%	140%	95%	60%	140%	96%	30%	130%
>C16-C21 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	122%	60%	140%	95%	60%	140%	96%	30%	130%
>C21-C32 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	127%	60%	140%	95%	60%	140%	96%	30%	130%
Comments: If Matrix spike value is N. If RPD value is NA, the results of the								ributior	۱.						

Atlantic RRCA Tier	1 Hydrocarbone i	n Soil (Version	3.1) - Field Preserved

Benzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	100%	60%	140%	103%	60%	140%			
Toluene	1	9615862	< 0.04	< 0.04	NA	< 0.04	110%	60%	140%	108%	60%	140%			
Ethylbenzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	108%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9615862	< 0.05	< 0.05	NA	< 0.05	119%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9615862	< 3	< 3	NA	< 3	116%	60%	140%	122%	60%	140%	NA	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

comy Wu

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395584
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED PROJECT: 11178792-02

SAMPLING SITE:

AGAT WORK ORDER: 18K395584 ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

		_	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

Laboratory Use C	nly	
Arrival Condition: Arrival Temperature AGAT Job Number:	1 0	Poor (see notes)
Notes:	18K3	95584

				P: 902.	168.8	3718	8 - F	90:	2.46	8.892	24	AGA	T Job	. Nu	mbe	r: 🕶	181	350	558	36	9	
Chain of Custody Record		Report Info	ormation									Not				-	18K	-39	55	84		_
Report Information		1 Name	James O'Neill				R	epo	rt Fo	orma	t											
Company: GHD Limited			James.Oneill@ghd.com					-														
Contact: James O'Neill		2. Name:] [⊒ ۾ چ	ingle amn	: le pe	.	T										
Address: 1118 Topsail Road			datanl@ghd.oom				11		age	.о ро							equir	•	11			
St. John's NL A1B 3N7		Liliali.	datamegna.com				1 1		1ultip			Regi	ular	TAT	V	5 to '	7 wor	king	days			
Phone 1-709-364-5353 Fax: 1	1-709-364-5368						Ţ.	- 5	amp age	les p	er	Rush	1 TA	Г		1 day	у]2 da	ys		
Site # and/or Name: MARYSTOWN SHIF		Regulator	y Requirements (Check):				11		xcel							3 day	ys					
Project #: 11178792-02		List Guideline	s on Report 🗵 Do Not List (Guidelines d	n Repo	ort	11 4		orma iclud													
AGAT Quotation #: GHD Standing Offer		□ PIRI □ Tier 1	□ Gas ☑ Pot Ⅰ	☑ Coarse					leide	eu	_	Date	Req	uire	d:							_
GHD PO #: TO FOLLOW		□Res	□ Fuel □ N/Pot I	□ Fine	;			rinki: eg. N		ater S					☑ No						-	
Invoice To	Same Yes ☑ / No □	☑ Com	□Lube					ag. IV	U		Ŧ	1		Т		-	_		=			_
Company:		□ CCME □ Industr	□ CDWQ ial			(POTABLE)																
Contact:		□ Comme				VEL (P			able			T.	Canister)			₁	ய					
Address:		□ Res/Pa			ER.	OW LE			☑ Available		ette)		Can			1	LEAHATE			1.1		
		□ Agricult □ FWAL	turai ——————	ပ္တ	3GA T	-	Z	Ê E	\ \(\(\)		g B		mma	훈		i i	\$			1 1		
Phone: Fax:		□ Sedime	ent	TAINE	ATLANTIC RBCA TIER	RBCA TIE	IONATIC	I PH/E	□ Diss		ieve an		ION (Su	MERCURY (Hg)		9	POSS. L				1 VEAB (V/N)	(1) (1) (I) (I) (I) (I) (I) (I) (I) (I) (I) (I
			T] §	ATLA	ANTIC	RACT	3 2 1	Potal		ZE (S		DNAT	RC			ĭ				V = A	į Š
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT		TPH/BTEX-	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL	TPH/BTEX FRACTIONATION	MIBE (ADDED TO IPH/BIEX)	METALS: Total	FOC	PARTICLE SIZE (Sieve and Pipette)	PCBs	TPH FRACTIONATION (Summa	OTHER: ME		OTHER:	HOLD FOR				HOI O IOH	
MAEB-MW1-2018-SS1	2018/02/10 00:00	Soil	VARIOUS	3	Ø			7					H	Ť		Ť	+-	\vdash	\rightarrow	+	-	+
MAEB-MW1-2018-SS2	2018/02/10 00:00	Soil	VARIOUS	3	Ø		T							\vdash			\top	П		+	_	+
MAEB-BH1-2018-SS2	2018/02/10 00:00	Soil	VARIOUS	3	Ø			T	T			1					_	\Box		\Box	\pm	+
MAEB-BH1-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3	Ø																	+
MAEB-BH1-2018-SS1 -	2018/02/10 00:00	Soil	VARIOUS	3	2								F				+	\vdash				+
MAEB-BH2-2018-SS2	2018/02/10 00:00	Soil	VARIOUS	3	Ø				T				П						\top	+	+	+
MAEB-BH2-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3				1			1				\Box		\top	\vdash	_	+	+	+
MAEB-MW2-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3		7	\top	1		H	+						+	\vdash	+	+	-	+
MAEB-MW2-2018-SS5	2018/02/10 00:00	Soil	VARIOUS	3	Ø			1	T		7	+				+	+	\vdash	+	+	+	+
MAEB-MW2-2018-DUP01	2018/02/10 00:00	Soil	VARIOUS	3	Ø	7	7		\top	П	+	1			\vdash	+	+-		_	+	+	+
MAEB-MW2-2018-SS1	2018/02/10 00:00	Soil	1 X 60 ML	1					Ø		1		Ħ			F	7	+		+	+	+
Samples Relinquished By (Print Name): Hubert Anderson	Zo18/10		ples Received By (Print Name)						Date/	Time	2/1	Q	T		_			age _1	1	of _2	<u></u>	_
Samples, Relinquisted By (Sign):	Date/Time	Sam	MMO Flowey Ipies Received By (Sigh):						Date	Time 2 2			1			Į	_					<u> </u>



Laboratories

Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902,468,8718 * F: 902,468,8924

Laboratory Use	Only	
Arrival Condition:	₫ Good	☐ Poor (see notes)
Arrival Temperatur	e:1,1,3.	2 19.6
LOAT LINE	18/12	GECSU

Chain	of Custody Record		Report Inf	ormation										otes:		amb	er:	0 1	2	9 2	7.5		
Report Inf	•								Don	ort F	O N 1990	.4	'\	nes.									
Company:	GHD Limited			James O'Neill				'	ĸep	Ort F	orma	at											
Contact:	James O'Neil	=======		James.Oneill@ghd.com		_		-		Single Samp	9	_	늗										
	1118 Topsail Road		2. Name:					=		sam, page	пе ре	i	Tu	rnar	oun	d Ti	me F	Requ	ired ((TAT))		
Addicss.	St. John's NL A1B 3N7		Email:	datani@ghd.oom				=	V	Multij	ole		Re	gula	r TAT	√]5 to	7 w	orking	, days	,		(*)
Phone		I-709-364-5368								Samp page	les p	er	Ru	sh T/	AΤ] 1 da	av	Γ]2 da	avs		
	or Name: MARYSTOWN SHIP		Regulator	y Requirements (Check)-			7		Excel] 3 da	•			<i>a,</i> 0		
	11178792-02	TAND - WALD	☐ List Guideline			on Rep	ort	Ш.	IV.	Forma	at												
Project #:			□PIRI							Includ	led		Da	te Re	quire	ed: _							
	GHD Standing Offer TO FOLLOW		☑ Tier 1 □ Res	☐ Gas ☐ Pot ☐ Fuel ☐ N/Pot	☑ Coarse □ Fine	е			Drink	ing W	ater S	amr				ØΝ							
GHD PO #:	<u> </u>		□ Res	□ Lube	□ Fine			- 11	Reg.	_													
Invoice To)	Same Yes ☑ / No □	□ CCME	EL ODWO	F	ı I	(i)		- 1	T	T		T	Т	T	T		-			$\overline{}$	ТТ	\equiv
Company:			□Industr	□ CDWQ rial			OTABL																
			□ Comme	ercial Other			VEL (P			∏ Available				1	lase			비비					
Address:			□ Res/Pa			IER.	OW LE			Avail		ette)			[8] (2)			¥.					
			□ Agricul □ FWAL	turai	_ မွ	3CA T	1	2	(EX)			d Pip			E	-		ËĀ					
Phone:	Fax:		□ Sedim	ent	CONTAINERS	TPH/BTEX - ATLANTIC RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	МТВЕ (АDDED ТО ТРН/ВТЕХ)	□ Diss		PARTICLE SIZE (Sieve and Pipette)		PCBs	MERCUREY (HG)			POSS. LEACHATE			1		(N)
3					- NO	LAN	IC RB	CT C	5	<u></u>		(Sie		Ę				S					N S
				(= 10 S	- g	A- AT	ATLAN	, FRΔ	DED	MTBE ONLY METALS: CI Total		SIZE		Į.				FOR					HOLD FOR 1 YEAR (Y/N) HAZARDOUS (Y/N)
	SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO,	NUMBER	/BTE	STEX.	/BTE	E (A	MTBE ONLY		ICLE		. 2		ä	این	- G					ARDC
			MAINA	TYPE OF CONTAMINANT	NUN	TPH,	TPH/E	TPH	MTB	MTB	FOC	PARI	PAHs	PCBs	OTHER	OTHER:	OTHER:	HOLD					HOLD
MAEB-MW2-	-2018-SS2	2018/02/10 00:00	Soil	1 X 60 ML	1					Ø					Ø	_		Ø					
						-			_	4		Щ		_ _	_								
										_						_							
					_	-			-	-	-	-	-	4	-	-	Н	-					
					-	-			+	-	\vdash	4	\dashv	+	-	┼	\vdash	-	_	\vdash	+	\vdash	_
					-			\dashv	-	+	\vdash	-	+		+	-	\vdash	-	+	\vdash	+		
								\dashv	+	+			+		+	-			-	\vdash	+	\vdash	_
Samples Relinquished Hubert Ande		Date/Time	Sar Sar	ngles Received By (Print Name):						Date	/Time		1			_		+		<u>_</u>	_ــــ	౼	
Samples Reignquis le	ndeson	2018/ Date/Time	10/10 t	much lenve	4					U(/Time	0/	15						Page		of _		
N. W	nacion	Date/Time	0 1	and The	1						2)	2											



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395586

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 19, 2018

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*	*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 10

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395586

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED:	MDSA-MW1- 2018-SS1 Soil	MDSA-MW1- 2018-SS2	DATE REPORTED: 2018-10-19
SAMPLE TYPE: DATE SAMPLED:	2018-SS1 Soil	2018-SS2	
SAMPLE TYPE: DATE SAMPLED:	Soil		
DATE SAMPLED:			
		Soil	
	2018-10-02	2018-10-02	
G/S RDL	9614934	9614935	
10	23100	19900	
1	<1	<1	
1	9	9	
5	53	63	
2	<2	<2	
2	<2	<2	
0.3	<0.3	<0.3	
2	64	52	
1	25	20	
2	63	58	
50	26300	25600	
0.5	11.9	15.6	
5	12	11	
2	1110	1160	
2	<2	<2	
2	40	31	
1	<1	<1	
0.5	<0.5	<0.5	
5			
0.1	<0.1	<0.1	
2	4		
0.1	0.2	0.2	
2	87	77	
5	116	121	
	G/S RDL 10 1 1 5 2 2 0.3 2 1 2 50 0.5 5 2 2 2 1 0.5 5 0.1 2 0.1 2	G/S RDL 9614934 10 23100 1 <1	G/S RDL 9614934 9614935 10 23100 19900 1 <1

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

9614934-9614935 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Casar Coaghtry



Certificate of Analysis

AGAT WORK ORDER: 18K395586

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury Analysis in Soil

				1010	Toury / triary	510 III 5 011
DATE RECEIVED: 2018-10-10						DATE REPORTED: 2018-10-19
				MDSA-MW1-	MDSA-MW1-	
	S	AMPLE DESC	CRIPTION:	2018-SS1	2018-SS2	
		SAME	PLE TYPE:	Soil	Soil	
		DATE S	SAMPLED:	2018-10-02	2018-10-02	
Parameter	Unit	G/S	RDL	9614934	9614935	
Mercury	mg/kg		0.05	<0.05	<0.05	

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

9614934-9614935 Results are based on the dry weight of the soil. Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:





CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395586

PROJECT: 11178792-02

SAMPLED BY:

ATTENTION TO: JAMES O'NEILL

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-10							DATE REPORTED: 2018-10-19
			MDSA-MW2-	MDSA-MW2-	MDSA-BH4-	MDSA-BH4-	
		SAMPLE DESCRIPTION:	2018-SS4	2018-SS5	2018-SS4	2018-SS5	
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	
		DATE SAMPLED:	2018-10-02	2018-10-02	2018-10-02	2018-10-02	
Parameter	Unit	G/S RDL	9614936	9614937	9614938	9614939	
Benzene	mg/kg	0.03	<0.03	<0.03	<0.03	<0.03	
Toluene	mg/kg	0.04	<0.04	<0.04	<0.04	<0.04	
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	<0.03	
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	<0.05	
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	<15	<15	
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	<15	<15	
>C21-C32 Hydrocarbons	mg/kg	15	15	22	24	36	
Modified TPH (Tier 1)	mg/kg	20	<20	22	24	36	
Resemblance Comment			LR	LR	LR	LR	
Return to Baseline at C32			Υ	Υ	Υ	Υ	
Surrogate	Unit	Acceptable Limits					
Isobutylbenzene - EPH	%	60-140	94	90	92	91	
Isobutylbenzene - VPH	%	60-140	113	119	125	124	
n-Dotriacontane - EPH	%	60-140	91	92	91	94	

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

9614936-9614939 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

my Muy

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



Certificate of Analysis

AGAT WORK ORDER: 18K395586

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

					Moistu	ire		
DATE RECEIVED: 2018-10-10								DATE REPORTED: 2018-10-19
				MDSA-MW2-	MDSA-MW2-	MDSA-BH4-	MDSA-BH4-	
		SAMPLE DESCRI	PTION:	2018-SS4	2018-SS5	2018-SS4	2018-SS5	
		SAMPLE	TYPE:	Soil	Soil	Soil	Soil	
		DATE SAM	/IPLED:	2018-10-02	2018-10-02	2018-10-02	2018-10-02	
Parameter	Unit	G/S	RDL	9614936	9614937	9614938	9614939	
% Moisture	%		0	18	17	10	15	

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K395586

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

			<u> </u>	Soi	l Ana	alysis	3						<u> </u>		
RPT Date: Oct 19, 2018			С	UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SP	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		eptable mits	Recovery		ptable nits	Recovery		ptable nits
		ld	'	.,			Value	Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9619456		8860	8530	3.8%	< 10	107%	80%	120%	100%	80%	120%	126%	70%	130%
Antimony	9619456		<1	<1	NA	< 1	91%	80%	120%	107%	80%	120%	NA	70%	130%
Arsenic	9619456		167	156	6.8%	< 1	97%	80%	120%	98%	80%	120%	108%	70%	130%
Barium	9619456		127	118	7.1%	< 5	100%	80%	120%	99%	80%	120%	106%	70%	130%
Beryllium	9619456		<2	<2	NA	< 2	105%	80%	120%	100%	80%	120%	109%	70%	130%
Boron	9619456		8	6	NA	< 2	108%	80%	120%	102%	80%	120%	108%	70%	130%
Cadmium	9619456		0.5	0.4	NA	< 0.3	99%	80%	120%	94%	80%	120%	101%	70%	130%
Chromium	9619456		16	16	3.6%	< 2	104%	80%	120%	93%	80%	120%	113%	70%	130%
Cobalt	9619456		10	9	9.8%	< 1	105%	80%	120%	98%	80%	120%	109%	70%	130%
Copper	9619456		54	51	5.0%	< 2	105%	80%	120%	99%	80%	120%	104%	70%	130%
Iron	9619456		23200	21400	8.2%	< 50	105%	80%	120%	95%	80%	120%	108%	70%	130%
Lead	9619456		97.9	93.4	4.6%	< 0.5	103%	80%	120%	103%	80%	120%	105%	70%	130%
Lithium	9619456		19	18	NA	< 5	105%	70%	130%	102%	70%	130%	113%	70%	130%
Manganese	9619456		546	488	11.2%	< 2	105%	80%	120%	97%	80%	120%	111%	70%	130%
Molybdenum	9619456		5	4	NA	< 2	101%	80%	120%	97%	80%	120%	105%	70%	130%
Nickel	9619456		20	20	2.3%	< 2	98%	80%	120%	106%	80%	120%	104%	70%	130%
Selenium	9619456		4	4	NA	< 1	104%	80%	120%	86%	80%	120%	107%	70%	130%
Silver	9619456		<0.5	<0.5	NA	< 0.5	96%	80%	120%	97%	80%	120%	102%	70%	130%
Strontium	9619456		57	43	NA	< 5	94%	80%	120%	87%	80%	120%	99%	70%	130%
Thallium	9619456		1.0	0.9	11.1%	< 0.1	99%	80%	120%	100%	80%	120%	81%	70%	130%
Tin	9619456		4	4	NA	< 2	98%	80%	120%	95%	80%	120%	95%	70%	130%
Uranium	9619456		0.6	0.6	3.1%	< 0.1	100%	80%	120%	99%	80%	120%	103%	70%	130%
Vanadium	9619456		33	31	6.1%	< 2	102%	80%	120%	97%	80%	120%	110%	70%	130%
Zinc	9619456		152	149	1.8%	< 5	103%	80%	120%	99%	80%	120%	104%	70%	130%
Mercury Analysis in Soil															
Mercury	1 9	9615884	<0.05	< 0.05	NA	< 0.05	115%	70%	130%		70%	130%	105%	70%	130%

Certified By:

Page 6 of 10



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395586
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			Trac	e Or	gani	cs Ar	nalys	is							
RPT Date: Oct 19, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery	1 1 1 1 1	ptable nits	Recovery	منا أ	ptable nits
		lu lu					value	Lower	Upper		Lower	Upper	,	Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbor	ns in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	121%	60%	140%	109%	60%	140%			
Toluene	1	9584397	< 0.04	< 0.04	NA	< 0.04	128%	60%	140%	114%	60%	140%			
Ethylbenzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	122%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9584397	< 0.05	< 0.05	NA	< 0.05	126%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9584397	< 3	< 3	NA	< 3	127%	60%	140%	101%	60%	140%	115%	30%	130%
>C10-C16 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	126%	60%	140%	95%	60%	140%	96%	30%	130%
>C16-C21 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	122%	60%	140%	95%	60%	140%	96%	30%	130%
>C21-C32 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	127%	60%	140%	95%	60%	140%	96%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

comy Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395586
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED
PROJECT: 11178792-02

SAMPLING SITE:

AGAT WORK ORDER: 18K395586 ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
·	·	
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
	Calculation	GRAVIMETRIC
	VOL-120-5013 VOL-120-5013 VOL-120-5013 VOL-120-5013 VOL-120-5013 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 VOL-120-5101	VOL-120-5013 Atlantic RBCA Guidelines for Laboratories Tier 1 VOL-120-5013 Atlantic RBCA Guidelines for Laboratories Tier 1 VOL-120-5013 VOL-120-5013 Atlantic RBCA Guidelines for Laboratories Tier 1 VOL-120-5013 Atlantic RBCA Guidelines for Laboratories Tier 1 VOL-120-5013 Atlantic RBCA Guidelines for Laboratories Tier 1 Atlantic RBCA Guidelines for Laboratories Tier 1 Atlantic RBCA Guidelines for Laboratories Tier 1 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 ORG-120-5101 Atlantic RBCA Guidelines for Laboratories Tier 1 Atlantic RBCA Guidelines for Laboratories Tier 1





Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

	Arrivai iemperai
2.468.8718 • F: 902.468.8924	ACAT Joh Niumb

= 1	Laboratory Use Only
	Arrival Condition: Good Poor (see notes) Arrival Temperature: AGAT Job Number: 18 39 556
	Notes:
1	
- 1	

			F	: 902.4	68.8	3718	= F	902	468	.892	4	AGA	ΓJob) Nu	mbe	er:		8K	.34	S	180	0	_
Chain of Custody Recor	'd	Report Info	ormation									Not	es:										
Report Information	Ī	1. Name:	James O'Neill				R	ероі	t Fo	rma	t												
Company: GHD Limited			James.Oneill@ghd.com					Si	ngle														
Contact: James O'Neill		_	datanl				[⊢ Sá	ampl	e pe	r [Turr	aro	unc	l Tir	me l	Req	uire	d (TA	ıT)			
Address: 1118 Topsail Road			datanl@ghd.oom						ige			Pog	ular	ΤΛΤ		15 tc	- - 7 v	vorkir	ng da	11/6			
St. John's NL A1B 3N7							1		ultip ampl	le es pe	2r												
Phone 1-709-364-5353 Fax	1-709-364-5368	-					1		ige	оо _Б .	.	Rusi	h TA	Γ] 1 da -	-		□2	2 days	i		
Site # and/or Name: MARYSTOWN Sh		Regulatory	Requirements (Check):					Z E	cel] 3 da	ays						
Project #: 11178792-02		List Guidelines	on Report 🛮 Do Not List G	uidelines o	n Repo	ort		1.0	rma clud			Date	Ren	uire	d•								
AGAT Quotation #: GHD Standing Off	er	□ PIRI □ Tier 1	□ Gas ☑ Pot B	2 Coarse			ŀ					Date	Ticq		u		_						=
GHD PO #: TO FOLLOW		□Res		Fine				rinkin	_	ter S	ampl	e: [l Yes		ØN	0							
Invoice To	Same Yes ☑ / No □	☑ Com	□Lube][R	eg. No).: 	r 7		-	7	=	,				_	=		_	_
Invoice to	Same residy Noti	□ CCME	□ CDWQ			(BLE)																	
Company:		□Industri				POT/			<u>a</u>				er)										
Contact:		□ Comme			17	LEVEL			ailab		(e)		Canister)				삗						
Address:	1	□ Res/Pa □ Agricult			TIER	MO7		⊋	⊡ Available		ipett						LEAHATE						
-		□ FWAL	-	ERS.	3BC	IER I	<u> </u>	/BTE	Diss		and F		Sumi	Ĭ			"					E	<u>:</u>
Phone: Fax:		☐ Sedime	ent —	OR CONTAINERS	TICI	RCA T	IONA	TPH,			SIZE (Sieve and Pipette)		NO	MERCURY (Hg)			POSS.					R IY	2
	-] S	ATLA	ANTIC	RACT	D 1	otal		ZE (S		TANC	絽			R P					YEA	. X
			COMMENTS -		Ä.	K-ATL	X	ADDE	[LESI		ACTIO	Σ			FOR					FOR :	: 00
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER	TPH/BTEX - ATLANTIC RBCA	IPH/BIEX - ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BTEX) MTBE ONLY	METALS: □Total	70C	PARTICLE:	PAHS	TPH FRACTIONATION (Summa	OTHER:	OTHER:	OTHER:	HOLD					HOLD FOR 1 YEAR (Y/N)	HAZABDOILS (V/N)
MDSA-MW1-2018-SS1	2018/02/10 00:00	Soil	1 X 60 ML	1					Ø					Ø	_		Ø						
MDSA-MW1-2018-SS2	2018/02/10 00:00	Soil	1 X 60 ML	1					Ø					Ø			Ø	\Box				_	4
MDSA-MW2-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3	Ø														_		\vdash	4	\perp
MDSA-MW2-2018-SS5	2018/02/10 00:00	Soil	VARIOUS	3	Ø					Ш			_	_	_	_			_		\vdash	_	+
MDSA-BH4-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3	Ø						_	_				1	\sqcup	\vdash	4	\perp	- 1	+	+
MDSA-BH4-2018-SS5	2018/02/10 00:00	Soil	VARIOUS	3	Ø		_	-			_	_	+	+	-	-	\vdash	-	+	+		+	+
X		X	X				4				_	+	+	\vdash	-	-	\vdash		_	4	\vdash	+	+
X		X	X				_	_	-	Ш	_	+	_	+	+	₩	\vdash		+	+	\vdash	+	+
X		X	X		1		4	-	1		-	-	+	+	-	\vdash	\vdash	\vdash	+	+	\vdash	+	+
X		Х	X	-			_	_		\vdash	+	+	+	+	-	\vdash			+	+	+	+	+
X		X	X Apples Received By (Print Nathe):		<u> </u>	Ш			Date	/Time	_		4		_		ᆛ				_		
Samples Relinquished By (Print Name): Hubert Anderson	Date/Time 2018/		mmerkemen						a	41	01	18					L	Pag ——	ge <u>1</u>		of _1		



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395595

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 20, 2018

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 6

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395595

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

			-		•	•				
DATE RECEIVED: 2018-10-10								DATE REPORTI	ED: 2018-10-20	
			MSGB-BH4-	MSGB-BH4-	MSGB-BH3-	MSGB-BH3-	MSGB-BH2-	MSGB-BH2-	MSGB-BH1-	
		SAMPLE DESCRIPTION:	2018-SS4	2018-SS6	2018-SS1	2018-SS4	2018-SS3	2018-SS4	2018-SS4	
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	
		DATE SAMPLED:	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	
Parameter	Unit	G/S RDL	9614967	9614968	9614969	9614970	9614971	9614972	9614973	
Benzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	<0.03	
Toluene	mg/kg	0.04	<0.04	<0.04	< 0.04	<0.04	< 0.04	<0.04	<0.04	
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	<0.03	
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05	
C6-C10 (less BTEX)	mg/kg	3	22	22	<3	29	4	<3	<3	
>C10-C16 Hydrocarbons	mg/kg	15	776	695	<15	302	<15	62	<15	
>C16-C21 Hydrocarbons	mg/kg	15	514	447	<15	228	<15	69	<15	
>C21-C32 Hydrocarbons	mg/kg	15	82	73	<15	48	<15	17	<15	
Modified TPH (Tier 1)	mg/kg	20	1390	1240	<20	607	<20	148	<20	
Resemblance Comment			FOF	FOF	NR	FOF	GR	WFOF	NR	
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140	92	89	88	97	88	100	88	
Isobutylbenzene - VPH	%	60-140	117	115	109	115	112	122	82	
n-Dotriacontane - EPH	%	60-140	92	89	86	95	86	97	83	

RDL - Reported Detection Limit; G / S - Guideline / Standard

9614967-9614973 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



Certificate of Analysis

AGAT WORK ORDER: 18K395595

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

o =				57 <u></u>									
					Moistu	ıre							
DATE RECEIVED: 2018-10-10								[DATE REPORTI	ED: 2018-10-20			
				MSGB-BH4-	MSGB-BH4-	MSGB-BH3-	MSGB-BH3-	MSGB-BH2-	MSGB-BH2-	MSGB-BH1-			
		SAMPLE DESC	RIPTION:	2018-SS4	2018-SS6	2018-SS1	2018-SS4	2018-SS3	2018-SS4	2018-SS4			
		SAMP	LE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
		DATE S	AMPLED:	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02	2018-10-02			
Parameter	Unit	G/S	RDL	9614967	9614968	9614969	9614970	9614971	9614972	9614973			
% Moisture	%		0	6	13	5	17	8	11	4			

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Hus



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395595
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			Trac	e Or	gani	cs Ar	alys	is							
RPT Date: Oct 20, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits			ptable nits	Recovery	1 1 1 1 1	eptable mits
		ld		·			Value	Lower	Upper		Lower	Upper	Í	Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbo	ns in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	100%	60%	140%	103%	60%	140%			
Toluene	1	9615862	< 0.04	< 0.04	NA	< 0.04	110%	60%	140%	108%	60%	140%			
Ethylbenzene	1	9615862	< 0.03	< 0.03	NA	< 0.03	108%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9615862	< 0.05	< 0.05	NA	< 0.05	119%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9615862	< 3	< 3	NA	< 3	116%	60%	140%	122%	60%	140%	NA	30%	130%
>C10-C16 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	126%	60%	140%	95%	60%	140%	96%	30%	130%
>C16-C21 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	122%	60%	140%	95%	60%	140%	96%	30%	130%
>C21-C32 Hydrocarbons	1	9614973	< 15	< 15	NA	< 15	127%	60%	140%	95%	60%	140%	96%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Benzene	1	9614973	< 0.03	< 0.03	NA	< 0.03	87%	60%	140%	81%	60%	140%			
Toluene	1	9614973	< 0.04	< 0.04	NA	< 0.04	90%	60%	140%	70%	60%	140%			
Ethylbenzene	1	9614973	< 0.03	< 0.03	NA	< 0.03	93%	60%	140%	73%	60%	140%			
Xylene (Total)	1	9614973	< 0.05	< 0.05	NA	< 0.05	96%	60%	140%	75%	60%	140%			
C6-C10 (less BTEX)	1	9614973	< 3	< 3	NA	< 3	116%	60%	140%	103%	60%	140%	117%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

comy Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395595 PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL SAMPLING SITE:

SAMPLED BY:

		_	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



GHD Limited

James O'Neill

1-709-364-5353

St. John's NL A1B 3N7

TO FOLLOW

Site # and/or Name: MARYSTOWN SHIPYARD -MGSB HS

GHD Standing Offer

11178792-02

Fax: 1-709-364-5368

Same Yes ☑ / No □

Address: 1118 Topsail Road

Report Information

Company:

Contact:

Phone

Project #:

GHD PO #:

Invoice To

Company:

Contact:

Address:

AGAT Quotation #:

Report Information

2. Name: datanl

☐ List Guidelines on Report

☑ Tier 1 □ Gas

☑ Com ☐ Lube

□ PIRI

□ Res

□ Industrial

□ Res/Park

□ Agricultural ☐ FWAL

□ Commercial

1. Name: James O'Neill

Email: datanl@ghd.oom

☐ Fuel

Email: James.Oneill@ghd.com

Regulatory Requirements (Check):

□ CDWO

□ Other

Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

☑ Do Not List Guidelines on Report

☑ Pot

□ N/Pot

☐ Poor	(see	notes
477	7	

Laboratory Use Only

	NOTIONAL TH									Aı	riva	I Te	mpe	erat	ure:	2	-0	,1		_	2.:	> <	_	
P;	902.4	68.	871	8 =	F: 9	02.	468	.89	24	A	GAT	Job	Nur	nbe	er:		8	K	30	5	20	15	-	_
										I	lote	s:												
					Rej	port	Fo	rm	at															H
				-		Sai pai Mu	igle mplo ge iltiplo mplo	le		Ш									(TA)					
: Gui	delines or	n Repo	ort		7	pag Exc For	ge cel mat	t	.01	R	ush	TAT			1 d 3 d	-]2	days	8			
		·				Inc	lude	ed		Da	ate I	Requ	uirec	i: _										-
	Coarse Fine					king . No.		ter S	Samı	ple:	01	/es	I	ZΝα)									
	NUMBER OR CONTAINERS	TPH/BTEX - ATLANTIC RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BTEX)	MTBE ONLY	METALS: ☐ Total ☐ Diss ☐ Available	FOC	PARTICLE SIZE (Sieve and Pipette)	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)	отнея: MERCURY (Hg)	отнек:	отнея:	HOLD FOR POSS. LEAHATE							HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
	3	Ø																						
	3	Ø																						

Phone:	Fax:	□ Sedim	ent	CONTAINE	TLANTIC R	ANTIC RBCA TII	티	о то трн//	Total Dis)	E (Sieve ar			TIONATION (SI	MERCURY		0	POSS.					rear (Y/N)	(Y/N)
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX - A	TPH/BTEX - ATLA		MTBE (ADDED	MTBE ONLY		PARTICLE SIZI	PAHS	PCBs	TPH FRACTIO		OTHER:	این	HOLD FOR					HOLD FOR 1	HAZARDOUS
MSGB-BH4-2018-SS4	2018/02/10 00:00	Soil	VARIOUS	3	Ø					T	П				\neg		7			П			\top	
MSGB-BH4-2018-SS6	2018/02/10 00:00	Soil	VARIOUS	3											\neg	T	\top	T		\Box	\neg	\top	\Box	Г
MSGB-BH3-2018-SS1	2018/03/10 00:00	Soil	VARIOUS	3	Ø										\neg		\top					\neg	\Box	П
MSGB-BH3-2018-SS4	2018/03/10 00:00	Soil	VARIOUS	3						Т							7	1					17	П
MSGB-BH2-2018-SS3	2018/03/10 00:00	Soil	VARIOUS	3						П							\neg	1	\top	\Box	T		11	
MSGB-BH2-2018-SS4	2018/03/10 00:00	Soil	VARIOUS	3	0												\top	\top		П		7	†	Г
MSGB-BH1-2018-SS4	2018/03/10 00:00	Soil	VARIOUS	3											T		T	T		П		_	T	
Х		Х	X														\top		\top	\Box		\neg	\Box	
Х		Х	X					\neg	\neg								7	\top	_	\Box		_	+	
X		Х	X					1	\top						\dashv	7	7	+	\top	\vdash	\neg	_	+	
Х		Х	X		Ħ	T		7									\top			\Box	\top	\top	\Box	
Samples Relinquished By (Print Name):	Date/Time	Sar	ngles Received By (Print Name):		-				Date	/Time					_	_	_	\vdash		4				=

Hubert Anderson

Darro	1	of 1	
age		or _ '	



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K395631

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 19, 2018

PAGES (INCLUDING COVER): 13

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 13

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

				Av	anable Met	ais iii 30ii		
DATE RECEIVED: 2018-10-10								DATE REPORTED: 2018-10-19
			N	MFPA-BH3-2018	MFPA-BH3-2018	MFPA-BH4-2018	MFPA-BH4-2018	
		SAMPLE DES	CRIPTION:	-SS1	-SS2	-SS1	-SS3	
		SAM	PLE TYPE:	Soil	Soil	Soil	Soil	
		DATE	SAMPLED:	2018-10-04	2018-10-04	2018-10-04	2018-10-04	
Parameter	Unit	G/S	RDL	9615521	9615522	9615526	9615527	
Aluminum	mg/kg		10	32000	19600	11200	5400	
Antimony	mg/kg		1	<1	<1	<1	<1	
Arsenic	mg/kg		1	5	14	11	6	
Barium	mg/kg		5	20	79	238	35	
Beryllium	mg/kg		2	<2	<2	<2	<2	
Boron	mg/kg		2	<2	<2	2	<2	
Cadmium	mg/kg		0.3	<0.3	<0.3	0.4	<0.3	
Chromium	mg/kg		2	107	33	43	46	
Cobalt	mg/kg		1	34	23	18	6	
Copper	mg/kg		2	54	29	66	22	
Iron	mg/kg		50	22600	43400	32100	13300	
Lead	mg/kg		0.5	5.9	7.6	96.7	8.5	
Lithium	mg/kg		5	15	14	9	7	
Manganese	mg/kg		2	1240	1700	1840	642	
Molybdenum	mg/kg		2	<2	<2	<2	7	
Nickel	mg/kg		2	69	24	23	11	
Selenium	mg/kg		1	<1	<1	<1	<1	
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	
Strontium	mg/kg		5	67	26	29	22	
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	
Tin	mg/kg		2	<2	<2	<2	<2	
Uranium	mg/kg		0.1	0.1	0.2	0.3	0.3	
Vanadium	mg/kg		2	84	79	60	28	
Zinc	mg/kg		5	101	96	152	43	

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

9615521-9615527 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray



Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

CANADA A1E 6A8 TEL (709)747-8573

FAX (709 747-2139 http://www.agatlabs.com

St. John's, NL

57 Old Pennywell Road, Unit I

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Mercury Analysis in Soil

DATE RECEIVED: 2018-10-10								DATE REPORTED: 2018-10-19
				MFPA-BH3-2018	MFPA-BH3-2018	MFPA-BH4-2018	3 MFPA-BH4-2018	
		SAMPLE DES	CRIPTION:	-SS1	-SS2	-SS1	-SS3	
		SAM	PLE TYPE:	Soil	Soil	Soil	Soil	
		DATE	SAMPLED:	2018-10-04	2018-10-04	2018-10-04	2018-10-04	
Parameter	Unit	G/S	RDL	9615521	9615522	9615526	9615527	
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	

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

9615521-9615527 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:



CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

					•	,				
DATE RECEIVED: 2018-10-10							[DATE REPORT	ED: 2018-10-19	
			MFPA-BH3-2018	3 MFPA-BH3-2018	MFPA-BH4-2018	MFPA-BH4-2018	MFPA-BH2-2018	MFPA-BH2-2018	MFPA-BH1-2018	MFPA-MW1-
		SAMPLE DESCRIPTION:	-SS5	-SS6	-SS4	-SS6	-SS4	-SS6	-SS4	2018-SS5
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-03
Parameter	Unit	G/S RDL	9615523	9615525	9615528	9615529	9615530	9615531	9615532	9615533
Benzene	mg/kg	0.03	< 0.03	<0.03	< 0.03	<0.03	< 0.03	<0.03	< 0.03	< 0.03
Toluene	mg/kg	0.04	< 0.04	< 0.04	< 0.04	<0.04	< 0.04	< 0.04	< 0.04	< 0.04
Ethylbenzene	mg/kg	0.03	< 0.03	<0.03	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	mg/kg	3	49	<3	<3	12	<3	62	<3	44
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	<15	1320	64	109	<15	3660
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	<15	912	39	87	<15	2740
>C21-C32 Hydrocarbons	mg/kg	15	<15	<15	<15	176	53	102	<15	1200
Modified TPH (Tier 1)	mg/kg	20	49	<20	<20	2420	156	360	<20	7640
Resemblance Comment			GR	NR	NR	FOF	LOF+LOF	FOF+LOF	NR	FOF
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140	91	94	93	97	89	92	95	103
Isobutylbenzene - VPH	%	60-140	127	126	125	122	122	129	130	132
n-Dotriacontane - EPH	%	60-140	98	99	97	92	94	97	100	106

Certified By:

any Huj



CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-1	0			DATE REPORTED: 2018-10
			MFPA-MW1-	
	S	SAMPLE DESCRIPTION:	2018-SS7	
		SAMPLE TYPE:	Soil	
		DATE SAMPLED:	2018-10-03	
Parameter	Unit	G/S RDL	9615534	
Benzene	mg/kg	0.03	<0.03	
Toluene	mg/kg	0.04	<0.04	
Ethylbenzene	mg/kg	0.03	<0.03	
Xylene (Total)	mg/kg	0.05	<0.05	
C6-C10 (less BTEX)	mg/kg	3	<3	
>C10-C16 Hydrocarbons	mg/kg	15	170	
>C16-C21 Hydrocarbons	mg/kg	15	141	
>C21-C32 Hydrocarbons	mg/kg	15	111	
Modified TPH (Tier 1)	mg/kg	20	422	
Resemblance Comment			FOF+LOF	
Return to Baseline at C32			Υ	
Surrogate	Unit	Acceptable Limits		
Isobutylbenzene - EPH	%	60-140	93	
Isobutylbenzene - VPH	%	60-140	124	
n-Dotriacontane - EPH	%	60-140	99	

Certified By:

any Mus



Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

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

9615523 Discrepancy between results obtained for VPH and EPH. VPH vials tested and a fuel product is observed. EPH jar sampled in duplicate and no product seen.

Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

CLIENT NAME: GHD LIMITED

DATE RECEIVED: 2018-10-10

SAMPLING SITE:

WGF - Weathered Gasoline Fraction GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction FR - Product in Fuel Oil Range LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

9615525-9615534 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hus

DATE REPORTED: 2018-10-19

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



Certificate of Analysis

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

SAMPLING SITE:	SAMPLED BY:										
Moisture											
DATE RECEIVED: 2018-10-10									DATE REPORT	ED: 2018-10-19	
				MFPA-BH3-2018	3 MFPA-BH3-2018	3 MFPA-BH4-2018	3 MFPA-BH4-201	3 MFPA-BH2-2018	3 MFPA-BH2-2018	3 MFPA-BH1-2018	MFPA-MW1-
		SAMPLE DESCRIPTION:		-SS5	-SS6	-SS4	-SS6	-SS4	-SS6	-SS4	2018-SS5
		SAMPLI	E TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SA	MPLED:	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-04	2018-10-03
Parameter	Unit	G/S	RDL	9615523	9615525	9615528	9615529	9615530	9615531	9615532	9615533
% Moisture	%		0	13	9	9	9	8	14	12	12
				MFPA-MW1-							
		SAMPLE DESCR	RIPTION:	2018-SS7							
		SAMPLI	E TYPE:	Soil							
		DATE SA	MPLED:	2018-10-03							
Parameter	Unit	G/S	RDL	9615534							
% Moisture	%		0	13							

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

Certified By:



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K395631

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

	Soil Analysis														
RPT Date: Oct 19, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SP	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery		ptable nits	Recovery		eptable mits
		ld	·	·			Value	Lower	Upper	,	Lower Upper			Lower	Upper
Available Metals in Soil															
Aluminum	9615940		3830	3410	11.7%	< 10	118%	80%	120%	114%	80%	120%	NA	70%	130%
Antimony	9615940		<1	<1	NA	< 1	102%	80%	120%	116%	80%	120%	70%	70%	130%
Arsenic	9615940		7	6	13.7%	< 1	101%	80%	120%	102%	80%	120%	98%	70%	130%
Barium	9615940		87	73	17.3%	< 5	99%	80%	120%	101%	80%	120%	111%	70%	130%
Beryllium	9615940		<2	<2	NA	< 2	111%	80%	120%	114%	80%	120%	106%	70%	130%
Boron	9615940		<2	6	NA	< 2	116%	80%	120%	115%	80%	120%	101%	70%	130%
Cadmium	9615940		< 0.3	< 0.3	NA	< 0.3	99%	80%	120%	101%	80%	120%	99%	70%	130%
Chromium	9615940		11	8	NA	< 2	103%	80%	120%	104%	80%	120%	129%	70%	130%
Cobalt	9615940		6	5	8.2%	< 1	100%	80%	120%	101%	80%	120%	107%	70%	130%
Copper	9615940		18	15	19.0%	< 2	106%	80%	120%	106%	80%	120%	100%	70%	130%
Iron	9615940		8430	7110	17.0%	< 50	102%	80%	120%	116%	80%	120%	70%	70%	130%
Lead	9615940		15.3	11.2	NA	< 0.5	106%	80%	120%	107%	80%	120%	93%	70%	130%
Lithium	9615940		<5	<5	NA	< 5	111%	70%	130%	115%	70%	130%	115%	70%	130%
Manganese	9615940		1150	873	NA	< 2	118%	80%	120%	119%	80%	120%	111%	70%	130%
Molybdenum	9615940		<2	<2	NA	< 2	100%	80%	120%	104%	80%	120%	101%	70%	130%
Nickel	9615940		7	33	NA	< 2	101%	80%	120%	104%	80%	120%	NA	70%	130%
Selenium	9615940		<1	<1	NA	< 1	100%	80%	120%	103%	80%	120%	87%	70%	130%
Silver	9615940		<0.5	<0.5	NA	< 0.5	103%	80%	120%	105%	80%	120%	98%	70%	130%
Strontium	9615940		25	22	NA	< 5	114%	80%	120%	116%	80%	120%	130%	70%	130%
Thallium	9615940		<0.1	<0.1	NA	< 0.1	103%	80%	120%	103%	80%	120%	NA	70%	130%
Tin	9615940		<2	<2	NA	< 2	101%	80%	120%	100%	80%	120%	96%	70%	130%
Uranium	9615940		0.2	0.2	NA	< 0.1	102%	80%	120%	101%	80%	120%	99%	70%	130%
Vanadium	9615940		21	18	17.9%	< 2	101%	80%	120%	102%	80%	120%	113%	70%	130%
Zinc	9615940		48	54	11.7%	< 5	101%	80%	120%	101%	80%	120%	95%	70%	130%
Mercury Analysis in Soil															
Mercury	1 9	9615884	<0.05	<0.05	NA	< 0.05	115%	70%	130%		70%	130%	105%	70%	130%

Certified By:

.(

AGAT QUALITY ASSURANCE REPORT (V1)

Page 8 of 13



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395631
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

Trace Organics Analysis															
RPT Date: Oct 19, 2018				DUPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery	Lin	ptable nits	Recovery	منا ا	ptable nits
		lu		·			value	Lower Upper			Lower Upper		·	Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbo	ons in Soil	(Version 3	s.1) - Field	Preserve	d										
Benzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	121%	60%	140%	109%	60%	140%			
Toluene	1	9584397	< 0.04	< 0.04	NA	< 0.04	128%	60%	140%	114%	60%	140%			
Ethylbenzene	1	9584397	< 0.03	< 0.03	NA	< 0.03	122%	60%	140%	105%	60%	140%			
Xylene (Total)	1	9584397	< 0.05	< 0.05	NA	< 0.05	126%	60%	140%	107%	60%	140%			
C6-C10 (less BTEX)	1	9584397	< 3	< 3	NA	< 3	127%	60%	140%	101%	60%	140%	115%	30%	130%
>C10-C16 Hydrocarbons	1	9616181	< 15	< 15	NA	< 15	103%	60%	140%	94%	60%	140%	108%	30%	130%
>C16-C21 Hydrocarbons	1	9616181	< 15	< 15	NA	< 15	98%	60%	140%	94%	60%	140%	108%	30%	130%
>C21-C32 Hydrocarbons	1	9616181	20	18	NA	< 15	97%	60%	140%	94%	60%	140%	108%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395631
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	ы.					
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE					
Soil Analysis								
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS					
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS					
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS					
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA					

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K395631
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis		·	•
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC

Report Information

Dartmouth, NS ВЗВ

webearth.agatlabs.com · www.agatlabse

V

P: 902,468.8718 * F: 902,468.8

Unit 122 11 Morris Drive

1M: con	n 4_	Arrival Condition:															
per		Tu	ırna	aroı	ınd	Tin	ne l	Req	uir	ed	(TAT	Γ)					187
s pe	r		Regular TAT														
		Date Required:															
r Sa	mp	le:	۱.	/es		☑ No)										
	(TICLE SIZE (Sieve and Pipette)	SI	38	FRACTIONATION (Summa Canister)	IER: MERCURY (Hg)	ER:	ER:	LD FOR POSS. LEAHATE					V		D FOR 1 YEAR (Y/N)	ZARDOUS (Y/N)	

Chain	of	Custody	Record	
2 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	£			

•																				- 1
Report Information		1. Name:	James O'Neill				Re	por	t For	mat										
Company: GHD Limited		Email: 🛁	James.Oneill@ghd.com					Si	nole							_				
Contact: James O'Neill		2. Name:	datanl						ngle ımple	per	lΤ	urna	arou	ınd	Time	e Re	equired (TA	 Г)		
Address: 1118 Topsail Road			datanl@ghd.oom					•	ge		Ш									
St. John's NL A1B 3N7		35						✓ Multiple Samples per					iar i	AI	СП	10 /	working day	S		
Phone 1-709-364-5353 Fax: 1-	709-364-5368						page				R	lush	TAT		\Box 1	. day	□2	days		
Site # and/or Name: MARYSTOWN SHIP		Regulatory	Requirements (Check):					, Ex	cel			□3 days								
Project #: 11178792-02		List Guidelines	on Report 🖸 Do Not List	Guidelines o	n Repo	ort	-		rmat clude				D	.:	27					
AGAT Quotation #: GHD Standing Offer		□ PIRI □ Tier 1	□ Gas ☑ Pot	☑ Coarse								ate I	Requ	ıırea						
GHD PO #: TO FOLLOW		□Res		☐ Fine			Dr	inkin	g Wat	er Sai	nple:	Π,	Yes	E	oN E					
	ame Yes ☑ / No □	☑ Com	Lube				Re	g. No	-1_											
Company: Contact: Address: Phone: Fax: SAMPLE IDENTIFICATION		□ CCME □ Industri □ Comme □ Res/Pa □ Agricult □ FWAL □ Sedime	rcial 🗆 Other rk ural	NUMBER OR CONTAINERS	TPH/BTEX - ATLANTIC RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE ONLY	METALS: ☐ Total ☐ Diss ☐ Available	FOC	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)	отнек: MERCURY (Hg)	OTHER:	OTHER: HOLD FOR POSS 1 FAHATE	S S S S S S S S S S S S S S S S S S S		HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
MFPA-BH3-2018-SS1	2018/04/10 00:00	Soil	1 X 60 ML	1			H 2			ш г	- -	1	H	0	0 0	0 T			<u> </u>	╁
MFPA-BH3-2018-SS2	2018/04/10 00:00	Soil	1 X 60 ML	1			-	+		+	+	H			-			\vdash	+	+
MFPA-BH3-2018-SS5	2018/04/10 00:00	Soil	VARIOUS	3	Ø		_	+	H		╁	\vdash			7	+	+	\vdash		+
MFPA-BH3-2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3		7	_	\top	1	7	+					+	+			
MFPA-BH4-2018-SS1	2018/04/10 00:00	Soil	1 X 60 ML	1	Ī	\neg	_	+		-	1		H		-	Ø	1	\vdash	\neg	+
MFPA-BH4-2018-SS3	2018/04/10 00:00	sOIL	1 X 60 ML	1				\top				Т				V	-			+
MFPA-BH4-2018-SS4	2018/04/10 00:00	Soil	VARIOUS	3				T			+					+				1
MFPA-BH4-2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3	Ø				\Box			F		\neg						
MFPA-BH2-2018-SS4	2018/04/10 00:00	sOIL	VARIOUS	3	Ø				\Box											\top
MFPA-BH2-2018-SS6	2018/04/10 00:00	Soil	VARIOUS	3	Ø			1				П								\top

Kenny

Samples Relinquished By (Sign)

2018/04/10 00:00

SoiL

08:00

VARIOUS

MFPA-BH1-2018-SS4

Samples Relinquished By (Print Name):

Hubert Anderson

Document ID: DIV-133-1502-001

of 2 1

Page 1



Dartmouth, NS B3B 1M2

Unit 122 • 11 Morris Drive

webearth.agatlabs.com • www.agatlabscom

Laboratory Use C	nly		
Arrival Condition:	Good	☐ Poor (see notes)	
Arrival Temperature):		
AGAT Job Number:			
Notes:			
Turnaround Time	Penuired	(TAT)	
	Arrival Condition: Arrival Temperature AGAT Job Number: Notes:	Arrival Temperature:AGAT Job Number:Notes:	Arrival Condition: Good Poor (see notes) Arrival Temperature: AGAT Job Number:

		Р	902.4	68.87	718 =	F: 9	02.4	68.8 <u>9</u>	24	AG	AT.	Job	Nur	mbe	r: _						
Chain of Custody Record	Report Info	ormation									lotes										
Report Information	1. Name:	James O'Neill				Re	port	Form	at												
Company: GHD Limited		James.Oneill@ghd.com					Sinc	مام													
Contact: James O'Neill	2. Name:	datanl						gle iple p	er	Tu	ırna	arou	ınd	Tin	ne R	equi	ired (TAT)			
Address: 1118 Topsail Road		datanl@ghd.gom					pag			ll							rking				
St. John's NL A1B 3N7		C				√	San	tiple iples j	oer	ll											
Phone 1-709-364-5353 Fax: 1-709-364-5368			_		=		pag	е		Ri	ısh	TAT			1 da	-	L] 2 da	iys		
Site # and/or Name: MARYSTOWN SHIPYARD - MFPA		y Requirements (Check):		. D		V	Exce	el nat						□.	3 da	ys					
Project #: 11178792-02	☐ List Guideline	s on Report 🗵 Do Not List G	ngelines o	n Keport				uded		_{Da}	ate F	Requ	ired	d:							
AGAT Quotation #: GHD Standing Offer	☑ Tier 1	□ Gas ☑ Pot ☑	l Coarse			D.:	امدادا	4/	C												
GHD PO #: TO FOLLOW	□ Res	□ Fuel □ N/Pot □ Lube	Fine			10	. No.:	Water	sam	pie:	ЦΥ	res	Ŀ	☑ No)						
Invoice To Same Yes ☑ / No □						T		1	T						\equiv	T		=	1	П	T
Company:	□ CCME □ Industr	□ CDWQ	-		OTABLE		П												1		
Contact:	□ Comme		· 6		ÆL (PC		Н	able				Canister)				ш					
Contact:	□ Res/Pa			TIER 1	OW LE			☑ Available	ette)			Can				¥					
Address:	☐ Agricult☐ FWAL	tural	SS S	3CA T	- L	EX)		\[\]	d Pip			mma	Hg)			LEAHATE					
Phone: Fax:	□ Sedim	ent	CONTAINERS	IC RE	CA TIE	PF		□ Diss	ve an			nS) N	RY (SS.					Ž
Trione.			JUON	LANT	TIC RB	10			(Sie			IATIO	SCU			POSS.					EAR (
		001415170		- A	ATLAN X FR/	DED	ONLY	[]	SIZE			STION	MEF			NG.					R 1 Y
SAMPLE IDENTIFICATION DATE/TIME SAMPLE	D SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX - ATLANTIC RBCA	TPH/BTEX-ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE) TPH/BTEX FRACTIONATION	МТВЕ (АDDED ТО ТРН/ВТЕХ)	MTBE ON	METALS: □ Total FOC	PARTICLE SIZE (Sieve and Pipette)	PAHS	PCBs	TPH FRACTIONATION (Summa	отнея: MERCURY (Hg)	OTHER:	OTHER:	HOLD	1.4				HOLD FOR 1 YEAR (Y/N) HAZARDOUS (Y/N)
MFPA-MW1-2018-SS5 2018/03/10 00:00	Soil	VARIOUS	3	Ø																	
MFPA-MW1-2018-SS7 2018/03/10 00:00	Soil	VARIOUS	3	Ø																	
					4			_ _		Щ								\perp	_		_
			-		-	+	\vdash		-	_		_			_	_		\dashv	+		_
	_		-		+	+	\vdash		-						=	+	+		+		+
			+	\vdash	+	+	H		+	-				Н	\dashv	+	+	\rightarrow	+	\vdash	+
			1	\vdash	+	+	H	-1-	\vdash					Н		+	+		+		
						\dagger	Ħ	-1-									+		+		_
																\top					
Samples Relinquished By (Print Name): Date/Time		sples Received By (Print (Marne):					1	ate/ ime								T		_		2	
Hubert Anderson Zor	8/10/10	moles Received By (Sign)						06	10	11	V					1	Page_	2	of _		_



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02 Marystown Shipyard - MDSA

AGAT WORK ORDER: 18K397501

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 24, 2018

PAGES (INCLUDING COVER): 12

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 12

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397501

PROJECT: 11178792-02 Marystown Shipyard - MDSA

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

Available Metals III Soli													
DATE RECEIVED: 2018-10-16	3								DATE REPORTE	D: 2018-10-24			
Parameter	Unit	SAMPLE DESCRIP SAMPLE 1 DATE SAMF G/S R	ΓΙΟΝ: ϓΡΕ:	MDSA-BH1- 2018-SS1 Soil 2018-10-09 9626499	MDSA-BH1- 2018-SS2 Soil 2018-10-09 9626518	MDSA-BH2- 2018-SS1 Soil 2018-10-09 9626519	MDSA-BH2- 2018-SS2 Soil 2018-10-09 9626520	MDSA-BH3- 2018-SS1 Soil 2018-10-10 9626534	MDSA-BH3- 2018-SS2 Soil 2018-10-10 9626535				
Aluminum	mg/kg		0	19600	9840	15900	8920	10000	7190				
Antimony	mg/kg		1	<1	<1	<1	<1	<1	<1				
Arsenic	mg/kg		1	12	11	11	11	11	11				
Barium	mg/kg		5	48	37	39	52	37	56				
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2				
Boron	mg/kg		2	<2	<2	<2	<2	<2	<2				
Cadmium	mg/kg	C	.3	<0.3	< 0.3	<0.3	<0.3	0.3	<0.3				
Chromium	mg/kg		2	37	13	33	12	20	13				
Cobalt	mg/kg		1	17	9	15	7	11	7				
Copper	mg/kg		2	40	17	33	14	78	19				
Iron	mg/kg	Ę	50	23600	12700	18500	12900	12100	10000				
Lead	mg/kg	C	.5	19.6	6.4	7.3	14.2	6.7	16.1				
Lithium	mg/kg		5	14	12	13	7	11	7				
Manganese	mg/kg		2	1060	671	865	812	721	752				
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2				
Nickel	mg/kg		2	23	11	22	9	27	9				
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1				
Silver	mg/kg		.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				
Strontium	mg/kg		5	29	20	26	17	19	18				
Thallium	mg/kg		.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2				
Uranium	mg/kg		.1	0.3	0.4	0.4	0.4	0.3	0.4				
Vanadium	mg/kg		2	73	45	66	36	51	37				
Zinc	mg/kg		5	83	50	62	50	87	51				

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

9626499-9626535 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray



Certificate of Analysis

AGAT WORK ORDER: 18K397501

PROJECT: 11178792-02 Marystown Shipyard - MDSA

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury Analysis in Soil

Mercury Analysis III Soli												
DATE RECEIVED: 2018-10-16	RECEIVED: 2018-10-16 DATE REPORTED: 2018-10-24											
				MDSA-BH1-	MDSA-BH1-	MDSA-BH2-	MDSA-BH2-	MDSA-BH3-	MDSA-BH3-			
		SAMPLE DES	CRIPTION:	2018-SS1	2018-SS2	2018-SS1	2018-SS2	2018-SS1	2018-SS2			
		SAM	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil			
		DATE	SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-10	2018-10-10			
Parameter	Unit	G/S	RDL	9626499	9626518	9626519	9626520	9626534	9626535			
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			

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

9626499-9626535 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Josephan Coaghtry



Certificate of Analysis

AGAT WORK ORDER: 18K397501

PROJECT: 11178792-02 Marystown Shipyard - MDSA

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

SAMPLING SITE:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved													
ATE RECEIVED: 2018-10-16 DATE REPORTED: 2018-10-24													
			MDSA-BH2-	MDSA-BH2-	MDSA-BH3-	MDSA-BH3-	MDSA-BH5-	MDSA-BH5-	MDSA-BH6-	MDSA-BH6-			
		SAMPLE DESCRIPTION:	2018-SS4	2018-SS5	2018-SS4	2018-SS5	2018-SS3	2018-SS4	2018-SS3	2018-SS4			
		SAMPLE TYPE:	Soil										
		DATE SAMPLED:	2018-10-09	2018-10-09	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10			
Parameter	Unit	G/S RDL	9626522	9626526	9626537	9626538	9626539	9626540	9626541	9626542			
Benzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03			
Toluene	mg/kg	0.04	< 0.04	< 0.04	<0.04	<0.04	< 0.04	< 0.04	< 0.04	<0.04			
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03			
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05			
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3			
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	<15	<15	<15	<15	<15	<15			
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	<15	20	<15	<15	<15	<15			
>C21-C32 Hydrocarbons	mg/kg	15	25	27	26	163	21	25	17	73			
Modified TPH (Tier 1)	mg/kg	20	25	27	26	183	21	25	<20	73			
Resemblance Comment			LOF										
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ			
Surrogate	Unit	Acceptable Limits											
Isobutylbenzene - EPH	%	60-140	89	93	95	95	98	97	97	93			
Isobutylbenzene - VPH	%	60-140	80	81	88	84	86	86	101	98			
n-Dotriacontane - EPH	%	60-140	104	106	106	107	110	109	104	107			

Certified By:



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397501

PROJECT: 11178792-02 Marystown Shipyard - MDSA

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

					,
DATE RECEIVED: 2018-10-16					DATE REPORTED: 2018-10-24
			MDSA-MW3-	MDSA-MW3-	
		SAMPLE DESCRIPTION:	2018-SS2	2018-SS4	
		SAMPLE TYPE:	Soil	Soil	
		DATE SAMPLED:	2018-10-10	2018-10-10	
Parameter	Unit	G/S RDL	9626543	9626544	
Benzene	mg/kg	0.03	<0.03	< 0.03	
Toluene	mg/kg	0.04	<0.04	< 0.04	
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	
C6-C10 (less BTEX)	mg/kg	3	<3	<3	
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	
>C21-C32 Hydrocarbons	mg/kg	15	106	79	
Modified TPH (Tier 1)	mg/kg	20	106	79	
Resemblance Comment			LOF	LOF	
Return to Baseline at C32			Υ	Υ	
Surrogate	Unit	Acceptable Limits			
Isobutylbenzene - EPH	%	60-140	96	95	
Isobutylbenzene - VPH	%	60-140	95	97	
n-Dotriacontane - EPH	%	60-140	112	111	

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

9626522-9626544 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

my Hu



Certificate of Analysis

AGAT WORK ORDER: 18K397501

PROJECT: 11178792-02 Marystown Shipyard - MDSA

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

Parameter

% Moisture

SAMPLING SITE:

Moisture DATE RECEIVED: 2018-10-16 **DATE REPORTED: 2018-10-24** MDSA-BH2-MDSA-BH2-MDSA-BH3-MDSA-BH3-MDSA-BH5-MDSA-BH5-MDSA-BH6-MDSA-BH6-SAMPLE DESCRIPTION: 2018-SS4 2018-SS5 2018-SS4 2018-SS5 2018-SS3 2018-SS4 2018-SS3 2018-SS4 SAMPLE TYPE: Soil Soil Soil Soil Soil Soil Soil Soil DATE SAMPLED: 2018-10-09 2018-10-09 2018-10-10 2018-10-10 2018-10-10 2018-10-10 2018-10-10 2018-10-10 Unit 9626522 9626526 9626537 9626538 9626539 9626540 9626541 9626542 Parameter G/S **RDL** % Moisture % 10 8 MDSA-MW3-MDSA-MW3-SAMPLE DESCRIPTION: 2018-SS2 2018-SS4 SAMPLE TYPE: Soil Soil

2018-10-10

9626544

2018-10-10

9626543

DATE SAMPLED:

RDL

G/S

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

Unit

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Mus



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397501
PROJECT: 11178792-02 Marystown Shipyard - MDSA ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

Soil Analysis															
RPT Date: Oct 24, 2018			С	UPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		eptable mits	Recovery	Lir	ptable nits	Recovery	Lir	ptable nits
		ld	·	·			Value	Lower	Upper	ĺ	Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9641128		6820	7420	8.3%	< 10	117%	80%	120%	116%	80%	120%	121%	70%	130%
Antimony	9641128		1	2	NA	< 1	99%	80%	120%	106%	80%	120%	103%	70%	130%
Arsenic	9641128		7	8	12.2%	< 1	108%	80%	120%	100%	80%	120%	117%	70%	130%
Barium	9641128		62	65	6.0%	< 5	106%	80%	120%	97%	80%	120%	123%	70%	130%
Beryllium	9641128		<2	<2	NA	< 2	110%	80%	120%	101%	80%	120%	122%	70%	130%
Boron	9641128		<2	3	NA	< 2	101%	80%	120%	98%	80%	120%	119%	70%	130%
Cadmium	9641128		< 0.3	< 0.3	NA	< 0.3	111%	80%	120%	99%	80%	120%	117%	70%	130%
Chromium	9641128		16	18	7.9%	< 2	108%	80%	120%	97%	80%	120%	119%	70%	130%
Cobalt	9641128		4	5	NA	< 1	109%	80%	120%	102%	80%	120%	125%	70%	130%
Copper	9641128		52	51	0.7%	< 2	111%	80%	120%	101%	80%	120%	106%	70%	130%
Iron	9641128		7530	9170	19.7%	< 50	110%	80%	120%	96%	80%	120%	119%	70%	130%
Lead	9641128		13.2	14.5	9.1%	< 0.5	115%	80%	120%	102%	80%	120%	114%	70%	130%
Lithium	9641128		<5	6	NA	< 5	110%	70%	130%	103%	70%	130%	122%	70%	130%
Manganese	9641128		149	154	3.3%	< 2	108%	80%	120%	99%	80%	120%	121%	70%	130%
Molybdenum	9641128		<2	<2	NA	< 2	106%	80%	120%	102%	80%	120%	127%	70%	130%
Nickel	9641128		9	9	NA	< 2	111%	80%	120%	95%	80%	120%	119%	70%	130%
Selenium	9641128		<1	<1	NA	< 1	104%	80%	120%	99%	80%	120%	116%	70%	130%
Silver	9641128		< 0.5	< 0.5	NA	< 0.5	109%	80%	120%	105%	80%	120%	130%	70%	130%
Strontium	9641128		13	14	NA	< 5	120%	80%	120%	109%	80%	120%	NA	70%	130%
Thallium	9641128		<0.1	<0.1	NA	< 0.1	111%	80%	120%	103%	80%	120%	87%	70%	130%
Tin	9641128		< 2	< 2	NA	< 2	105%	80%	120%	97%	80%	120%	118%	70%	130%
Uranium	9641128		0.6	0.5	10.4%	< 0.1	109%	80%	120%	99%	80%	120%	123%	70%	130%
Vanadium	9641128		31	35	11.4%	< 2	105%	80%	120%	96%	80%	120%	124%	70%	130%
Zinc	9641128		56	61	8.7%	< 5	107%	80%	120%	94%	80%	120%	123%	70%	130%
Mercury Analysis in Soil															
Mercury	1 :	9634372	<0.05	< 0.05	NA	< 0.05	88%	70%	130%		70%	130%	72%	70%	130%

Certified By:

Joseph Cought

AGAT QUALITY ASSURANCE REPORT (V1)

Page 7 of 12



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397501
PROJECT: 11178792-02 Marystown Shipyard - MDSA ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

Trace Organics Analysis															
RPT Date: Oct 24, 2018				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery	Lin	ptable nits	Recovery	Lie	ptable nits
		lu lu	Dup #1 Dup #2 RPD			value	Lower	Upper		Lower Upper			Lower	Upper	
Atlantic RBCA Tier 1 Hydrocarbor	ns in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9629306	< 0.005	< 0.005	0	< 0.03	73%	60%	140%	63%	60%	140%			
Toluene	1	9629306	< 0.025	< 0.025	0	< 0.04	77%	60%	140%	66%	60%	140%			
Ethylbenzene	1	9629306	<0.01	< 0.01	0	< 0.03	79%	60%	140%	68%	60%	140%			
Xylene (Total)	1	9629306	< 0.05	< 0.05	0	< 0.05	82%	60%	140%	70%	60%	140%			
C6-C10 (less BTEX)	1	9629306	<3	<3	0	< 3	114%	60%	140%	116%	60%	140%	117%	30%	130%
>C10-C16 Hydrocarbons	1	9626743	< 15	< 15	NA	< 15	129%	60%	140%	94%	60%	140%	125%	30%	130%
>C16-C21 Hydrocarbons	1	9626743	35	42	NA	< 15	123%	60%	140%	94%	60%	140%	125%	30%	130%
>C21-C32 Hydrocarbons	1	9626743	20	25	NA	< 15	133%	60%	140%	94%	60%	140%	125%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Atlantic RRCA T	ier 1 Hydrocarbon	e in Soil (Version	3.1) - Field Preserved

Benzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	113%	60%	140%	89%	60%	140%			
Toluene	1	9626541	< 0.04	< 0.04	NA	< 0.04	122%	60%	140%	91%	60%	140%			
Ethylbenzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	120%	60%	140%	89%	60%	140%			
Xylene (Total)	1	9626541	< 0.05	< 0.05	NA	< 0.05	125%	60%	140%	93%	60%	140%			
C6-C10 (less BTEX)	1	9626541	< 3	< 3	NA	< 3	118%	60%	140%	113%	60%	140%	120%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397501
PROJECT: 11178792-02 Marystown Shipyard - MDSA ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397501
PROJECT: 11178792-02 Marystown Shipyard - MDSA ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE				
Trace Organics Analysis		·	•				
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID				
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION				
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID				
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
% Moisture		Calculation	GRAVIMETRIC				



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902.468.8718 • F: 902.468.8924

Laboratory Use Only
Arrival Condition: Good Poor (see notes)
Arrival Temperature: 25 63 5-1
AGAT Job Number: 397501
Notes:

Chain of Custody Record		Report Information								tes:	0 140	iiiibe							=			
Report Information		1 Name:	James O'Neill				R	epor	Form	at												
Company: GHD Limited			James.Oneill@ghd.com					0.														
Contact: James O'Neill		-	datanl					⊐ Sir Sa	igle mple p	er	Tu	naro	nunc	d Tin	ne R	equir	ed (T	ΔΤ)				
Address: 1118 Topsail Road		2. Namo:	datanl@ghd.oom					pa														
St. John's NL A1B 3N7		Elinani g						MI SO	ıltiple mples	nor	Ke	guiar	IAI	¥	010	/ work	7 working days					
Phone 1-709-364-5353 Fax: 1	-709-364-5368					=		pa		pe ₁	Ru	sh TA	T		1 day	-		2 day	S			
Site # and/or Name: MARYSTOWN SHIP		Regulatory	Requirements (Check):	1				7 Ex	cel		□3 days											
Project #: 11178792-02		☐ List Guidelines	on Report 🗹 Do Not List	Guidelines o	n Repo	rt		_ F0	mat luded		Date Required:											
AGAT Quotation #: GHD Standing Offer	- th.	□ PIRI ☑ Tier 1	□ Gas ☑ Pot	☑ Coarse			<u> </u>				Dat	е ке	quire	u.								
GHD PO #: TO FOLLOW		□ Res		□ Fine			11		Water	Samp	le:	□Yes		☑ No)							
	Same Yes ☑ / No ☐	☑ Com	□Lube				Re	eg. No										==_				
Thivoice to	sums 100 = / 110 =	□ CCME	□ CDWQ			(BLE)																
Company:		□ Industria				(POTA			<u>o</u>			5	;									
Contact:		☐ Comme			닌	LEVEL			ailab	(e)		anict				븯						
Address:		□ Res/ Pai			TER	MOI		\$	⊡ Available	ipett		2			5	Ž	П					
		□ FWAL	-	- S	3BCA	<u> </u>	NO.	9		and P			Ę		!	븨				9	,	
Phone: Fax:		□ Sedime	nt	CONTAINERS	ATLANTIC RBCA	BCA T	ONA	HA	□ Diss	SIZE (Sieve and Pipette)		N N	MERCURY (Hg)		5	POSS. LEAHATE				\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		
-					TLAN	NTICE	ACTI	2	otal	E (Si		NATI	S			조 기				YEAF	3	
		1	COMMENTS -	3 OR		-ATLA	X	NE POR				L S	B			FOR				DR 1	,	
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER	гРН/ВТЕХ-	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MIBE (ADDED 10 IPH/BIEX) MTBE ONLY	METALS: Total	PARTICLE	PAHs	PCBs TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER	HOLD				HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)	
					르	直	를 :	ΣΣ		P. P.	P.A	S E	+	_	_	_	1	1		ᆜ⋍	<u> </u>	
MDSA-BH1-2018-SS1	2018/09/10 00:00	Soil	VARIOUS	入		-	_		Ø	\vdash	-1	_	✓	-		Ø	-	_		_	-	
MDSA-BH1-2018-SS2	2018/09/10 00:00	Soil	VARIOUS	2		-	-			\vdash	-1	4		_		Ø	\vdash	_		_	-	
MDSA-BH2-2018-SS1	2018/09/10 00:00	Soil	VARIOUS	2		-	-			\vdash	_	+	<u> </u>	-			1	+	-	+	+	
MDSA-BH2-2018-SS2	2018/09/10 00:00	Soil	VARIOUS	<u> </u>			-	+		\vdash	-	+	V	-		Ø	\vdash	+	-	+	+	
MDSA-BH2-2018-SS4	2018/09/10 00:00	Soil	VARIOUS	3	Ø	-	-	-		+	-	+	+			+	\vdash	+-	\vdash	+	+	
MDSA-BH2-2018-SS5	2018/09/10 00:00	Soil	VARIOUS	3	Ø	-	-			+	-	+	+			_	+	_		+	+	
MDSA-BH3-2018-SS1	2018/10/10 00:00	Soil	VARIOUS	31	Н	-+	+	-		\vdash	-	-		-	_		+	+	-	+	+	
MDSA-BH3-2018-SS2	2018/10/10 00:00	Soil	VARIOUS	3_	Н	-1	-	-		+	-	-	Ø	-		Ø	++	+	-	_	+	
MDSA-BH3-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3		-	-	-		1-1	-	+	+		\vdash	+	-	+	-	+	+-	
MDSA-BH3-2018-SS5	2018/10/10 00:00	Soil	VARIOUS	3	Ø	_	4	-		\vdash	-	+		1	\vdash	+	-	+	\vdash	-	-	
MDSA-BH5-2018-SS3	2018/10/10 00:00	Soil	VARIOUS	3	Ø				Date/Time			4		<u> </u>	Ш	\perp						
Samples Relinquished By (Print Name): Robert Perry	1916/10		ples Received By (Print/Kame):	~					Date/Time	116	H	5				P	age <u>1</u>		of _2			
Samples Relinquished By (Sign);	Date/fime	Sam	ples Received By (Sign):						Date/Time	131	0	•										



GGGT Laboratories

Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

Laboratory Use Only

rival Condition:	Good	☐ Poor (see notes)
rival Temperature	25	6.3,5-1

		Joracc		: 902.4	168.	8718	3 = F	: 902	.468.	892								- 3			7 -1	
Chain of Custody Record		Report Info	ormation									Note		rivai	TIDO	/1.	_					
Report Information Company: GHD Limited	Í	1. Name:	James O'Neill				R	epor			- 11											
Contact: James O'Neill			James.Oneill@ghd.com datanl			_		Si	ngle imple	nor	H											
Address: 1118 Topsail Road		page					hei		Turnaround Time Required (TAT)													
St. John's NL A1B 3N7		Multiple)	- 11	Regular TAT ☑ 5 to 7 working days													
	700 264 5269	Samples per page					r	Rush TAT □ 1 day □ 2 days														
	-709-364-5368	Pagulatary Paguiroments (Chack):										3 da	-			- , -						
Site # and/or Name: MARYSTOWN SHIP	YARD - MDSA	☐ List Guidelines on Report ☐ Do Not List Guidelines on Report ☐ Format																				
Project #: 11178792-02		□ PIRI Included						Date	Requ	uirec	d: "				_							
AGAT Quotation #: GHD Standing Offer		☑ Tier 1		Coarse	!			rinkin	s Mat	~ Ca					⊒ No				_	_	_	
GHD PO #: TO FOLLOW		□ Res ☑ Com	□ Fuel □ N/Pot □ Lube] Fine			10.1	eg. No	_	er Sa	пріє	. ப	165		ži NO	,						
Invoice To	Same Yes ☑ / No □	EI COIII	□ Lube				1	Ť		_	Ŧ	T	7					_		$\overline{}$	$\overline{}$	
Company:		□ CCME □ Industr				. (POTABLE			<u>a</u>				(er)									
Contact:		□ Comme □ Res/Pa			4	LEVEL	П		⊡ Available		(E)		anist				빌					
Address:		□ Agricult			THE	- LOW		₽	□ A		jbet		na C	<u></u>			¥					
Phone: Fax:		□ FWAL □ Sedim	ent	ONTAINERS	ANTIC RBCA	IC RBCA TIER I	CTIONATION	то тРН/вте	al 🗆 Diss		(Sieve and F		ATION (Sum	MERCURY (Hg)			POSS. LE					EAR (Y/N)
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR CONTAINERS	TPH/BTEX - ATLANTIC RBCA TIER	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BTEX) MTBE ONLY	METALS: □ Total	FOC	PARTICLE SIZE (Sieve and Pipette)	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER: MER	OTHER:	OTHER:	HOLD FOR POSS. LEAHATE					HOLD FOR 1 YEAR (Y/N) HAZARDOUS (Y/N)
MDSA-BH5-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3	Ø																	
MDSA-BH6-2018-SS3	2018/10/10 00:00	Soil	VARIOUS	3	Ø																	
MDSA-BH6-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3	Ø												\Box		Ш			
MDSA-MW3-2018-SS2	2018/10/10 00:00	Soil	VARIOUS	3	Ø																	
MDSA-MW3-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3	Ø				\vdash		+	-	-				+	-	\vdash	-	+	
					1		\dashv				t	۲			$\overline{}$		\forall		H		\vdash	
								1														
							_			\	\downarrow							_		\rightarrow	\downarrow	
							-		Н		-	\rightarrow	_				+	-	-	_	4	\
Samples Relinquished By (Print Name):	Date/Time	/ Sar	nples Received By Print Name)		/	\sim			Date/T:	me			-				4	_				1
Robert Perry	10/16/	12018	I	_					10	11	01	15	1					Page		of	2	
Samples Relinquished By (Sign):	Date/Time	Sar	nples Received By (Sign):						Date/T	me /	3 /	. 15	V									



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02 Marystown Shipyard - MSBL

AGAT WORK ORDER: 18K397519

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 24, 2018

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 10

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397519

PROJECT: 11178792-02 Marystown Shipyard - MSBL

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

				A	valiable Metals	111 3011
DATE RECEIVED: 2018-10-16						DATE REPORTED: 2018-10-24
				MSBL-MW2-	MSBL-BH4-2018	
		SAMPLE DESCR	RIPTION:	2018-SS1	-SS1	
		SAMPL	E TYPE:	Soil	Soil	
		DATE SA	MPLED:	2018-10-04	2018-10-09	
Parameter	Unit	G/S	RDL	9626709	9626723	
Aluminum	mg/kg		10	10800	11400	
Antimony	mg/kg		1	<1	<1	
Arsenic	mg/kg		1	8	9	
Barium	mg/kg		5	40	35	
Beryllium	mg/kg		2	<2	<2	
Boron	mg/kg		2	<2	<2	
Cadmium	mg/kg		0.3	<0.3	<0.3	
Chromium	mg/kg		2	13	9	
Cobalt	mg/kg		1	7	6	
Copper	mg/kg		2	13	13	
ron	mg/kg		50	8310	12100	
_ead	mg/kg		0.5	8.7	12.5	
Lithium	mg/kg		5	8	13	
Manganese	mg/kg		2	714	451	
Molybdenum	mg/kg		2	<2	<2	
Nickel	mg/kg		2	9	6	
Selenium	mg/kg		1	<1	<1	
Silver	mg/kg		0.5	<0.5	<0.5	
Strontium	mg/kg		5	14	9	
Γhallium	mg/kg		0.1	<0.1	<0.1	
Гin	mg/kg		2	<2	<2	
Uranium	mg/kg		0.1	0.3	0.4	
Vanadium	mg/kg		2	26	26	
Zinc	mg/kg		5	39	101	
	0 0					

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

9626709-9626723 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Casar Coaghtry



Certificate of Analysis

AGAT WORK ORDER: 18K397519

PROJECT: 11178792-02 Marystown Shipyard - MSBL

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury Analysis in Soil

DATE RECEIVED: 2018-10-16 DATE REPORTED: 2018-10-24

MSBL-MW2-MSBL-BH4-2018 SAMPLE DESCRIPTION: 2018-SS1 -SS1 SAMPLE TYPE: Soil Soil DATE SAMPLED: 2018-10-04 2018-10-09 9626709 9626723 G/S RDL 0.05 < 0.05 < 0.05

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

Unit

mg/kg

9626709-9626723 Results are based on the dry weight of the soil. Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

Parameter

SAMPLING SITE:

Mercury

Certified By:

Josephan Coaghtry



Certificate of Analysis

AGAT WORK ORDER: 18K397519

PROJECT: 11178792-02 Marystown Shipyard - MSBL

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

St. John's, NL

57 Old Pennywell Road, Unit I

SAMPLING SITE:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved										
DATE RECEIVED: 2018-10-16						DATE REPORTED: 2018-10-24				
		MSBL-MW2-	MSBL-MW2-	MSBL-BH4-2018	MSBL-BH4-2018					
	SAMPLE DESCRIPTION:	2018-SS4	2018-SS6	-SS5	-SS6					
	SAMPLE TYPE:	Soil	Soil	Soil	Soil					
	DATE SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09					
Parameter Unit	G/S RDL	9626713	9626717	9626742	9626743					
Benzene mg/kg	0.03	<0.03	< 0.03	< 0.03	<0.03					
Toluene mg/kg	0.04	< 0.04	< 0.04	< 0.04	<0.04					
Ethylbenzene mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03					
Xylene (Total) mg/kg	0.05	< 0.05	< 0.05	< 0.05	<0.05					
C6-C10 (less BTEX) mg/kg	3	14	<3	70	<3					
>C10-C16 Hydrocarbons mg/kg	15	380	<15	1520	<15					
>C16-C21 Hydrocarbons mg/kg	15	374	<15	1200	35					
>C21-C32 Hydrocarbons mg/kg	15	337	17	190	20					
Modified TPH (Tier 1) mg/kg	20	1110	<20	2980	55					
Resemblance Comment		WFOF+LOF	LOF	WFOF	WFOF					
Return to Baseline at C32		Υ	Υ	Υ	Υ					
Surrogate Unit	Acceptable Limits									
Isobutylbenzene - EPH %	60-140	93	96	90	98					
Isobutylbenzene - VPH %	60-140	107	78	95	100					
n-Dotriacontane - EPH %	60-140	119	106	96	102					

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

9626713-9626743 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Mus



Certificate of Analysis

AGAT WORK ORDER: 18K397519

PROJECT: 11178792-02 Marystown Shipyard - MSBL

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

N	1^	i۰	tı.	ıro

				MOISI	ure		
							DATE REPORTED: 2018-10-24
			MSBL-MW2-	MSBL-MW2-	MSBL-BH4-2018	MSBL-BH4-2018	
	SAMPLE DESC	CRIPTION:	2018-SS4	2018-SS6	-SS5	-SS6	
	SAMI	PLE TYPE:	Soil	Soil	Soil	Soil	
	DATE S	SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09	
Unit	G/S	RDL	9626713	9626717	9626742	9626743	
%		0	12	11	9	10	
		SAMI DATE S Unit G/S		SAMPLE DESCRIPTION: 2018-SS4 SAMPLE TYPE: Soil DATE SAMPLED: 2018-10-09 Unit G/S RDL 9626713	MSBL-MW2- MSBL-MW2- SAMPLE DESCRIPTION: 2018-SS4 2018-SS6 SAMPLE TYPE: Soil Soil DATE SAMPLED: 2018-10-09 2018-10-09 Unit G/S RDL 9626713 9626717	SAMPLE DESCRIPTION: 2018-SS4 2018-SS6 -SS5 SAMPLE TYPE: Soil Soil Soil DATE SAMPLED: 2018-10-09 2018-10-09 2018-10-09 Unit G / S RDL 9626713 9626717 9626742	MSBL-MW2- MSBL-BH4-2018 MSBL-BH4-2018 SAMPLE DESCRIPTION: 2018-SS4 2018-SS6 -SS5 -SS6 SAMPLE TYPE: Soil Soil Soil Soil DATE SAMPLED: 2018-10-09 2018-10-09 2018-10-09 Unit G/S RDL 9626713 9626717 9626742 9626743

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Huj



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397519
PROJECT: 11178792-02 Marystown Shipyard - MSBL ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

				Soi	l Ana	alysis	3									
RPT Date: Oct 24, 2018			DUPLICATE				REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MATRIX SPIKE			
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured	Acceptable Limits		Recovery	Lir	ptable nits	Recovery		eptable mits	
		ld	,				Value	Lower	Upper		Lower	Upper		Lower	Upper	
Available Metals in Soil																
Aluminum	9634372		19600	20200	2.7%	< 10	120%	80%	120%	119%	80%	120%	107%	70%	130%	
Antimony	9634372		<1	<1	NA	< 1	111%	80%	120%	115%	80%	120%	NA	70%	130%	
Arsenic	9634372		15	16	10.6%	< 1	113%	80%	120%	110%	80%	120%	94%	70%	130%	
Barium	9634372		45	51	13.0%	< 5	107%	80%	120%	111%	80%	120%	102%	70%	130%	
Beryllium	9634372		<2	<2	NA	< 2	119%	80%	120%	113%	80%	120%	94%	70%	130%	
Boron	9634372		<2	<2	NA	< 2	105%	80%	120%	105%	80%	120%	90%	70%	130%	
Cadmium	9634372		< 0.3	< 0.3	NA	< 0.3	114%	80%	120%	108%	80%	120%	91%	70%	130%	
Chromium	9634372		14	17	15.4%	< 2	80%	80%	120%	83%	80%	120%	93%	70%	130%	
Cobalt	9634372		8	10	14.7%	< 1	91%	80%	120%	89%	80%	120%	91%	70%	130%	
Copper	9634372		13	15	13.1%	< 2	97%	80%	120%	94%	80%	120%	88%	70%	130%	
Iron	9634372		20900	18600	11.4%	< 50	80%	80%	120%	81%	80%	120%	98%	70%	130%	
Lead	9634372		14.4	16.0	10.8%	< 0.5	116%	80%	120%	109%	80%	120%	92%	70%	130%	
Lithium	9634372		28	32	11.9%	< 5	120%	70%	130%	114%	70%	130%	99%	70%	130%	
Manganese	9634372		550	539	2.0%	< 2	86%	80%	120%	84%	80%	120%	103%	70%	130%	
Molybdenum	9634372		<2	<2	NA	< 2	104%	80%	120%	104%	80%	120%	90%	70%	130%	
Nickel	9634372		13	16	19.9%	< 2	93%	80%	120%	85%	80%	120%	87%	70%	130%	
Selenium	9634372		1	1	NA	< 1	107%	80%	120%	110%	80%	120%	79%	70%	130%	
Silver	9634372		<0.5	< 0.5	NA	< 0.5	98%	80%	120%	98%	80%	120%	82%	70%	130%	
Strontium	9634372		6	7	NA	< 5	106%	80%	120%	105%	80%	120%	101%	70%	130%	
Thallium	9634372		<0.1	<0.1	NA	< 0.1	110%	80%	120%	103%	80%	120%	NA	70%	130%	
Tin	9634372		< 2	< 2	NA	< 2	110%	80%	120%	110%	80%	120%	89%	70%	130%	
Uranium	9634372		0.8	0.9	15.4%	< 0.1	107%	80%	120%	102%	80%	120%	92%	70%	130%	
Vanadium	9634372		18	21	14.3%	< 2	83%	80%	120%	81%	80%	120%	95%	70%	130%	
Zinc	9634372		46	52	13.0%	< 5	97%	80%	120%	94%	80%	120%	89%	70%	130%	
Mercury Analysis in Soil																
Mercury	1 :	9620020	<0.05	< 0.05	NA	< 0.05	93%	70%	130%		70%	130%	76%	70%	130%	

Certified By:

AGAT QUALITY ASSURANCE REPORT (V1)

Page 6 of 10



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397519
PROJECT: 11178792-02 Marystown Shipyard - MSBL ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMI LING SITE.										1.					
			Trac	e Or	gani	cs Ar	nalys	is							
RPT Date: Oct 24, 2018				DUPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	Lin	ptable nits	Recovery	1 1 1 1 1 1	eptable mits
		ld	''				Value	Lower	Upper	,	1	Upper	,	Lower	Upper
Atlantic RBCA Tier 1 Hydrocar	bons in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	113%	60%	140%	89%	60%	140%			
Toluene	1	9626541	< 0.04	< 0.04	NA	< 0.04	122%	60%	140%	91%	60%	140%			
Ethylbenzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	120%	60%	140%	89%	60%	140%			
Xylene (Total)	1	9626541	< 0.05	< 0.05	NA	< 0.05	125%	60%	140%	93%	60%	140%			
C6-C10 (less BTEX)	1	9626541	< 3	< 3	NA	< 3	118%	60%	140%	113%	60%	140%	120%	30%	130%
>C10-C16 Hydrocarbons	1	9626743	< 15	< 15	NA	< 15	129%	60%	140%	94%	60%	140%	125%	30%	130%
>C16-C21 Hydrocarbons	1	9626743	35	42	NA	< 15	123%	60%	140%	94%	60%	140%	125%	30%	130%
>C21-C32 Hydrocarbons	1	9626743	20	25	NA	< 15	133%	60%	140%	94%	60%	140%	125%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397519
PROJECT: 11178792-02 Marystown Shipyard - MSBL ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397519
PROJECT: 11178792-02 Marystown Shipyard - MSBL ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis		·	•
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

Arrival Condition:	Good	Poor (see notes
Arrival Temperature	2.5	6.35.1

				P: 902.4	68.8	718	3 = F;	90:	2.468	3.89	24	AG.	AT Jo	ob N	lum	ber:		8	K	39	7	519
Chain of Custody Record		Report Info	ormation										tes:									
Report Information			James O'Neill				R	еро	rt Fo	rma	at											
Company: GHD Limited		Email:	James.Oneill@ghd.com			_		_ S	ingle			<u> </u>										
Contact: James O'Neill		2. Name:	datanl				. '	3	amp	e pe	r	Tui	nar	our	nd 1	Гime	Rec	uire	d (TA	.T)		
Address: 1118 Topsail Road		Email:	datanl@ghd.oom			_			age /lultip	ما		Re	gula	r TA	λT	 51	to 7 ·	worki	ng day	ys		
St. John's NL A1B 3N7								[∐] S	amp		er		sh T			□1				days		
	709-364-5368			,			1		age 			Ku:	311 I	A.I			days			uays		
Site # and/or Name: MARYSTOWN SHIPY	ARD - MSBL	Regulatory List Guidelines	Requirements (Check) : st Guidelines o	n Renor	+			xcel orma	t						,	Jays					
Project #: 11178792-02		□ PIRI	5 Off Report Ed Do Not Lis	st duidennes o	п кери	L			nclud			Dat	e Re	qui	red;	-						
AGAT Quotation #: GHD Standing Offer		☑ Tier 1	□ Gas ☑ Pot	☑ Coarse				de Late	ng Wa	4 0			_		_	No	_					
GHD PO #: TO FOLLOW		□ Res □ Com	☐ Fuel ☐ N/Pot ☐ Lube	□ Fine			111		o.:	iter 3	amp	ie.	LI IE	5	Ľ	INO						
Invoice To S	ame Yes ☑ / No □		-		1 1	n l	-	Ť	T	T		7	_	-	T		T			T	$\overline{}$	
Company:		□ CCME □ Industria □ Comme				LOW LEVEL (POTABLE)			ole					ter)								
Contact:		□ Res/Par		-	4	/ LEVE			⊡ Available		(e)			anis			ATE					
Address:		□ Agricult		- v	CA TIE	WO7 ~ I	z	EX)			l Pipet			mma ((g)		LEAHATE					
Phone: Fax:		□ FWAL □ Sedime	ent	CONTAINERS	TPH/BTEX - ATLANTIC RBCA TIER	TPH/BTEX - ATLANTIC RBCA TIER I ~	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BIEX)	Fotal Diss		PARTICLE SIZE (Sieve and Pipette)			TPH FRACTIONATION (Summa Canister)	OTHER: MERCURY (Hg)		POSS.					HOLD FOR 1 YEAR (Y/N) HAZARDOUS (Y/N)
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS – SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX -	TPH/BTEX - ATL	TPH/BTEX F	MTBE (ADD)	METALS: Total	FOC	PARTICLE SI	PAHs	PCBs	TPH FRACTI	OTHER: MI	OTHER:	HOLD FOR					HOLD FOR 1 YEAR (
MSBL-MW2-2018-SS1	2018/04/10 00:00	Soil	VARIOUS	1					Ø						V		Ø					
MSBL-MW2-2018-SS4	2018/09/10 00:00	Soil	VARIOUS	3	Ø							_		1	_				_	\perp		
MSBL-MW2-2018-SS6	2018/09/10 00:00	Soil	VARIOUS	3	Ø										4			\Box	_	\perp		
MSBL-BH4-2018-SS1	2018/09/10 00:00	Soil	VARIOUS	1		_	_	_	Ø	_		_	4		Ø		☑	\vdash		\perp	+-	
MSBL-BH4-2018-SS5	2018/09/10 00:00	Soil	VARIOUS	3	☑		4		-			-	4	+	4	-	_	\vdash	_	++		
MSBL-BH4-2018-SS6	2018/09/10 00:00	Soil	VARIOUS	3	Ø	_	4	+	+			-	_	+	-		+	H		+	+	
							-	+	+	-		-	+	+	-	+	+-	H	-	++	+	
						-		-	+	_			-	+	+	-	+-	\vdash		++	+	
						+	+		+				7	+	4	_	1					
						+	+	+	+			+	-	+					_	+		
Samples Relinquished By (Print Name): Robert Perry Samples Relinquished By (Bign):	Date/Time 10/16/201	В	piles Received By (Print Name):						10	/Time	60/	18					T	Pa	ge <u>1</u>	0	f 1	



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02 Marystown Shipyard - MAEB

AGAT WORK ORDER: 18K397528

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 24, 2018

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 10



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397528

PROJECT: 11178792-02 Marystown Shipyard - MAEB

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

				A۱	/allable Met	ais in Soii				
DATE RECEIVED: 2018-10-16									DATE REPORTE	D: 2018-10-24
Parameter	Unit		CRIPTION: PLE TYPE: SAMPLED: RDL	MAEB-BH3- 2018-SS1 Soil 2018-10-09 9626852	MAEB-BH3- 2018-SS2 Soil 2018-10-09 9626862	MAEB-BH4- 2018-SS1 Soil 2018-10-09 9626902	MAEB-BH4- 2018-SS2 Soil 2018-10-09 9626904	MAEB-BH5- 2018-SS1 Soil 2018-10-09 9626925	MAEB-BH5- 2018-SS2 Soil 2018-10-09 9626926	
Aluminum	mg/kg	G/3	10	8940	8890	10500	12500	10700	8520	
Antimony	mg/kg		10	<1	<1	<1	<1	<1	<1 <1	
Arsenic	mg/kg		1	14	15	13	19	13	11	
Barium	mg/kg		5	38	75	44	111	44	36	
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	
Boron	mg/kg		2	<2	<2	<2	<2	<2	<2	
Cadmium	mg/kg		0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	
Chromium	mg/kg		2	11	17	15	19	13	14	
Cobalt	mg/kg		1	6	10	9	11	8	9	
Copper	mg/kg		2	18	18	20	25	18	18	
Iron	mg/kg		50	16800	13900	17700	23700	18200	13300	
Lead	mg/kg		0.5	23.8	12.1	18.3	22.5	16.1	8.6	
Lithium	mg/kg		5	11	9	12	10	11	8	
Manganese	mg/kg		2	1030	1060	1100	1810	828	553	
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	
Nickel	mg/kg		2	6	12	10	14	8	10	
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1	
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Strontium	mg/kg		5	12	21	16	15	13	20	
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	
Uranium	mg/kg		0.1	0.5	0.3	0.6	0.4	0.5	0.3	
Vanadium	mg/kg		2	33	47	44	50	37	46	
Zinc	mg/kg		5	75	59	110	97	78	47	

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

9626852-9626926 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray



Certificate of Analysis

AGAT WORK ORDER: 18K397528

PROJECT: 11178792-02 Marystown Shipyard - MAEB

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

	Mercury Analysis in Soil												
DATE RECEIVED: 2018-10-16 DATE REPORTED: 2018-10-24													
				МАЕВ-ВН3-	MAEB-BH3-	MAEB-BH4-	MAEB-BH4-	MAEB-BH5-	MAEB-BH5-				
		SAMPLE DES	CRIPTION:	2018-SS1	2018-SS2	2018-SS1	2018-SS2	2018-SS1	2018-SS2				
		SAMI	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil				
		DATES	SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09				
Parameter	Unit	G/S	RDL	9626852	9626862	9626902	9626904	9626925	9626926				
Mercury	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05				

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

9626852-9626926 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Jasan Coaghtray



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397528

PROJECT: 11178792-02 Marystown Shipyard - MAEB

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-16							Ī	DATE REPORTED): 2018-10-24
			MAEB-BH3-	MAEB-BH3-	MAEB-BH4-	MAEB-BH4-	MAEB-BH5-	MAEB-BH5-	
		SAMPLE DESCRIPTION:	2018-SS2	2018-SS3	2018-SS2	2018-SS3	2018-SS2	2018-SS3	
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	
		DATE SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09	
Parameter	Unit	G/S RDL	9626862	9626869	9626904	9626916	9626926	9626930	
Benzene	mg/kg	0.03	< 0.03	<0.03	<0.03	< 0.03	< 0.03	<0.03	
Toluene	mg/kg	0.04	< 0.04	< 0.04	<0.04	<0.04	< 0.04	<0.04	
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	<0.03	
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	<0.05	< 0.05	< 0.05	< 0.05	
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	
>C10-C16 Hydrocarbons	mg/kg	15	164	<15	<15	<15	<15	<15	
>C16-C21 Hydrocarbons	mg/kg	15	248	<15	<15	<15	<15	<15	
>C21-C32 Hydrocarbons	mg/kg	15	103	<15	<15	<15	<15	21	
Modified TPH (Tier 1)	mg/kg	20	515	<20	<20	<20	<20	21	
Resemblance Comment			FOF	NR	NR	NR	NR	UC	
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	
Surrogate	Unit	Acceptable Limits							
Isobutylbenzene - EPH	%	60-140	87	96	90	93	99	94	
Isobutylbenzene - VPH	%	60-140	100	99	98	95	96	96	
n-Dotriacontane - EPH	%	60-140	95	100	96	99	107	107	

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

9626862-9626930 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Mus



Certificate of Analysis

AGAT WORK ORDER: 18K397528

PROJECT: 11178792-02 Marystown Shipyard - MAEB

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

		Maiati

	Moisture											
DATE RECEIVED: 2018-10-16									DATE REPORTE	ED: 2018-10-24		
				MAEB-BH3-	MAEB-BH3-	MAEB-BH4-	MAEB-BH4-	MAEB-BH5-	MAEB-BH5-			
		SAMPLE DES	CRIPTION:	2018-SS2	2018-SS3	2018-SS2	2018-SS3	2018-SS2	2018-SS3			
		SAMI	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil			
		DATES	SAMPLED:	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09	2018-10-09			
Parameter	Unit	G/S	RDL	9626862	9626869	9626904	9626916	9626926	9626930			
% Moisture	%		0	7	9	9	9	8	11			

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397528 PROJECT: 11178792-02 Marystown Shipyard - MAEB ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

				Soi	l Ana	alysis	3								
RPT Date: Oct 24, 2018			С	UPLICATI	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	K SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured			Recovery	Lir	eptable mits	Recovery		ptable nits
		ld	''				Value	Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil															
Aluminum	9641128		6820	7420	8.3%	< 10	117%	80%	120%	116%	80%	120%	121%	70%	130%
Antimony	9641128		1	2	NA	< 1	99%	80%	120%	106%	80%	120%	103%	70%	130%
Arsenic	9641128		7	8	12.2%	< 1	108%	80%	120%	100%	80%	120%	117%	70%	130%
Barium	9641128		62	65	6.0%	< 5	106%	80%	120%	97%	80%	120%	123%	70%	130%
Beryllium	9641128		<2	<2	NA	< 2	110%	80%	120%	101%	80%	120%	122%	70%	130%
Boron	9641128		<2	3	NA	< 2	101%	80%	120%	98%	80%	120%	119%	70%	130%
Cadmium	9641128		< 0.3	< 0.3	NA	< 0.3	111%	80%	120%	99%	80%	120%	117%	70%	130%
Chromium	9641128		16	18	7.9%	< 2	108%	80%	120%	97%	80%	120%	119%	70%	130%
Cobalt	9641128		4	5	NA	< 1	109%	80%	120%	102%	80%	120%	125%	70%	130%
Copper	9641128		52	51	0.7%	< 2	111%	80%	120%	101%	80%	120%	106%	70%	130%
Iron	9641128		7530	9170	19.7%	< 50	110%	80%	120%	96%	80%	120%	119%	70%	130%
Lead	9641128		13.2	14.5	9.1%	< 0.5	115%	80%	120%	102%	80%	120%	114%	70%	130%
Lithium	9641128		<5	6	NA	< 5	110%	70%	130%	103%	70%	130%	122%	70%	130%
Manganese	9641128		149	154	3.3%	< 2	108%	80%	120%	99%	80%	120%	121%	70%	130%
Molybdenum	9641128		<2	<2	NA	< 2	106%	80%	120%	102%	80%	120%	127%	70%	130%
Nickel	9641128		9	9	NA	< 2	111%	80%	120%	95%	80%	120%	119%	70%	130%
Selenium	9641128		<1	<1	NA	< 1	104%	80%	120%	99%	80%	120%	116%	70%	130%
Silver	9641128		<0.5	<0.5	NA	< 0.5	109%	80%	120%	105%	80%	120%	130%	70%	130%
Strontium	9641128		13	14	NA	< 5	120%	80%	120%	109%	80%	120%	NA	70%	130%
Thallium	9641128		<0.1	<0.1	NA	< 0.1	111%	80%	120%	103%	80%	120%	87%	70%	130%
Tin	9641128		< 2	< 2	NA	< 2	105%	80%	120%	97%	80%	120%	118%	70%	130%
Uranium	9641128		0.6	0.5	10.4%	< 0.1	109%	80%	120%	99%	80%	120%	123%	70%	130%
Vanadium	9641128		31	35	11.4%	< 2	105%	80%	120%	96%	80%	120%	124%	70%	130%
Zinc	9641128		56	61	8.7%	< 5	107%	80%	120%	94%	80%	120%	123%	70%	130%
Mercury Analysis in Soil															
Mercury	1 9	9620020	<0.05	< 0.05	NA	< 0.05	93%	70%	130%		70%	130%	76%	70%	130%

Certified By:

Page 6 of 10



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K397528

PROJECT: 11178792-02 Marystown Shipyard - MAEB

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.									LLDD	1.					
			Trac	e Or	gani	cs Ar	nalys	is							
RPT Date: Oct 24, 2018				DUPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	Lin	ptable nits	Recovery	1 1 1 1	eptable mits
		ld	''				Value	Lower	Upper	,	Lower	Upper	,		Upper
Atlantic RBCA Tier 1 Hydrocar	bons in Soil	(Version 3	.1) - Field	Preserve	d										
Benzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	113%	60%	140%	89%	60%	140%			
Toluene	1	9626541	< 0.04	< 0.04	NA	< 0.04	122%	60%	140%	91%	60%	140%			
Ethylbenzene	1	9626541	< 0.03	< 0.03	NA	< 0.03	120%	60%	140%	89%	60%	140%			
Xylene (Total)	1	9626541	< 0.05	< 0.05	NA	< 0.05	125%	60%	140%	93%	60%	140%			
C6-C10 (less BTEX)	1	9626541	< 3	< 3	NA	< 3	118%	60%	140%	113%	60%	140%	120%	30%	130%
>C10-C16 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	88%	60%	140%	84%	60%	140%	NA	30%	130%
>C16-C21 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	80%	60%	140%	84%	60%	140%	NA	30%	130%
>C21-C32 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	83%	60%	140%	84%	60%	140%	NA	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

my Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397528
PROJECT: 11178792-02 Marystown Shipyard - MAEB ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397528
PROJECT: 11178792-02 Marystown Shipyard - MAEB ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMI LING SITE.		SAIVII LLD DT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis		•	•
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902.468.8718 * F: 902.468.8924

	/	
rrival Condition:	Good	
	-	- 1

Laboratory Use Only

rival Condition:	Good	☐ Poor	(see note:
rival Temperatur	e:	5,6	3.5.

arrival lemperature:_	6	0 2.5
AGAT Job Number:	18K30	17524
-	-	

Chain of Custody Record	Report Info	ormation								Notes:											
Report Information	1. Name:	James O'Neill				R	eport	For	mat												
Company: GHD Limited		James.Oneill@ghd.com					Cir	- اس													
Contact: James O'Neill	2. Name:						Sar Sa	gle nple	per	T	ırna	rom	nd T	lme	Rea	ulrec	L (TA	L)			
Address: 1118 Topsail Road	11	datanl@ghd.oom					pa	ge		Ш	Turnaround Time Required (TAT) Regular TAT ☑ 5 to 7 working days										
St. John's NL A1B 3N7							Mu Sa	Itiple	e s per	Re	eguia	ar IA	AI I	≰15 t	.0 / W	vorkin	ig day	/S			
Phone 1-709-364-5353 Fax: 1-709-364-5368							pa		s pei	R	ush 1	AT]10	-		□2	days			
Site # and/or Name: MARYSTOWN SHIPYARD - MAEB	Regulatory Requirements (Check):						Exc			11			ı	☐ 3 days							
Project #: 11178792-02	List Guidelines on Report							d		ata D		vo di									
AGAT Quotation #: GHD Standing Offer	□ PIRI □ Tier 1 □ Gas □ Pot □ Coarse □ □ Included □] Di	ale K	equi	rea:	-							=	
GHD PO #: TO FOLLOW	□Res		□ Fine			11	_		er San	iple:	□Ye	es	✓	No							
Invoice To Same Yes ☑ / No □	☐	□ Lube	Г			Re	eg. No.	·										-			
Same les ary No a	CCME	□ CDWQ			JE)																
Company:	_				(POTABLE)			l m				<u>-</u>						1 1			
Contact:	□ Comme			4	EVEL (⊡ Available				niste			l _E						
Address:	□ Res/Pa □ Agricult			빌	LOWL			Ava	T du			la Ca			LEAHATE						
	□ FWAL	-	ျ	BCA	<u>-</u>	NO.	<u> </u>		<u> </u>			mmn	된		l _P			1 1			
Phone: Fax:	□ Sedime	ent ======	OR CONTAINERS	ATLANTIC RBCA TIER	3CA TI	NAT	E	□ Diss	0			S) N	MERCURY (Hg)							3N	
-			NOS	I AN	TICRI	ACTIC	2		is)			ATIC	ارچ ا		FOR POSS.				- 4	ÊAR	3N
		0011115150	OR O		ATLAN	X FR.	(ADDEL ONLY	<u>9</u>	217			<u> </u>	ME		l R					R 1	Sno
SAMPLE IDENTIFICATION DATE/TIME SAMPI	LED SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER (TPH/BTEX	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BLEX) MTBE ONLY	METALS: [] Total	FOC DARTICI E SIZE (Sieve and Pinette)	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)		OTHER:	HOLD					HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
MAEB-BH3-2018-SS1 2018/09/10 00:00) Soil	VARIOUS	1			T		Ø					Ø								
MAEB-BH3-2018-SS2 2018/09/10 00:00	Soil	VARIOUS	04	Ø				Ø					Ø		Ø						
MAEB-BH3-2018-SS3 2018/09/10 00:00	Soil	VARIOUS	3	Ø																	
MAEB-BH4-2018-SS1 2018/09/10 00:00) Soil	VARIOUS	1					Ø					Ø		Ø						
MAEB-BH 4- 2018-SS2 2018/09/10 00:00	Soil	VARIOUS	84	Ø				Ø					Ø		Ø						
MAEB-BH4-2018-SS3 2018/09/10 00:00) Soil	VARIOUS	3	Ø																	
MAEB-BH5-2018-SS1 2018/09/10 00:00	Soil	VARIOUS	1										Ø								
MAEB-BH5-2018-SS2 2018/09/10 00:00	Soil	VARIOUS	34	4				Ø					Ø								
MAEB-BH5-2018-SS3 2018/09/10 00:00	Soil	VARIOUS	3	Ø		_							_	_		\perp			_		
			_	\						\pm			_			\sqcup		1			
Samples Relinquished By (Print Name): Distra/Tri							-										_	4			1
Pohort Porny	6/20/8 Sar	mples Received By (Print Nimber		_				Date/I	ime//	100	18					Pa	ge <u>1</u>		of <u>1</u>		
Samples Relinquished By (Sign) A Many Date/Ti	me Sur	mples Received By (Sign):						Peter	Time	10					5						



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K397507

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 26, 2018

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 7

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397507

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

			•		`	,				
DATE RECEIVED: 2018-10-16								DATE REPORTI	ED: 2018-10-26	
			MASO-BH2-	MASO-BH2-	MASO-BH3-	MASO-BH3-	MASO-BH1-	MASO-BH1-	MASO-BH1-	MASO-MW1-
		SAMPLE DESCRIPTION:	2018-SS3	2018-SS4	2018-SS4	2018-SS5	2018-SS2	2018-SS7	2018-SS8	2018-SS2
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10
Parameter	Unit	G/S RDL	9626548	9626557	9626558	9626559	9626560	9626561	9626562	9626563
Benzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	<0.03
Toluene	mg/kg	0.04	< 0.04	< 0.04	<0.04	<0.04	< 0.04	<0.04	< 0.04	<0.04
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons	mg/kg	15	<15	<15	92	21	<15	<15	<15	<15
>C16-C21 Hydrocarbons	mg/kg	15	<15	<15	59	<15	<15	<15	<15	<15
>C21-C32 Hydrocarbons	mg/kg	15	<15	<15	<15	<15	<15	<15	<15	67
Modified TPH (Tier 1)	mg/kg	20	<20	<20	151	21	<20	<20	<20	67
Resemblance Comment			NR	NR	FOF	FOF	NR	NR	NR	LOF
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140	102	82	78	82	83	84	87	84
Isobutylbenzene - VPH	%	60-140	99	83	79	77	77	77	75	75
n-Dotriacontane - EPH	%	60-140	111	76	69	75	78	80	83	83

Certified By:

any Huj



SAMPLING SITE:

n-Dotriacontane - EPH

Certificate of Analysis

AGAT WORK ORDER: 18K397507

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

C O'NEIL I

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved

DATE RECEIVED: 2018-10-16 **DATE REPORTED: 2018-10-26** MASO-MW1-SAMPLE DESCRIPTION: 2018-SS3 SAMPLE TYPE: Soil DATE SAMPLED: 2018-10-10 9626564 Parameter Unit G/S **RDL** Benzene 0.03 < 0.03 mg/kg Toluene 0.04 < 0.04 mg/kg Ethylbenzene mg/kg 0.03 < 0.03 0.05 Xylene (Total) mg/kg < 0.05 C6-C10 (less BTEX) 3 <3 mg/kg >C10-C16 Hydrocarbons 15 27 mg/kg >C16-C21 Hydrocarbons 15 mg/kg <15 >C21-C32 Hydrocarbons mg/kg 15 90 Modified TPH (Tier 1) 20 117 mg/kg FOF, LOF Resemblance Comment Return to Baseline at C32 Υ Surrogate Unit Acceptable Limits Isobutylbenzene - EPH % 60-140 89 Isobutylbenzene - VPH % 60-140 81

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

%

60-140

89

9626548-9626564 Results are based on the dry weight of the soil.

Resemblance Comment Key:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Mus



Certificate of Analysis

AGAT WORK ORDER: 18K397507

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

OAMI LING OITL.					OAINI LLD DT.											
					Moistu	ıre										
DATE RECEIVED: 2018-10-16		DATE REPORTED: 2018-10-26														
				MASO-BH2-	MASO-BH2-	MASO-BH3-	MASO-BH3-	MASO-BH1-	MASO-BH1-	MASO-BH1-	MASO-MW1-					
		SAMPLE DES	CRIPTION:	2018-SS3	2018-SS4	2018-SS4	2018-SS5	2018-SS2	2018-SS7	2018-SS8	2018-SS2					
	SAM	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil						
		DATE	SAMPLED:	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10	2018-10-10					
Parameter	Unit	G/S	RDL	9626548	9626557	9626558	9626559	9626560	9626561	9626562	9626563					
% Moisture	%		0	10	11	7	11	8	13	9	10					
				MASO-MW1-												
	SAMPLE DES	CRIPTION:	2018-SS3													
		SAMPLE TYPE:														
	DATE	SAMPLED:	2018-10-10													
Parameter	Unit	G/S	RDL	9626564												
% Moisture	%		0	12												

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397507
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER Batch Sample Id Dup #1 Dup #2 RPD Method Blank Measured Value Limits Lower Upper Upper	RPT Date: Oct 26, 2018				DUPLICAT			DEEEDEN	ICE MA	TEDIAL	METHOD	DIANK	CDIKE	MAT	DIA 6DI	WE.	
PARAMETER Batch Sample Id Dup #1 Dup #2 RPD Blank Measured Value Limits Lower Upper Limits Lower Limits L	RP1 Date: Oct 26, 2018				JUPLICAT		1	KEFEKEN			METHOD			IVIA	MATRIX SPIKE		
Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved Benzene	PARAMETER	Batch		Dup #1	Dup #2	Blank					Recovery	Lin		Recovery	Lin		
Benzene 1 9635341 < 0.03 < 0.03 NA < 0.03 98% 60% 140% 75% 60% 140% Toluene 1 9635341 < 0.04 < 0.04 NA < 0.04 99% 60% 140% 79% 60% 140% Ethylbenzene 1 9635341 < 0.03 < 0.03 NA < 0.03 100% 60% 140% 79% 60% 140% Xylene (Total) 1 9635341 < 0.05 < 0.05 NA < 0.05 104% 60% 140% 82% 60% 140% C6-C10 (less BTEX) 1 9635341 < 3 < 3 NA < 3 124% 60% 140% 115% 60% 140% NA 30% 130% >C10-C16 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 88% 60% 140% 84% 60% 140% NA 30% 130% >C16-C21 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 80% 60% 140% 84% 60% 140% NA 30% 130%			lu lu					value	Lower	Upper		Lower Upper			Lower	Upper	
Toluene 1 9635341 < 0.04 < 0.04 NA < 0.04 99% 60% 140% 79% 60% 140% Ethylbenzene 1 9635341 < 0.03 < 0.03 NA < 0.03 100% 60% 140% 79% 60% 140% Xylene (Total) 1 9635341 < 0.05 < 0.05 NA < 0.05 104% 60% 140% 82% 60% 140% C6-C10 (less BTEX) 1 9635341 < 3 < 3 NA < 3 124% 60% 140% 115% 60% 140% NA 30% 130% >C10-C16 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 88% 60% 140% 84% 60% 140% NA 30% 130% >C16-C21 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 80% 60% 140% 84% 60% 140% NA 30% 130%																	
Ethylbenzene 1 9635341 < 0.03	Benzene	1	9635341	< 0.03	< 0.03	NA	< 0.03	98%	60%	140%	75%	60%	140%				
Xylene (Total) 1 9635341 < 0.05	Toluene	1	9635341	< 0.04	< 0.04	NA	< 0.04	99%	60%	140%	79%	60%	140%				
C6-C10 (less BTEX) 1 9635341 < 3 < 3 NA < 3 124% 60% 140% 115% 60% 140% NA 30% 130% >C10-C16 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 88% 60% 140% 84% 60% 140% NA 30% 130% >C16-C21 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 80% 60% 140% 84% 60% 140% NA 30% 130%	Ethylbenzene	1	9635341	< 0.03	< 0.03	NA	< 0.03	100%	60%	140%	79%	60%	140%				
>C10-C16 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 88% 60% 140% 84% 60% 140% NA 30% 130% >C16-C21 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 80% 60% 140% 84% 60% 140% NA 30% 130%	Xylene (Total)	1	9635341	< 0.05	< 0.05	NA	< 0.05	104%	60%	140%	82%	60%	140%				
>C16-C21 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 80% 60% 140% 84% 60% 140% NA 30% 130%	C6-C10 (less BTEX)	1	9635341	< 3	< 3	NA	< 3	124%	60%	140%	115%	60%	140%	NA	30%	130%	
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	>C10-C16 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	88%	60%	140%	84%	60%	140%	NA	30%	130%	
>C21-C32 Hydrocarbons 1 9615152 < 15 < 15 NA < 15 83% 60% 140% 84% 60% 140% NA 30% 130%	>C16-C21 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	80%	60%	140%	84%	60%	140%	NA	30%	130%	
	>C21-C32 Hydrocarbons	1	9615152	< 15	< 15	NA	< 15	83%	60%	140%	84%	60%	140%	NA	30%	130%	

Benzene	1	9626557	< 0.03	< 0.03	NA	< 0.03	64%	60%	140%	74%	60%	140%			
Toluene	1	9626557	< 0.04	< 0.04	NA	< 0.04	67%	60%	140%	80%	60%	140%			
Ethylbenzene	1	9626557	< 0.03	< 0.03	NA	< 0.03	68%	60%	140%	82%	60%	140%			
Xylene (Total)	1	9626557	< 0.05	< 0.05	NA	< 0.05	71%	60%	140%	84%	60%	140%			
C6-C10 (less BTEX)	1	9626557	< 3	< 3	NA	< 3	105%	60%	140%	113%	60%	140%	NA	30%	130%
>C10-C16 Hydrocarbons	1	9615144	<15	<15	0	< 15	90%	60%	140%	69%	60%	140%	56%	30%	130%
>C16-C21 Hydrocarbons	1	9615144	<15	<15	0	< 15	79%	60%	140%	69%	60%	140%	56%	30%	130%
>C21-C32 Hydrocarbons	1	9615144	<15	<15	0	< 15	84%	60%	140%	69%	60%	140%	56%	30%	130%
>C16-C21 Hydrocarbons	1 1 1	9615144	<15	<15	0 0 0	< 15	79%	60%	140%	69%	60%	140%	56%	30%	1

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397507 PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis		·	•
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC



Dartmouth, NS

B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902	.468.871	8 = F:	902.468	.8924

1	Laboratory Use Only
١	
ı	Arrival Condition: ☐Good ☐ Poor (see notes)
l	Arrival Temperature: 6 5 5 - C
ı	AGAT Job Number: 184 39750
١	Notes:
l	
١	

Samples Relinquished By (Print Name): Robert Perry Date/Tyne Samples Received By (Print Name). Date/Tyne Page 1 of 1	Chain of Custody Recor	d	Report Information						١	lotes	s:													
Contact: James O'Neill J			1. Name: .	James O'Neill				R	por	t For	mat													
Address: 1118 Topsall Road			Email:	James.Oneill@ghd.com				_	- Sir	ngle		L												_
Address: 1118 Topsal Road			2. Name:	datanl			_	٢			per	T	Turnaround Time Required (TAT)											
Samples per	Address: 1118 Topsail Road		Email:	datanl@ghd.oom						_		11												
Phone 1-709-364-538 Fax: 1-709-364-538 Regulatory Requirements (Check): Data MarySTOWN SHIPYARD - MASO Project #: 11179782-02 General Country GHD Standing Offer	St. John's NL A1B 3N7	- i						Samples per				Ш												
Project #:	Phone <u>1-709-364-5353</u> Fax:	1-709-364-5368							0 001	R	ush '	TAT				-	[∃2 d	ays					
Project #: 11178792-02 Project #: Project Project #: Project		IPYARD - MASO		. , ,				E									3 da	ys						
AGAT Quotation #:	110,000111			on Report 🔟 Do Not List (iuidelinės oi	1 Repor	t				d	$\ _{D}$	ate 5	Sear	iired	(e)								
TO FOLLOW	AGAT Quotation #: GHD Standing Offe	er		□ Gas ☑ Pot	☑ Coarse			H			_			1040	<i>x</i> 111 G G								_	
COMPANY:	TO FOLLOW!	.1		•	□ Fine					_	er Sar	nple:	□Y	⁄es	[☑ No								
Contract: Commercial Other Res,Paris Res,Par	Invoice To	Same Yes ☑ / No □	☑ Com	Lube	[-		_	L	g, NO		_	_	_							_			_	_
Contract: Commercial Other Res,Paris Res,Par	Company			•			(ABLE)																	
Phone: Fax:							EL (PO			e e				ter)										
Phone: Fax:						H H	V LEVE		Ь	aila	1			anis										
MASO-BH2-2018-SS3	Address:		□ Agricultural □ □ H V N N N N N N N N N N N N N N N N N N						3	\vec{\delta}{\delta}	id	3		ma ((g)			¥.	ľ	1		4 1		
MASO-BH2-2018-SS3					ERS	RBC	TER			Sign	5	2		Sum	E			ا إ					⊋ l	
MASO-BH2-2018-SS3	Phone: Fax:		□ Sealme	ent	NTAIN	NTIC	RBCA	NOIL			9	3		NOI	UR)			OSS					'R (Y)	2
MASO-BH2-2018-SS3					1 8	ATC	ANTIC	-RAC		Total	175 /	1		ONA	ERC			A P					1 YEA	$s \leq$
MASO-BH2-2018-SS3 2018/10/10 00:00 Soil VARIOUS 3	SAMPLE IDENTIFICATION	DATE/TIME SAMPLED		SITE/SAMPLE INFO,	NUMBER O	TPH/BTEX-	TPH/BTEX - ATI	TPH/BTEX F	MTBE ONLY	METALS:	FOC	PAHS	PCBs	TPH FRACTI	OTHER: M	OTHER:	отнек:	HOLD FO					HOLD FOR 1	HAZARDOU
MASO-BH3-2018-SS4	MASO-BH2-2018-SS3	2018/10/10 00:00	Soil	VARIOUS	3															\Box				Ī
MASO-BH1-2018-SS5	MASO-BH2-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3	Ø						1	T						\neg					=
MASO-BH1-2018-SS2	MASO-BH3-2018-SS4	2018/10/10 00:00	Soil	VARIOUS	3	Ø																		_
MASO-BH1-2018-SS7	MASO-BH3-2018-SS5	2018/10/10 00:00	Soil	VARIOUS	3	Ø							П											
MASO-BH1-2018-SS8	MASO-BH1-2018-SS2	2018/10/10 00:00	Soil	VARIOUS	3	Ø							П	П						\Box				
MASO-MW1-2018-SS2 2018/10/10 00:00 Soil VARIOUS 3	MASO-BH1-2018-SS7	2018/10/10 00:00	Soil	VARIOUS	3	Ø																		Ξ
MASO-MW1-2018-SS3 2018/10/10 00:00 Soil VARIOUS 3 🖸 Samples Relinquished By (Print Name): Robert Perry Samples Relinquished By (Sign): Date/Time Samples Relinquished By (Sign):	MASO-BH1-2018-SS8	2018/10/10 00:00	Soil	VARIOUS	3	Ø																		Ξ
Samples Relinquished By (Print Name): Robert Perry Samples Relinquished By (Print Name): Robert Perry Samples Relinquished By (Print Name): Date/Tyne Date/Tyne Date/Tyne Date/Tyne Page 1 of 1 Date/Time/ Date/Tim		2018/10/10 00:00	Soil	VARIOUS	3																			Τ
Robert Perry O 6 2 0 0 Page 1 of 1	MASO-MW1-2018-SS3	2018/10/10 00:00	Soil	VARIOUS	3	Ø																		Ī
Robert Perry O 6 2 0 0 Page 1 of 1									+								/							
Robert Perry 0/6/20/0 Date/fined Samples Received By (Sign): Date/fined Date/f	Samples Relinquished By (Print Name):	Data/fime	I Out	Photos Character of Davidson March		+									_						\perp	+	-	_
Samples Retinquished & (Sign): Date/Time Samples Received By (Sign): Date/Time	Robert Perry	10/16/2	20/8	The state of the s						10	16	11	8						Page	<u> 1</u>	0	f_1_	_	
	Samples reunquisted by (Sign):	Date/Time	San	nples Received By (Sign):						Date/	imyo							-						_



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD

ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT:

AGAT WORK ORDER: 18K399949

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

DATE REPORTED: Oct 29, 2018

PAGES (INCLUDING COVER): 27

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 27

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

			Λ,	allable Met	ais iii Soii								
DATE RECEIVED: 2018-10-22 DATE REPORTED: 2018-10-29													
		SAMPLE DESCRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8			
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment			
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19			
Parameter	Unit	G/S RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099			
Aluminum	mg/kg	10	10900	10500	11900	14300	11700	11900	9980	9140			
Antimony	mg/kg	1	<1	28	<1	<1	1	2	1	1			
Arsenic	mg/kg	1	22	17	19	19	24	19	22	20			
Barium	mg/kg	5	250	83	79	97	148	92	73	58			
Beryllium	mg/kg	2	<2	<2	<2	<2	<2	<2	<2	<2			
Boron	mg/kg	2	38	30	32	38	53	40	32	45			
Cadmium	mg/kg	0.3	0.3	< 0.3	<0.3	0.3	0.4	< 0.3	<0.3	0.3			
Chromium	mg/kg	2	71	32	31	26	35	38	19	39			
Cobalt	mg/kg	1	13	13	13	13	14	12	10	10			
Copper	mg/kg	2	147	98	171	161	207	170	99	63			
Iron	mg/kg	50	27600	23800	30900	37900	31300	30900	36200	22400			
Lead	mg/kg	0.5	358	135	284	381	125	252	143	222			
Lithium	mg/kg	5	18	17	22	19	22	18	16	13			
Manganese	mg/kg	2	326	288	351	397	321	338	390	387			
Molybdenum	mg/kg	2	4	4	4	5	6	5	2	3			
Nickel	mg/kg	2	22	24	24	22	27	24	14	17			
Selenium	mg/kg	1	1	1	1	1	2	1	1	1			
Silver	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5			
Strontium	mg/kg	5	92	77	47	38	70	40	30	50			
Thallium	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
Tin	mg/kg	2	14	8	8	10	15	12	13	20			
Uranium	mg/kg	0.1	1.0	1.0	1.0	1.2	1.1	0.9	0.8	1.0			
Vanadium	mg/kg	2	47	42	46	42	53	47	25	40			
Zinc	mg/kg	5	799	267	282	329	397	297	629	868			

Certified By:



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

Available Metals in Soil

DATE RECEIVED: 2018-10-22							[DATE REPORTI	ED: 2018-10-29	
Parameter	Unit	SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: G/S RDL	18-MNMA-S9 Sediment 2018-10-19 9642100	18-MNMA-S10 Sediment 2018-10-19 9642101	18-MNMA-S11 Sediment 2018-10-19 9642102	18-MNMA-S12 Sediment 2018-10-19 9642103	18-MNMA-S13 Sediment 2018-10-19 9642104	18-MNMA-S14 Sediment 2018-10-19 9642105	18-MNMA-S15 Sediment 2018-10-19 9642106	18-MNMA-DUP Sediment 2018-10-19 9642107
Aluminum	mg/kg	10	7190	9842101	8010	11400	10900	12600	9940	10900
Antimony	mg/kg	10	7 190	9330	<1	<1	<1	12000	9940 <1	<1
Arsenic	mg/kg	1	22	34	28	29	31	78	65	25
Barium	mg/kg	5	106	149	48	120	66	122	135	214
Beryllium	mg/kg	2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	mg/kg	2	26	50	104	60	152	65	86	51
Cadmium	mg/kg	0.3	0.3	0.5	0.5	0.4	1.0	0.4	0.5	0.4
Chromium	mg/kg	2	15	24	26	20	27	11	12	31
Cobalt	mg/kg	1	8	12	9	12	10	18	19	15
Copper	mg/kg	2	98	122	77	144	111	159	158	260
Iron	mg/kg	50	19400	28100	48700	29900	34600	50000	43100	27400
Lead	mg/kg	0.5	343	332	54.4	252	67.0	728	236	135
Lithium	mg/kg	5	13	16	15	20	17	17	16	20
Manganese	mg/kg	2	316	343	274	559	283	115	116	332
Molybdenum	mg/kg	2	2	4	9	5	9	<2	2	6
Nickel	mg/kg	2	9	17	16	14	17	14	23	25
Selenium	mg/kg	1	1	2	<1	<1	<1	2	1	<1
Silver	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg	5	31	73	345	61	200	15	24	48
Thallium	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg	2	22	26	7	13	8	17	10	10
Uranium	mg/kg	0.1	0.7	1.2	2.4	1.4	2.5	1.5	1.8	1.3
Vanadium	mg/kg	2	22	39	45	39	63	14	16	50
Zinc	mg/kg	5	1450	1660	334	585	379	5020	662	375

Certified By:

Joseph Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Available Metals in Soil

DATE RECEIVED: 2018-10-22							DATE REPORTED: 2018-10-29
	S	SAMPLE DESCRIPTION:	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3	
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	
Parameter	Unit	G/S RDL	9642108	9642109	9642110	9642111	
Aluminum	mg/kg	10	11900	8770	8780	9750	
Antimony	mg/kg	1	3	<1	<1	<1	
Arsenic	mg/kg	1	41	9	11	13	
3arium Sarium	mg/kg	5	167	37	34	53	
Beryllium	mg/kg	2	<2	<2	<2	<2	
Boron	mg/kg	2	100	15	16	20	
Cadmium	mg/kg	0.3	0.6	< 0.3	<0.3	<0.3	
Chromium	mg/kg	2	98	11	16	22	
Cobalt	mg/kg	1	22	7	8	10	
Copper	mg/kg	2	145	6	8	14	
ron	mg/kg	50	41200	6990	7390	9550	
_ead	mg/kg	0.5	466	5.9	6.5	7.4	
_ithium	mg/kg	5	17	13	17	17	
Manganese	mg/kg	2	279	197	211	183	
Molybdenum	mg/kg	2	9	<2	3	2	
Nickel	mg/kg	2	45	11	13	18	
Selenium	mg/kg	1	3	<1	<1	<1	
Silver	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	
Strontium	mg/kg	5	120	17	22	27	
Fhallium	mg/kg	0.1	<0.1	<0.1	0.1	0.1	
Гin	mg/kg	2	28	3	3	4	
Uranium	mg/kg	0.1	2.0	1.1	1.4	1.4	
Vanadium	mg/kg	2	48	26	33	40	
Zinc	ma/ka	5	1730	30	34	38	

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

9642091-9642111 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Fraction Organic Carbon

DATE RECEIVED: 2018-10-22							Γ	DATE REPORTE	ED: 2018-10-29	
		SAMPLE DESCRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8
		SAMPLE TYPE:	Sediment	Sediment						
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099
Fraction Organic Carbon-1	NA	0.003	0.018	0.062	0.058	0.054	0.049	0.079	0.082	0.112
Fraction Organic Carbon-2	NA	0.003	0.019	0.062	0.057	0.058	0.051	0.080	0.080	0.113
Fraction Organic Carbon-3	NA	0.003	0.019	0.062	0.055	0.059	0.049	0.082	0.083	0.113
Fraction Organic Carbon-Avg	NA	0.003	0.019	0.062	0.057	0.057	0.049	0.080	0.083	0.113
		SAMPLE DESCRIPTION:	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-S12	18-MNMA-S13	18-MNMA-S14		18-MNMA-S1
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment		Sediment
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19		2018-10-19
Parameter	Unit	G/S RDL	9642100	9642101	9642102	9642103	9642104	9642105	RDL	9642106
Fraction Organic Carbon-1	NA	0.003	0.107	0.088	0.098	0.109	0.159	0.198	0.006	0.371
Fraction Organic Carbon-2	NA	0.003	0.106	0.088	0.099	0.108	0.160	0.198	0.006	0.371
Fraction Organic Carbon-3	NA	0.003	0.105	0.089	0.099	0.109	0.159	0.198	0.006	0.369
Fraction Organic Carbon-Avg	NA	0.003	0.106	0.088	0.099	0.109	0.159	0.198	0.006	0.370
		SAMPLE DESCRIPTION:	18-MNMA-DUP1	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3			
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment			
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19			
Parameter	Unit	G/S RDL	9642107	9642108	9642109	9642110	9642111			
Fraction Organic Carbon-1	NA	0.003	0.075	0.100	0.034	0.050	0.029			
Fraction Organic Carbon-2	NA	0.003	0.075	0.102	0.034	0.052	0.029			
Fraction Organic Carbon-3	NA	0.003	0.075	0.100	0.034	0.051	0.030			
Fraction Organic Carbon-Avg	NA	0.003	0.075	0.101	0.034	0.051	0.029			

Certified By:

Jasan Coaghtray



Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

ATTENTION TO: JAMES O'NEILL SAMPLED BY:

Fraction Organic Carbon

DATE RECEIVED: 2018-10-22 DATE REPORTED: 2018-10-29

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

9642091-9642105 Samples were analyzed and are reported in triplicate.

FOC was calculated from the Total Organic Carbon determined by Walkley Black Wet oxidation procedure.

9642106 Samples were analyzed and are reported in triplicate.

FOC was calculated from the Total Organic Carbon determined by Walkley Black Wet oxidation procedure.

Elevated RDLs indicate the degree of sample dilutions prior to the analysis to keep analytes within the calibration range, reduce matrix interference and/or to avoid contaminating the instrument.

9642107-9642111 Samples were analyzed and are reported in triplicate.

FOC was calculated from the Total Organic Carbon determined by Walkley Black Wet oxidation procedure.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Jasar Coughtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Mercury Analysis in Soil DATE RECEIVED: 2018-10-22 **DATE REPORTED: 2018-10-29** SAMPLE DESCRIPTION: 18-MNMA-S1 18-MNMA-S2 18-MNMA-S3 18-MNMA-S4 18-MNMA-S5 18-MNMA-S6 18-MNMA-S7 18-MNMA-S8 SAMPLE TYPE: Sediment Sediment Sediment Sediment Sediment Sediment Sediment Sediment DATE SAMPLED: 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 G/S **RDL** 9642091 9642093 9642094 9642095 9642096 9642097 9642098 9642099 Parameter Unit Mercury mg/kg 0.05 0.14 0.08 0.10 0.64 0.09 0.11 0.06 0.06 SAMPLE DESCRIPTION: 18-MNMA-S9 18-MNMA-S10 18-MNMA-S11 18-MNMA-S12 18-MNMA-S13 18-MNMA-S14 18-MNMA-S15 18-MNMA-DUP1 SAMPLE TYPE: Sediment Sediment Sediment Sediment Sediment Sediment Sediment Sediment DATE SAMPLED: 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 9642101 9642102 9642103 9642104 9642105 9642106 9642107 Parameter Unit G/S **RDL** 9642100 0.05 0.07 0.05 0.05 0.05 0.07 mg/kg 0.07 0.05 0.14 Mercury SAMPLE DESCRIPTION: 18-MNMA-DUP2 18-MNMA-REF1 18-MNMA-REF2 18-MNMA-REF3 SAMPLE TYPE: Sediment Sediment Sediment Sediment DATE SAMPLED: 2018-10-19 2018-10-19 2018-10-19 2018-10-19 9642111 Parameter Unit G/S **RDL** 9642108 9642109 9642110 Mercury 0.05 0.05 < 0.05 0.05 0.05 mg/kg

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

9642091-9642111 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Jasan Coughtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

SAMPLED BY:

ATTENTION TO: JAMES O'NEILL

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel

DATE RECEIVED: 2018-10-22 DATE REPORTED: 2018-10-29													
		SAMPLE DESCRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8			
		SAMPLE TYPE:	Sediment										
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19			
Parameter	Unit	G/S RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099			
Benzene	mg/kg	0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03			
Toluene	mg/kg	0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04			
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03			
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05			
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3			
>C10-C16 Hydrocarbons - 1X silica gel	mg/kg	15	<15	<15	<15	<15	<15	<15	<15	<15			
>C16-C21 Hydrocarbons - 1X silica gel	mg/kg	15	76	54	56	66	76	103	19	<15			
>C21-C32 Hydrocarbons - 1X silica gel	mg/kg	15	203	139	179	187	226	316	81	63			
Modified TPH (Tier 1) - 1X silica gel	mg/kg	20	279	193	235	253	302	419	100	63			
Resemblance Comment			FR, LR										
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ			
Silica Gel Cleanup			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ			
Surrogate	Unit	Acceptable Limits											
Isobutylbenzene - EPH	%	60-140	71	78	96	89	78	97	87	98			
Isobutylbenzene - VPH	%	60-140	78	76	79	80	78	79	75	77			
n-Dotriacontane - EPH	%	60-140	83	87	103	93	84	105	89	101			

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

ONEILI

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel

			•	,	•					
DATE RECEIVED: 2018-10-22							[DATE REPORTI	ED: 2018-10-29	
		SAMPLE DESCRIPTION	: 18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-S12	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA-DUP
		SAMPLE TYPE	: Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
		DATE SAMPLED	: 2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S RDL	9642100	9642101	9642102	9642103	9642104	9642105	9642106	9642107
Benzene	mg/kg	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	mg/kg	0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	<0.03	< 0.03	< 0.03	< 0.03	< 0.03
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3
>C10-C16 Hydrocarbons - 1X silica gel	mg/kg	15	19	<15	<15	<15	<15	<15	<15	<15
>C16-C21 Hydrocarbons - 1X silica gel	mg/kg	15	77	51	28	<15	55	<15	24	48
>C21-C32 Hydrocarbons - 1X silica gel	mg/kg	15	178	149	70	38	51	54	41	129
Modified TPH (Tier 1) - 1X silica gel	mg/kg	20	274	200	98	38	106	54	65	177
Resemblance Comment			FR, LR	FR, LR	FR, LR	LR	FR, LR	LR	FR, LR	FR, LR
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Silica Gel Cleanup			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	60-140	94	89	89	99	99	100	69	63
Isobutylbenzene - VPH	%	60-140	79	81	75	78	79	75	80	78
n-Dotriacontane - EPH	%	60-140	95	89	97	107	102	104	77	69

Certified By:

any Mus



Unit

%

%

%

Acceptable Limits

60-140

60-140

60-140

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

ATTENTION TO: JAMES O'NEILL
SAMPLING SITE:

SAMPLED BY:

97

78

98

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel											
DATE RECEIVED: 2018-10-22								DATE REPORTED: 2018-10-29			
		SAMPLE DESC	CRIPTION:	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3				
		SAMF	PLE TYPE:	Sediment	Sediment	Sediment	Sediment				
		DATE S	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19				
Parameter	Unit	G/S	RDL	9642108	9642109	9642110	9642111				
Benzene	mg/kg		0.03	<0.03	< 0.03	<0.03	< 0.03				
Toluene	mg/kg		0.04	<0.04	<0.04	<0.04	<0.04				
Ethylbenzene	mg/kg		0.03	<0.03	< 0.03	< 0.03	<0.03				
Xylene (Total)	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05				
C6-C10 (less BTEX)	mg/kg		3	<3	<3	<3	<3				
>C10-C16 Hydrocarbons - 1X silica gel	mg/kg		15	<15	<15	<15	<15				
>C16-C21 Hydrocarbons - 1X silica gel	mg/kg		15	75	<15	<15	<15				
>C21-C32 Hydrocarbons - 1X silica gel	mg/kg		15	182	22	<15	<15				
Modified TPH (Tier 1) - 1X silica gel	mg/kg		20	257	22	<20	<20				
Resemblance Comment				FR, LR	LR	NR	NR				
Return to Baseline at C32				Υ	Υ	Υ	Υ				
Silica Gel Cleanup				Υ	Υ	Υ	Υ				

93

75

Certified By:

105

81

110

98

77

102

any Mul

Surrogate

Isobutylbenzene - EPH

Isobutylbenzene - VPH

n-Dotriacontane - EPH



Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

CLIENT NAME: GHD LIMITED

ATTENTION TO: JAMES O'NEILL
SAMPLING SITE:

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel

DATE RECEIVED: 2018-10-22 DATE REPORTED: 2018-10-29

omments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9642091-9642111 Results are based on the dry weight of the soil.

Resemblance Comment Key: GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Huj



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

				Moistu	re					
							Г	DATE REPORTE	ED: 2018-10-29	
	SAMPLE DES	CRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8
	SAM	PLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
	DATE	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Unit	G/S	RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099
%		0	47	39	33	46	57	60	34	36
	SAMPLE DES	CRIPTION:	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-S12	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA-DUP1
	SAM	PLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
	DATE	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Unit	G/S	RDL	9642100	9642101	9642102	9642103	9642104	9642105	9642106	9642107
%		0	54	46	49	68	77	48	38	55
	SAMPLE DES	CRIPTION:	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3				
	SAM	PLE TYPE:	Sediment	Sediment	Sediment	Sediment				
	DATE	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19				
Unit	G/S	RDL	9642108	9642109	9642110	9642111				
%		0	57	22	22	22				
	Unit	SAM DATE: Unit G/S SAMPLE DES SAM DATE: Unit G/S SAMPLE DES SAM DATE: Unit G/S Unit G/S	% 0 SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: Unit G/S RDL % 0 SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: Unit G/S RDL	SAMPLE TYPE: Sediment	SAMPLE DESCRIPTION: 18-MNMA-S1 18-MNMA-S2 SAMPLE TYPE: Sediment Sediment DATE SAMPLED: 2018-10-19 2018-10-19 9642093 964	SAMPLE TYPE: Sediment Sediment Sediment DATE SAMPLED: 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 2018-10-19 30642094	SAMPLE DESCRIPTION: 18-MNMA-S1	SAMPLE DESCRIPTION: 18-MNMA-S1 18-MNMA-S2 18-MNMA-S3 18-MNMA-S4 18-MNMA-S5 SAMPLE TYPE: Sediment Sediment	SAMPLE DESCRIPTION: 18-MNMA-S1 18-MNMA-S2 18-MNMA-S3 18-MNMA-S4 18-MNMA-S5 18-MNMA-S6 SAMPLE TYPE: Sediment Sediment Sediment Sediment Sediment DATE SAMPLED: 2018-10-19 2018-	SAMPLE DESCRIPTION: 18-MNMA-S1 18-MNMA-S2 18-MNMA-S3 18-MNMA-S4 18-MNMA-S5 18-MNMA-S6 18-MNMA-S7 SAMPLE TYPE: Sediment Sedime

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

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hus



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-10-22							Г	DATE REPORTE	ED: 2018-10-29	
	;	SAMPLE DESCRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099
1-Methylnaphthalene	mg/kg	0.05	<0.05	0.06	0.20	0.05	0.27	0.06	<0.05	<0.05
2-Methylnaphthalene	mg/kg	0.01	0.05	0.07	0.24	0.06	0.38	0.07	0.03	<0.01
Acenaphthene	mg/kg	0.00671	0.122	0.146	0.279	0.168	0.728	0.179	0.101	< 0.00671
Acenaphthylene	mg/kg	0.004	0.039	< 0.004	0.045	0.043	0.076	0.063	0.034	0.020
Acridine	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.11	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.03	0.19	0.22	0.31	0.24	1.01	0.27	0.17	0.05
Benzo(a)anthracene	mg/kg	0.01	0.36	0.42	0.58	0.43	1.55	0.59	0.29	0.11
Benzo(a)pyrene	mg/kg	0.01	0.37	0.42	0.60	0.44	1.34	0.57	0.29	0.10
Benzo(b)fluoranthene	mg/kg	0.05	0.36	0.39	0.55	0.41	1.23	0.56	0.27	0.11
Benzo(b+j)fluoranthene	mg/kg	0.1	0.57	0.60	0.90	0.64	1.96	0.80	0.39	0.17
Benzo(e)pyrene	mg/kg	0.05	0.30	0.32	0.42	0.32	0.93	0.43	0.21	0.08
Benzo(ghi)perylene	mg/kg	0.01	<0.01	0.28	0.41	0.29	0.86	0.38	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	0.01	0.19	0.23	0.31	0.26	0.72	0.29	0.19	0.05
Chrysene	mg/kg	0.01	0.47	0.51	0.67	0.53	1.70	0.70	0.33	0.14
Dibenzo(a,h)anthracene	mg/kg	0.006	<0.006	<0.006	< 0.006	< 0.006	< 0.006	< 0.006	<0.006	< 0.006
Fluoranthene	mg/kg	0.05	0.92	0.99	1.59	1.16	3.62	1.37	0.80	0.30
Fluorene	mg/kg	0.01	0.15	0.17	0.32	0.19	0.94	0.20	0.12	0.03
Indeno(1,2,3)pyrene	mg/kg	0.01	<0.01	0.29	0.51	0.38	1.09	<0.01	<0.01	<0.01
Naphthalene	mg/kg	0.01	<0.01	<0.01	0.32	<0.01	0.62	<0.01	<0.01	<0.01
Perylene	mg/kg	0.05	< 0.05	0.11	0.15	0.12	0.33	0.15	< 0.05	< 0.05
Phenanthrene	mg/kg	0.03	0.91	0.94	1.67	1.12	4.05	1.26	0.74	0.22
Pyrene	mg/kg	0.05	0.87	0.80	1.19	0.90	2.61	1.13	0.57	0.24
Quinoline	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Surrogate	Unit	Acceptable Limits								
Nitrobenzene-d5	%	50-140	105	108	106	123	116	111	118	109
2-Fluorobiphenyl	%	50-140	95	93	92	105	103	92	101	90
Terphenyl-d14	%	50-140	107	107	107	118	118	107	117	102

Certified By:



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-10-22							ſ	DATE REPORTE	ED: 2018-10-29	
		SAMPLE DESCRIPTION:	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-S12	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA-DUP
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S RDL	9642100	9642101	9642102	9642103	9642104	9642105	9642106	9642107
1-Methylnaphthalene	mg/kg	0.05	<0.05	0.20	0.07	<0.05	<0.05	<0.05	<0.05	0.11
2-Methylnaphthalene	mg/kg	0.01	0.04	0.20	0.09	0.02	0.02	0.02	0.01	0.13
Acenaphthene	mg/kg	0.00671	0.0831	0.226	0.269	<0.00671	< 0.00671	< 0.00671	0.0478	0.480
Acenaphthylene	mg/kg	0.004	0.058	0.060	0.095	0.049	0.465	0.030	0.039	0.084
Acridine	mg/kg	0.05	< 0.05	<0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.03	0.17	0.33	0.49	0.12	0.56	0.28	0.16	0.72
Benzo(a)anthracene	mg/kg	0.01	0.35	0.59	1.26	0.28	1.45	0.34	0.30	1.08
Benzo(a)pyrene	mg/kg	0.01	0.35	0.52	1.06	0.22	1.42	0.25	0.24	1.04
Benzo(b)fluoranthene	mg/kg	0.05	0.35	0.49	1.00	0.23	1.20	0.26	0.24	1.00
Benzo(b+j)fluoranthene	mg/kg	0.1	0.35	0.81	1.41	0.38	1.80	0.39	0.38	1.39
Benzo(e)pyrene	mg/kg	0.05	0.35	0.37	0.74	0.18	0.89	0.18	0.19	0.74
Benzo(ghi)perylene	mg/kg	0.01	<0.01	0.32	0.64	<0.01	0.76	<0.01	<0.01	0.68
Benzo(k)fluoranthene	mg/kg	0.01	0.43	0.25	0.53	0.11	0.59	0.19	0.11	0.38
Chrysene	mg/kg	0.01	0.41	0.66	1.63	0.33	1.37	0.39	0.33	1.19
Dibenzo(a,h)anthracene	mg/kg	0.006	< 0.006	<0.006	<0.006	<0.006	<0.006	< 0.006	<0.006	< 0.006
Fluoranthene	mg/kg	0.05	0.92	1.67	2.76	1.08	3.93	0.49	0.56	2.91
Fluorene	mg/kg	0.01	0.11	0.26	0.35	0.04	0.13	0.06	0.07	0.52
Indeno(1,2,3)pyrene	mg/kg	0.01	<0.01	0.42	0.65	<0.01	1.13	<0.01	<0.01	0.87
Naphthalene	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.32
Perylene	mg/kg	0.05	<0.05	0.13	0.25	< 0.05	0.41	< 0.05	< 0.05	0.29
Phenanthrene	mg/kg	0.03	0.78	1.50	2.41	0.32	1.42	0.33	0.42	2.82
Pyrene	mg/kg	0.05	0.76	1.27	2.13	0.83	2.98	0.41	0.50	2.27
Quinoline	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Surrogate	Unit	Acceptable Limits								
Nitrobenzene-d5	%	50-140	110	116	94	98	96	96	98	110
2-Fluorobiphenyl	%	50-140	89	95	82	85	82	83	79	91
Terphenyl-d14	%	50-140	103	109	85	85	85	84	79	94

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

ATTENTION TO: JAMES O'NEILL
SAMPLING SITE:

SAMPLED BY:

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-10-22							DATE REPORTED: 2018-10-29
	S	SAMPLE DESCRIPTION:	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3	
		SAMPLE TYPE:	Sediment	Sediment	Sediment	Sediment	
		DATE SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	
Parameter	Unit	G/S RDL	9642108	9642109	9642110	9642111	
I-Methylnaphthalene	mg/kg	0.05	0.08	<0.05	<0.05	<0.05	
2-Methylnaphthalene	mg/kg	0.01	0.09	<0.01	<0.01	<0.01	
Acenaphthene	mg/kg	0.00671	0.209	< 0.00671	< 0.00671	<0.00671	
cenaphthylene	mg/kg	0.004	0.081	< 0.004	< 0.004	<0.004	
Acridine	mg/kg	0.05	< 0.05	< 0.05	< 0.05	<0.05	
Anthracene	mg/kg	0.03	0.44	< 0.03	<0.03	<0.03	
Benzo(a)anthracene	mg/kg	0.01	0.72	0.03	0.02	<0.01	
Benzo(a)pyrene	mg/kg	0.01	0.66	<0.01	<0.01	<0.01	
Benzo(b)fluoranthene	mg/kg	0.05	0.66	< 0.05	< 0.05	<0.05	
Senzo(b+j)fluoranthene	mg/kg	0.1	0.94	<0.1	<0.1	<0.1	
Benzo(e)pyrene	mg/kg	0.05	0.49	< 0.05	< 0.05	<0.05	
Benzo(ghi)perylene	mg/kg	0.01	0.40	<0.01	<0.01	<0.01	
Benzo(k)fluoranthene	mg/kg	0.01	0.35	0.02	<0.01	<0.01	
Chrysene	mg/kg	0.01	0.83	0.03	0.03	<0.01	
Dibenzo(a,h)anthracene	mg/kg	0.006	< 0.006	<0.006	< 0.006	<0.006	
luoranthene	mg/kg	0.05	1.84	0.07	0.07	< 0.05	
luorene	mg/kg	0.01	0.26	<0.01	<0.01	<0.01	
ndeno(1,2,3)pyrene	mg/kg	0.01	0.53	<0.01	<0.01	<0.01	
laphthalene	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01	
Perylene	mg/kg	0.05	0.18	<0.05	<0.05	<0.05	
Phenanthrene	mg/kg	0.03	1.51	0.06	0.04	<0.03	
Pyrene	mg/kg	0.05	1.54	0.05	0.06	<0.05	
Quinoline	mg/kg	0.05	< 0.05	< 0.05	<0.05	<0.05	
Surrogate	Unit	Acceptable Limits					
Nitrobenzene-d5	%	50-140	103	103	92	104	
-Fluorobiphenyl	%	50-140	87	86	76	90	
Terphenyl-d14	%	50-140	90	88	81	89	

Certified By:



RDL - Reported Detection Limit; G / S - Guideline / Standard

Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

ATTENTION TO: JAMES O'NEILL
SAMPLING SITE:

SAMPLED BY:

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-10-22 DATE REPORTED: 2018-10-29

9642091-9642111 Results are based on the dry weight of the soil.

Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hus



Certificate of Analysis

AGAT WORK ORDER: 18K399949

PROJECT:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

ATTENTION TO: JAMES O'NEILL
SAMPLING SITE:

SAMPLED BY:

			Tota	al Polychic	rinated Bip	henyls in S	oil - (PCB)				
DATE RECEIVED: 2018-10-22								[DATE REPORT	ED: 2018-10-29	
		SAMPLE DES	CRIPTION:	18-MNMA-S1	18-MNMA-S2	18-MNMA-S3	18-MNMA-S4	18-MNMA-S5	18-MNMA-S6	18-MNMA-S7	18-MNMA-S8
		SAMI	PLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
		DATE S	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S	RDL	9642091	9642093	9642094	9642095	9642096	9642097	9642098	9642099
Total Polychlorinated Biphenyls	mg/kg		0.02	0.10	0.17	0.65	0.05	0.10	0.53	<0.02	<0.02
Surrogate	Unit	Acceptab	le Limits								
Decachlorobiphenyl	%	50-1	130	121	128	107	110	111	120	118	104
		SAMPLE DES	CRIPTION:	18-MNMA-S9	18-MNMA-S10	18-MNMA-S11	18-MNMA-S12	18-MNMA-S13	18-MNMA-S14	18-MNMA-S15	18-MNMA-DUP1
		SAMI	PLE TYPE:	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
		DATES	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19
Parameter	Unit	G/S	RDL	9642100	9642101	9642102	9642103	9642104	9642105	9642106	9642107
Total Polychlorinated Biphenyls	mg/kg		0.02	0.13	0.03	0.08	<0.02	<0.02	0.27	<0.02	0.07
Surrogate	Unit	Acceptab	le Limits								
Decachlorobiphenyl	%	50-1	130	93	116	128	104	108	115	108	109
		SAMPLE DES	CRIPTION:	18-MNMA-DUP2	18-MNMA-REF1	18-MNMA-REF2	18-MNMA-REF3				
		SAMI	PLE TYPE:	Sediment	Sediment	Sediment	Sediment				
		DATES	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19				
Parameter	Unit	G/S	RDL	9642108	9642109	9642110	9642111				
Total Polychlorinated Biphenyls	mg/kg		0.02	0.05	<0.02	<0.02	<0.02				
Surrogate	Unit	Acceptab	le Limits								
Decachlorobiphenyl	%	50-1	130	116	83	95	96				

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

9642091-9642111 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K399949
PROJECT: ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

				Soi	l Ana	alysis	S								
RPT Date: Oct 29, 2018				DUPLICATI	 E		REFEREN	ICE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		eptable mits	Recovery	Lin	ptable	Recovery	منا أ	ptable nits
TATAMETER	Baton	ld	Bup #1	Bup #2	Tu B		Value	Lower	Upper	recoursely	Lower	Upper	recoursely	Lower	Upper
Available Metals in Soil		•				•			•	•	•	•	•	•	
Aluminum	9645716		4040	3990	1.1%	< 10	119%	80%	120%	NA	80%	120%	102%	70%	130%
Antimony	9645716		<1	<1	NA	< 1	94%	80%	120%	119%	80%	120%	78%	70%	130%
Arsenic	9645716		2	2	NA	< 1	110%	80%	120%	110%	80%	120%	92%	70%	130%
Barium	9645716		19	18	NA	< 5	108%	80%	120%	104%	80%	120%	94%	70%	130%
Beryllium	9645716		<2	<2	NA	< 2	119%	80%	120%	112%	80%	120%	93%	70%	130%
Boron	9645716		7	7	NA	< 2	110%	80%	120%	112%	80%	120%	96%	70%	130%
Cadmium	9645716		< 0.3	< 0.3	NA	< 0.3	109%	80%	120%	108%	80%	120%	91%	70%	130%
Chromium	9645716		8	8	NA	< 2	100%	80%	120%	104%	80%	120%	100%	70%	130%
Cobalt	9645716		2	2	NA	< 1	109%	80%	120%	110%	80%	120%	94%	70%	130%
Copper	9645716		3	3	NA	< 2	109%	80%	120%	110%	80%	120%	92%	70%	130%
Iron	9645716		5100	5040	1.2%	< 50	106%	80%	120%	108%	80%	120%	99%	70%	130%
Lead	9645716		2.1	2.0	NA	< 0.5	113%	80%	120%	103%	80%	120%	91%	70%	130%
Lithium	9645716		11	10	NA	< 5	120%	70%	130%	120%	70%	130%	98%	70%	130%
Manganese	9645716		85	84	0.7%	< 2	108%	80%	120%	108%	80%	120%	102%	70%	130%
Molybdenum	9645716		<2	<2	NA	< 2	105%	80%	120%	111%	80%	120%	88%	70%	130%
Nickel	9645716		5	5	NA	< 2	111%	80%	120%	111%	80%	120%	95%	70%	130%
Selenium	9645716		<1	<1	NA	< 1	103%	80%	120%	113%	80%	120%	95%	70%	130%
Silver	9645716		<0.5	<0.5	NA	< 0.5	113%	80%	120%	113%	80%	120%	92%	70%	130%
Strontium	9645716		44	41	7.6%	< 5	102%	80%	120%	101%	80%	120%	85%	70%	130%
Thallium	9645716		<0.1	<0.1	NA	< 0.1	109%	80%	120%	105%	80%	120%	NA	70%	130%
Tin	9645716		3	3	NA	< 2	108%	80%	120%	113%	80%	120%	88%	70%	130%
Uranium	9645716		0.5	0.5	3.2%	< 0.1	106%	80%	120%	100%	80%	120%	87%	70%	130%
Vanadium	9645716		11	11	0.5%	< 2	103%	80%	120%	104%	80%	120%	101%	70%	130%
Zinc	9645716		7	7	NA	< 5	95%	80%	120%	97%	80%	120%	92%	70%	130%
Moroury Analysis in Soil															
Mercury Analysis in Soil Mercury	1	9645117	0.10	0.11	NA	< 0.05	94%	70%	130%		70%	130%	113%	70%	130%
·															
Available Metals in Soil															
Aluminum	9644818		15300	17200	11.7%	< 10	NA	80%	120%	114%	80%	120%	90%	70%	130%
Antimony	9644818		<1	<1	NA	< 1	90%	80%	120%	118%	80%	120%	73%	70%	130%
Arsenic	9644818		31	30	0.4%	< 1	113%	80%	120%	103%	80%	120%	97%	70%	130%
Barium	9644818		63	63	0.0%	< 5	113%	80%	120%	105%	80%	120%	104%	70%	130%
Beryllium	9644818		<2	<2	NA	< 2	119%	80%	120%	106%	80%	120%	104%	70%	130%
Boron	9644818		3	4	NA	< 2	115%	80%	120%	110%	80%	120%	85%	70%	130%
Cadmium	9644818		<0.3	< 0.3	NA	< 0.3	110%	80%	120%	106%	80%	120%	101%	70%	130%
Chromium	9644818		33	32	3.0%	< 2	104%	80%	120%	100%	80%	120%	89%	70%	130%
Cobalt	9644818		14	14	3.3%	< 1	108%	80%	120%	101%	80%	120%	92%	70%	130%
Copper	9644818		30	29	1.7%	< 2	108%	80%	120%	103%	80%	120%	97%	70%	130%
Iron	9644818		23100	26800	15.1%	< 50	106%	80%	120%	101%	80%	120%	95%	70%	130%

AGAT QUALITY ASSURANCE REPORT (V1)

Page 18 of 27

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

Soil Analysis (Continued)														
RPT Date: Oct 29, 2018			DUPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	1 1:00	ptable nits	Recovery	1 :-	ptable nits
	ld ld		'			Value	Lower	Upper	,	Lower	Upper		Lower	Upper
Lead	9644818	30.5	22.3	31.1%	< 0.5	116%	80%	120%	109%	80%	120%	86%	70%	130%
Lithium	9644818	20	21	NA	< 5	121%	70%	130%	108%	70%	130%	93%	70%	130%
Manganese	9644818	828	884	6.5%	< 2	109%	80%	120%	103%	80%	120%	95%	70%	130%
Molybdenum	9644818	<2	<2	NA	< 2	102%	80%	120%	96%	80%	120%	80%	70%	130%
Nickel	9644818	31	31	1.2%	< 2	106%	80%	120%	99%	80%	120%	91%	70%	130%
Selenium	9644818	<1	<1	NA	< 1	104%	80%	120%	92%	80%	120%	83%	70%	130%
Silver	9644818	<0.5	<0.5	NA	< 0.5	90%	80%	120%	99%	80%	120%	93%	70%	130%
Strontium	9644818	15	15	NA	< 5	107%	80%	120%	101%	80%	120%	103%	70%	130%
Thallium	9644818	<0.1	<0.1	NA	< 0.1	118%	80%	120%	107%	80%	120%	NA	70%	130%
Tin	9644818	4	4	NA	< 2	110%	80%	120%	102%	80%	120%	93%	70%	130%
Uranium	9644818	1.2	1.0	12.6%	< 0.1	116%	80%	120%	107%	80%	120%	94%	70%	130%
Vanadium	9644818	51	54	4.3%	< 2	107%	80%	120%	98%	80%	120%	92%	70%	130%
Zinc	9644818	88	92	4.3%	< 5	106%	80%	120%	98%	80%	120%	92%	70%	130%
Fraction Organic Carbon														
Fraction Organic Carbon-1	9642091 9642091	0.018	0.019	5.4%	< 0.003	113%	70%	130%				102%	70%	130%
Fraction Organic Carbon														
Fraction Organic Carbon-1	9642108 9642108	0.100	0.102	2.0%	< 0.003	108%	70%	130%				102%	70%	130%

Certified By:

Josephan Coughtry

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K399949
PROJECT: ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			Trac	e Or	ganio	cs Ar	nalys	is							
RPT Date: Oct 29, 2018			С	UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	1 1 1 1 1	eptable mits	Recovery	1 1 1 1	ptable nits
		ld	·				Value	Lower	Upper	,	Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbon	s in Soil	(Version 3	.1) - Field	Preserve	d + 1X Si	lica Gel									
Benzene	1	9642091	< 0.03	< 0.03	NA	< 0.03	68%	60%	140%	66%	60%	140%			
Toluene	1	9642091	< 0.04	< 0.04	NA	< 0.04	69%	60%	140%	69%	60%	140%			
Ethylbenzene	1	9642091	< 0.03	< 0.03	NA	< 0.03	70%	60%	140%	70%	60%	140%			
Xylene (Total)	1	9642091	< 0.05	< 0.05	NA	< 0.05	75%	60%	140%	73%	60%	140%			
C6-C10 (less BTEX)	1	9642091	< 3	< 3	NA	< 3	105%	60%	140%	113%	60%	140%	NA	30%	130%
>C10-C16 Hydrocarbons - 1X silica gel	1	9642101	< 15	< 15	NA	< 15	106%	60%	140%	111%	60%	140%	101%	30%	130%
>C16-C21 Hydrocarbons - 1X silica gel	1	9642101	51	49	NA	< 15	115%	60%	140%	111%	60%	140%	101%	30%	130%
>C21-C32 Hydrocarbons - 1X silica gel	1	9642101	149	153	2.6%	< 15	131%	60%	140%	111%	60%	140%	101%	30%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

	·														
Polycyclic Aromatic Hydrocar	bons in Soi	I													
1-Methylnaphthalene	1	9642101	0.20	0.15	NA	< 0.05	131%	50%	140%	103%	50%	140%	71%	50%	140%
2-Methylnaphthalene	1	9642101	0.20	0.17	16.2%	< 0.01	131%	50%	140%	104%	50%	140%	76%	50%	140%
Acenaphthene	1	9642101	0.226	0.177	24.3%	< 0.00671	135%	50%	140%	109%	50%	140%	86%	50%	140%
Acenaphthylene	1	9642101	0.060	0.041	37.6%	< 0.004	130%	50%	140%	97%	50%	140%	98%	50%	140%
Acridine	1	9642101	< 0.05	< 0.05	NA	< 0.05	91%	50%	140%	90%	50%	140%	95%	50%	140%
Anthracene	1	9642101	0.33	0.27	20.0%	< 0.03	121%	50%	140%	100%	50%	140%	99%	50%	140%
Benzo(a)anthracene	1	9642101	0.59	0.56	5.2%	< 0.01	116%	50%	140%	98%	50%	140%	75%	50%	140%
Benzo(a)pyrene	1	9642101	0.52	0.44	16.7%	< 0.01	123%	50%	140%	103%	50%	140%	78%	50%	140%
Benzo(b)fluoranthene	1	9642101	0.49	0.47	4.2%	< 0.05	107%	50%	140%	92%	50%	140%	68%	50%	140%
Benzo(b+j)fluoranthene	1	9642101	0.81	0.72	11.8%	< 0.1	119%	50%	140%	116%	50%	140%	59%	50%	140%
Benzo(e)pyrene	1	9642101	0.37	0.33	11.4%	< 0.05	130%	50%	140%	104%	50%	140%	79%	50%	140%
Benzo(ghi)perylene	1	9642101	0.32	0.27	16.9%	< 0.01	129%	50%	140%	98%	50%	140%	78%	50%	140%
Benzo(k)fluoranthene	1	9642101	0.25	0.30	18.2%	< 0.01	103%	50%	140%	90%	50%	140%	68%	50%	140%
Chrysene	1	9642101	0.66	0.66	0.0%	< 0.01	129%	50%	140%	102%	50%	140%	73%	50%	140%
Dibenzo(a,h)anthracene	1	9642101	< 0.006	< 0.006	NA	< 0.006	101%	50%	140%	87%	50%	140%	86%	50%	140%
Fluoranthene	1	9642101	1.67	1.37	19.7%	< 0.05	124%	50%	140%	102%	50%	140%	99%	50%	140%
Fluorene	1	9642101	0.26	0.20	26.1%	< 0.01	132%	50%	140%	106%	50%	140%	84%	50%	140%
Indeno(1,2,3)pyrene	1	9642101	0.42	0.36	15.4%	< 0.01	98%	50%	140%	83%	50%	140%	55%	50%	140%
Naphthalene	1	9642101	< 0.01	< 0.01	NA	< 0.01	134%	50%	140%	109%	50%	140%	110%	50%	140%
Perylene	1	9642101	0.13	0.12	NA	< 0.05	123%	50%	140%	101%	50%	140%	85%	50%	140%
Phenanthrene	1	9642101	1.50	1.17	24.7%	< 0.03	136%	50%	140%	107%	50%	140%	60%	50%	140%
Pyrene	1	9642101	1.27	1.06	18.0%	< 0.05	121%	50%	140%	99%	50%	140%	91%	50%	140%
Quinoline	1	9642101	< 0.05	< 0.05	NA	< 0.05	117%	50%	140%	100%	50%	140%	97%	50%	140%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

AGAT QUALITY ASSURANCE REPORT (V1)

Page 20 of 27



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE:

SAMPLED BY:

	Trace Organics Analysis (Continued)														
RPT Date: Oct 29, 2018				UPLICAT	E		REFEREN	ICE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPII	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		otable nits	Recovery	Lin	ptable nits	Recovery	Lim	ptable nits
		la la					Value	Lower	Upper		Lower	Upper	,	Lower	Upper

Total Polychlorinated Biphenyls in Soil - (PCB)

Total Polychlorinated Biphenyls 1 9615144 < 0.02 < 0.02 NA < 0.02 124% 60% 130% 91% 60% 130% 103% 60% 130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Total Polychlorinated Biphenyls in Soil - (PCB)

Total Polychlorinated Biphenyls 1 9642102 0.08 0.10 NA < 0.02 121% 60% 130% 96% 60% 130% 125% 60% 130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K399949
PROJECT: ATTENTION TO: JAMES O'NEILL

	1		1
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Fraction Organic Carbon-1	INOR-93-6062	Skjemstad & Baldock, 2008 & Walkley & Balck 1934	SPECTROPHOTOMETER
Fraction Organic Carbon-2	INOR-93-6062	& Baick 1934	SPECTROPHOTOMETER
Fraction Organic Carbon-3	INOR-93-6062	Skjemstad & Baldock, 2008 & Walkley & Balck 1934	SPECTROPHOTOMETER



Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Fraction Organic Carbon-Avg	INCR-93-bub/	Skjemstad & Baldock, 2008 & Walkley & Balck 1934	SPECTROPHOTOMETER
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K399949

PROJECT:

ATTENTION TO: JAMES O'NEILL

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C21-C32 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Modified TPH (Tier 1) - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Silica Gel Cleanup			GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
% Moisture		Calculation	GRAVIMETRIC
1-Methylnaphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
2-Methylnaphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acenaphthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acenaphthylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acridine	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(a)anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(a)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(b)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(b+j)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(e)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(ghi)perylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(k)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Chrysene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Dibenzo(a,h)anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Fluorene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Indeno(1,2,3)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Naphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Perylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Phenanthrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS



Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K399949
PROJECT: ATTENTION TO: JAMES O'NEILL

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Quinoline	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Nitrobenzene-d5	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
2-Fluorobiphenyl	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Terphenyl-d14	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Total Polychlorinated Biphenyls	ORG-120-5106	EPA SW846/8081/8080	GC/ECD
Decachlorobiphenyl	ORG-120-5106	EAP SW846 3510C/8080/8010	GC/ECD



Dartmouth, B3B 1N

webearth.agatlabs.com • www.agatlabsco

P: 902.468.8718 • F: 902.468.89

ive				
NS	Laboratory	Use Only		
M2 om 24	Arrival Condit Arrival Tempe AGAT Job Nur	erature:	od Poor (see n	otes)
at	Notes:	moer.		
er	Turnaround	Time Requ	ired (TAT)	
	Regular TAT	□5 to 7 wo	rking days	
er	Rush TAT	☐ 1 day	☑ 2 days	111

Chain	of Cust	tody Record		Report Info	rmation								I	lotes	S;									
Report Inf	ormation			1. Name:					Re	po	t Fo	rmat	Ш											Ш
Company:	GHD Limite	ed			James O'Neill				Н															
Contact:	James O'N	eill			James.O'Neill@ghd.com] Si	ngle ample	e per	I T	irna	rou	nd T	ime	Rec	quire	d (TA	T)			Ħ
Address:	1118 Tops	ail Road			DataNL						age		Ш											
	St. John's	NL A1B 3N7			datanl@ghd.com] M	ultipl	e es per		egul	ar T	AT	∐5	to 7 1	workii	ng day	ys			
Phone:	1-709-364-5	5353 Fax: 1-	709-364-5368	\$ 1					-		age	o pei	R	ush '	TAT			day		2	days	16	1	$\!$
IOL Site #	and Name:	Marystown Shipyard V	Vaterlot	Regulatory	Requirements (Check):					E	cel						□3	days			7	15	П	
Project #:		11178792-02		☐ List Guidelines	on Report 🖸 Do Not List Gu	idelines o	n Repoi	rt	1		rmat clude			-1- 5		ton als				1	56		-	
AGAT Quo	tation #:	GHD 'Standing Offer"		□ PIRI □ Tier 1	□ Gas ☑ Pot ☑	Coarse			-				ال	ate n	requ	ired:	_			-2				
GHD PO #	-	ollow		□Res		Fine			11		_	er Sa	nple:	ΠY	'es	7	No							
Invoice To		S	ame Yes ☑ / No □	☑ Com	□ Lube		u V		Re	g. No).: ₋				- 10			Di -						
			, , , , ,	☑ CCME	□ CDWQ			BLE)																П
Company:				□ Industria			1	LOW LEVEL (POTABLE)			يو ا				(a)									
Contact:				□ Commer □ Res/Par			4	LEVEL			ailab		<u> </u>		aniste				11		1 1			
Address:				□ Agricultu			胄	MO.	8	-	☑ Available		1		na C	Clean-up								
	-			□ FWAL	7	ERS	1 ABC	<u>E</u>	S F	3	4 1	1	5		JIII	lear							3	
Phone:	4	Fax:		☑ Sedime	ent	CONTAINERS	ATLANTIC RBCA TIER	RBCA TIER I	ONA		□Diss		SIZE (SIEVE BIID FIPERE)		0N (S	-	_						(8)	=
						8	MILA	ATLANTIC F	3ACT	2	otal	1	2		NATI	Silica	Mercury						YEA	3
****				DAMADLE	COMMENTS -	ROR		-AIII	X 2	2 5			5		CTIC								NR 1	Snoc
	SAMPLE IDEN	ITIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBE	TPH/BTEX	тРН/ВТЕХ-	TPH/BTEX FRACTIONATION	MTRE ONLY	METALS: □ Total	FOC	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER					HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
18-MNMA-S	51		2018/10/19 09:30	Sediment	2 x250ml& 2 x40ml &2x120m	6	Ø				Ø	Ø	Ø	Ø		Ø	Ø				1			П
18-MNMA-S	32		2018/10/19 09:45	Sediment	2 x250ml& 2 x40ml &2x120m	6	Ø				Ø	Ø	Ø	Ø		V	Ø							
18-MNMA-S	33		2018/10/19 10:30	Sediment	2 x250ml& 2 x40ml &2x120m	6	Ø				Ø	Ø	Ø	Ø		Ø	Ø							17
18-MNMA-S		×	2018/10/19 11:00	Sediment	2 x250ml& 2 x40ml &2x120m		Ø				Ø	Ø	Ø	Ø		Ø	Ø							
18-MNMA-S			2018/10/19 11:20		2 x250ml& 2 x40ml &2x120m		Ø				Ø	Ø	Ø											
18-MNMA-S			2018/10/19 11:45	Sediment	2 x250ml& 2 x40ml &2x120m	1					Ø	Ø	Ø	Ø		Ø	Ø							
18-MNMA-S			2018/10/19 12:00	Sediment	2 x250ml& 2 x40ml &2x120m	-	Ø			_	Ø		Ø	_		Ø	Ø							
18-MNMA-S			2018/10/19 12:20	Sediment	2 x250ml& 2 x40ml &2x120m		Ø		_	\perp	✓	Ø		Ø		_	Ø		\perp		Ш			
18-MNMA-S			2018/10/19 12:40	Sediment	2 x250ml& 2 x40ml &2x120m	-					Ø	Ø	Z	-			Ø		\perp	_	\perp			
18-MNMA-S 18-MNMA-S			2018/10/19 13:05	Sediment	2 x250ml& 2 x40ml &2x120m					+	Ø	☑	V	-		_	Ø		\perp	_			1	
Samples Relinquish	ed By (Print Name):	1.6	2018/10/19 13:25	I San	2 x250ml& 2 x40ml &2x120m	1 6	Ø			┸	☑ Date/	Z Z		Ø		Ø		1	Ш		\perp			
Samples Relinquish	A.	bert Percy	1-70 d	8912	Sammi	IV	06	1	_		L	10	7						Pa	age <u>1</u>		of _2	_	
pampies relinquish	eu ay (algil):	11/120	Date/Time	Sam	nples Received Br15((n))	11	1.		/		Date	Time						-						





Dartmouth, NS

B3B 1M2

webearth.agatlabs.com • www.agatlabscom

	Arrival Temperature
P: 902.468.8718 • F: 902.468.8924	AGAT Joh Number

Laboratory Use Only

☐ Poor	see	notes)

Arrival Condition:	Good	☐ Poor (s
Arrival Temperature	E 8.1	83,9
10171111	12K	2000

	All Ival Collation.	ŧ.
	Arrival Temperature: 818386	
-	AGAT Job Number: 185399949	
	Notes:	
7		

Chain of Custody Record	ı .	Report Info	rmation								- 11	Note	s:										1
Report Information		1. Name:					Re	oqe	t Fo	rmat													
Company: GHD Limited		Email:	James O'Neill					C:	ngle		IIL												
Contact: James O'Neill		2. Name:	James.O'Neill@ghd.com					Sa	mple	per	l -		aroı	und	Tim	ne Re	auir:	=== ed (1	(TAT)		_		i
Address: 1118 Topsail Road		Email: [DataNL				11	pa	ige		Н						•	•	,				1
St. John's NL A1B 3N7			datanl@ghd.com						ultipl ımple	e e ne		∢egu	iar i			5 to 7		ing d	ays				
Phone: 1-709-364-5353 Fax:	1-709-364-5368						-		ige	,5 pc		Rush	TAT	•		1 day		✓	2 day	ys -	-	##	1
IOL Site # and Name: Marystown Shipyar	d Waterlot		Requirements (Check):				Ⅱ┌		cel							3 days	3		m!	10	7	11	
Project #: 11178792-02		☐ List Guidelines	on Report	lelines o	n Repo	rt	-		rmat clude		11,)ato	Pogi	uired					1			0	
AGAT Quotation #: GHD 'Standing Offe	er"	☑ Tier 1	□ Gas ☑ Pot ☑ C	Coarse	,		-				_الـ	Jale	тец	aneu	77			7	7 00				
GHD PO #: To Follow		□ Res		ine			1.1		g Wat	er Sa	mple	: 🗆	Yes	Œ	⊠ No								
Invoice To	Same Yes ☑ / No □	☑ Com	Lube	_] [Re	g. No	·-														
	, II	☑ CCME	□ CDWQ			BLE)																	
Company:		□ Industria				(POTA			o l				<u>F</u>										1
Contact:		☐ Comme	= *****		4	LOW LEVEL (POTABLE)			ailab		n l		aniste			- 1							
Address:		□ Agriculti			RBCA TIER	MO		2	☑ Available		jbett		la Co	린									
		□ FWAL	71	:RS	1 BCA	ER -	NO E	2			E		umn	lear					1			_	
Phone: Fax:		☑ Sedime	ent	TAINE	IIIC F	BCA T	ONA		□ Diss		SIZE (Sieve and Pipette)	Ш	S) NC	Gel Clean-up								3	,
				NO NO	ATLANTIC	NTIC	ACT	3	otaí		E (Si		NAT		Mercury				- 1			YEAR	
		01,101	COMMENTS -	R OR		ATLA	E H		ļ		E SIZ		CTIO	Silica								R 1	3
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBE	TPH/BTEX	TPH/BTEX - ATLANTIC RBCA TIER I -	TPH/BTEX FRACTIONATION	MIBE (ADDED TO TETT) DIEX)	METALS: □ Total	F0C	PARTICLE	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER:						HOLD FOR 1 YEAR (Y/N)	!
18-MNMA-S12	2018/10/19 13:40	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø					Ø	Ø			Ø	Ø								Ī
18-MNMA-S13	2018/10/19 13:55	Sediment	2 x250ml& 2 x40ml &2x120ml	6	V				Ø	Ø	Œ			Ø	Ø								_
18-MNMA-S14	2018/10/19 14:05	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				V	Ø	Ø			Ø	Ø								
18-MNMA-S15	2018/10/19 14:15	Sediment	2 x250ml& 2 x40ml &2x120ml	6					✓	Ø	Ø	0 0		Ø	V								
18-MNMA-DUP1	2018/10/19 11:46	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Ø	Ø	G			Ø	Ø								
18-MNMA-DUP2	2018/10/19 13:26	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Ø	✓	G	0 0		Ø	Ø								
18-MNMA-REF1	2018/10/19 14:30	Sediment	2 x250ml& 2 x40ml &2x120ml	6	☑				Ø	Ø	Q			☑	Ø								
18-MNMA-REF2	2018/10/19 14:45	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Ø	Ø	Ū.	0 0		Ø	Ø								
18-MNMA-REF3	2018/10/19 15:00	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Ø	Ø	6	0 0		Ø	Ø								
Samples Relinguished By (Print Name):							1																
Kebert	(0/22	2/20/8 Sam	oples Received By Print Viguna):	in	VI	/			Date/	Time							Р	age _	2	of .	2		
Samples Relinquished By (Sign):	Date/Time	San	oples Received By Bigm.		111				Date/	Time		_				13							-

Document ID: DIV 133 1502 001



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K397661

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Nov 01, 2018

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES	

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 10

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397661

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

57 Old Pennywell Road, Unit I

Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)

DATE RECEIVED: 2018-10-16							[DATE REPORT	ED: 2018-11-01	
			MASO-MW1-	MLLA-MW1-	MFPA-MW1-		MSBL-MW2-		MAEB-MW1-	MAEB-MW2-
		SAMPLE DESCRIPTION:	2018	2018	2018	MSBL-MW6	2018	MW0	2018	2018
		SAMPLE TYPE:	Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:	2018-10-12	2018-10-12	2018-10-12	2018-10-12	2018-10-12	2018-10-12	2018-10-12	2018-10-12
Parameter	Unit	G/S RDL	9627307	9627322	9627336	9627337	9627338	9627339	9627340	9627341
Benzene	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	0.001	<0.001	<0.001	<0.001	< 0.001	< 0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.001	<0.001	<0.001	<0.001	< 0.001	<0.001	<0.001	<0.001	<0.001
Xylene (Total)	mg/L	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
C6-C10 (less BTEX)	mg/L	0.01	0.04	<0.01	0.24	0.04	<0.01	<0.01	<0.01	0.22
>C10-C16 Hydrocarbons	mg/L	0.05	1.28	< 0.05	0.40	1.99	0.16	0.44	< 0.05	6.51
>C16-C21 Hydrocarbons	mg/L	0.10	0.64	<0.10	0.46	2.72	0.15	0.51	<0.10	4.88
>C21-C32 Hydrocarbons	mg/L	0.1	1.29	<0.1	0.32	0.76	<0.1	0.20	<0.1	0.68
Modified TPH (Tier 1)	mg/L	0.1	3.3	<0.1	1.4	5.5	0.3	1.2	<0.1	12.3
Resemblance Comment			FOF, LOF	NR	WFOF	WFOF	WFOF	WFOF	NR	FOF
Return to Baseline at C32			Υ	Υ	Υ	Υ	Υ	Υ	Υ	Υ
Surrogate	Unit	Acceptable Limits								
Isobutylbenzene - EPH	%	70-130	70	88	109	92	87	117	92	103
Isobutylbenzene - VPH	%	70-130	91	95	96	96	97	89	92	100
n-Dotriacontane - EPH	%	70-130	71	87	111	94	84	124	93	88

Certified By:

any Hu



Certificate of Analysis

AGAT WORK ORDER: 18K397661

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)

DATE RECEIVED: 2018-10-16 **DATE REPORTED: 2018-11-01** MDSA-MW3-MDSA-MW2-SAMPLE DESCRIPTION: MGSB-MW15 MW00 2018 2018 MDSA-MW9 MGSB-MW17 SAMPLE TYPE: Water Water Water Water Water Water DATE SAMPLED: 2018-10-12 2018-10-12 2018-10-12 2018-10-12 2018-10-12 2018-10-12 9627342 9627343 9627344 9627347 9627348 9627349 Parameter Unit G/S **RDL** Benzene 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 mg/L Toluene 0.001 < 0.001 < 0.001 <0.001 < 0.001 < 0.001 < 0.001 mg/L Ethylbenzene mg/L 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 Xylene (Total) mg/L 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 C6-C10 (less BTEX) 0.01 1.08 0.01 < 0.01 < 0.01 < 0.01 mg/L 1.09 >C10-C16 Hydrocarbons mg/L 0.05 230 88.6 < 0.05 0.12 < 0.05 1.87 >C16-C21 Hydrocarbons 0.10 190 71.2 <0.10 0.17 3.23 ma/L < 0.10 >C21-C32 Hydrocarbons mg/L 0.1 26.0 10.9 < 0.1 < 0.1 < 0.1 0.92 Modified TPH (Tier 1) 0.1 447 172 < 0.1 0.3 < 0.1 6.0 mg/L FOF GR WFOF WFOF Resemblance Comment **FOF** NR Return to Baseline at C32 Unit Acceptable Limits Surrogate Isobutylbenzene - EPH % 70-130 72 124 101 109 109 107 Isobutylbenzene - VPH % 70-130 97 86 97 96 96 99 n-Dotriacontane - EPH % 70-130 105 93 103 115 115 113

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

9627307-9627349 Resemblance Comment Key: GF - Gasoline Fraction

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hus

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139

http://www.agatlabs.com



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K397661

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Dissolved Metals

				Dissolved	wetais				
DATE RECEIVED: 2018-10-16								DATE REPORTE	D: 2018-11-01
Parameter	Unit	SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: G/S RDL	Water	MLLA-MW4- 2018 Water 2018-10-12 9627317	MLLA-MW2- 2018 Water 2018-10-12 9627325	MAEB-MW2- 2018 Water 2018-10-12 9627341	MDSA-MW1- 2018 Water 2018-10-12 9627345	MW000 Water 2018-10-12 9627346	
Dissolved Aluminum	ug/L	5	14	14	110	39	13	<5	
Dissolved Antimony	ug/L	2	<2	<2	<2	<2	<2	<2	
Dissolved Arsenic	ug/L	2	240	362	87	19	27	36	
Dissolved Barium	ug/L	5	55	76	483	97	87	82	
Dissolved Beryllium	ug/L	2	<2	<2	<2	<2	<2	<2	
Dissolved Bismuth	ug/L	2	<2	<2	<2	<2	<2	<2	
Dissolved Boron	ug/L	5	2370	2960	387	20	1930	1720	
Dissolved Cadmium	ug/L	0.09	0.13	0.16	< 0.09	< 0.09	0.11	0.11	
Dissolved Chromium	ug/L	1	6	7	4	2	3	3	
Dissolved Cobalt	ug/L	1	1	2	1	<1	<1	<1	
Dissolved Copper	ug/L	2	4	7	3	3	5	4	
Dissolved Iron	ug/L	50	<50	<50	2780	149	<50	<50	
Dissolved Lead	ug/L	0.5	<0.5	<0.5	0.5	<0.5	0.5	<0.5	
Dissolved Manganese	ug/L	2	176	33	4790	320	20	18	
Dissolved Molybdenum	ug/L	2	4	5	<2	4	2	2	
Dissolved Nickel	ug/L	2	8	10	4	<2	7	8	
Dissolved Selenium	ug/L	1	109	156	43	3	97	96	
Dissolved Silver	ug/L	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	
Dissolved Strontium	ug/L	5	4040	5290	969	139	3860	3630	
Dissolved Thallium	ug/L	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	
Dissolved Tin	ug/L	2	<2	<2	<2	<2	<2	<2	
Dissolved Titanium	ug/L	2	4	6	6	4	2	2	
Dissolved Uranium	ug/L	0.1	1.5	1.9	0.4	0.1	0.8	0.8	
Dissolved Vanadium	ug/L	2	478	494	152	18	25	32	
Dissolved Zinc	ug/L	5	17	32	12	9	17	15	

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

9627313-9627346 Analysis completed on a filtered sample. Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397661
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE:								SAIVIP	LED B	Τ.					
Trace Organics Analysis															
RPT Date: Nov 01, 2018		DUPLICATE				REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE				
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Limits Value Lower Uppe		Recovery	Lin	ptable nits	Recovery	Acceptable Limits		
		ld		'				Lower	Upper	,	Lower	Upper		Lower	Upper
Atlantic RBCA Tier 1 Hydrocarbor	ns in Wat	er (Versior	າ 3.0)												
Benzene	1	9640692	< 0.001	< 0.001	NA	< 0.001	79%	70%	130%	70%	70%	130%			
Toluene	1	9640692	< 0.001	< 0.001	NA	< 0.001	84%	70%	130%	71%	70%	130%			
Ethylbenzene	1	9640692	< 0.001	< 0.001	NA	< 0.001	85%	70%	130%	72%	70%	130%			
Xylene (Total)	1	9640692	< 0.002	< 0.002	NA	< 0.002	89%	70%	130%	75%	70%	130%			
C6-C10 (less BTEX)	1	9640692	< 0.01	< 0.01	NA	< 0.01	120%	70%	130%	111%	70%	130%	NA	70%	130%
>C10-C16 Hydrocarbons	1	9627338	0.16	0.20	NA	< 0.05	102%	70%	130%	96%	70%	130%	74%	70%	130%
>C16-C21 Hydrocarbons	1	9627338	0.19	0.26	NA	< 0.10	88%	70%	130%	96%	70%	130%	74%	70%	130%
>C21-C32 Hydrocarbons	1	9627338	<0.1	<0.1	NA	< 0.1	93%	70%	130%	96%	70%	130%	74%	70%	130%
Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.															
Atlantic RBCA Tier 1 Hydrocarbor	ns in Wat	er (Versior	າ 3.0)												
Benzene	1	9632900	< 0.001	< 0.001	NA	< 0.001	84%	70%	130%	70%	70%	130%			
Toluene	1	9632900	< 0.001	< 0.001	NA	< 0.001	92%	70%	130%	77%	70%	130%			
Ethylbenzene	1	9632900	< 0.001	< 0.001	NA	< 0.001	96%	70%	130%	82%	70%	130%			
Xylene (Total)	1	9632900	< 0.002	< 0.002	NA	< 0.002	99%	70%	130%	84%	70%	130%			
C6-C10 (less BTEX)	1	9632900	< 0.01	< 0.01	NA	< 0.01	124%	70%	130%	118%	70%	130%	NA	70%	130%
Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.															
Atlantic RBCA Tier 1 Hydrocarbor	ns in Wat	er (Versior	3.0)												
Benzene	1	9654418	<0.001	<0.001	0	< 0.001	87%	70%	130%	75%	70%	130%			
Toluene	1	9654418	<0.001	<0.001	0	< 0.001	89%	70%	130%	83%	70%	130%			
Ethylbenzene	1	9654418	<0.001	<0.001	0	< 0.001	90%	70%	130%	86%	70%	130%			
Xylene (Total)	1	9654418	< 0.002	< 0.002	0	< 0.002	95%	70%	130%	90%	70%	130%			
C6-C10 (less BTEX)	1	9654418	<0.01	<0.01	0	< 0.01	95%	70%	130%	101%	70%	130%	104%	70%	130%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

< 0.05

< 0.05

< 0.01

< 0.05

< 0.05

< 0.01

0

< 0.05

< 0.10

< 0.1

98%

90%

97%

70% 130%

70% 130%

70% 130%

82%

82%

82%

70% 130%

70% 130%

70% 130%

87%

87%

87%

70% 130%

70% 130%

70% 130%

9643254

9643254

9643254

Certified By:

my Hus

AGAT QUALITY ASSURANCE REPORT (V1)

>C10-C16 Hydrocarbons

>C16-C21 Hydrocarbons

>C21-C32 Hydrocarbons

Page 5 of 10



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K397661

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE:

SAMPLED BY:

Water Analysis															
RPT Date: Nov 01, 2018		DUPLICATE			REFERE	NCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE				
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured	Acceptable d Limits	Recovery	Lir	ptable	Recovery	Acceptable Limits		
		ld		'			Value Lower U	Upper		Lower	Upper		Lower	Upper	
Dissolved Metals															
Dissolved Aluminum	9643800		<5	<5	NA	< 5	115%	80%	120%	109%	80%	120%	116%	70%	130%
Dissolved Antimony	9643800		<2	<2	NA	< 2	100%	80%	120%	109%	80%	120%	95%	70%	130%
Dissolved Arsenic	9643800		<2	<2	NA	< 2	97%	80%	120%	93%	80%	120%	NA	70%	130%
Dissolved Barium	9643800		199	233	15.7%	< 5	99%	80%	120%	94%	80%	120%	NA	70%	130%
Dissolved Beryllium	9643800		<2	<2	NA	< 2	92%	80%	120%	89%	80%	120%	124%	70%	130%
Dissolved Bismuth	9643800		<2	<2	NA	< 2	99%	80%	120%	95%	80%	120%	103%	70%	130%
Dissolved Boron	9643800		28	36	25.4%	< 5	96%	80%	120%	86%	80%	120%	122%	70%	130%
Dissolved Cadmium	9643800		< 0.09	< 0.09	NA	< 0.09	101%	80%	120%	93%	80%	120%	108%	70%	130%
Dissolved Chromium	9643800		4	5	NA	< 1	103%	80%	120%	93%	80%	120%	83%	70%	130%
Dissolved Cobalt	9643800		<1	<1	NA	< 1	103%	80%	120%	93%	80%	120%	82%	70%	130%
Dissolved Copper	9643800		<2	<2	NA	< 2	102%	80%	120%	93%	80%	120%	90%	70%	130%
Dissolved Iron	9643800		<50	<50	NA	< 50	101%	80%	120%	91%	80%	120%	73%	70%	130%
Dissolved Lead	9643800		< 0.5	<0.5	NA	< 0.5	99%	80%	120%	94%	80%	120%	105%	70%	130%
Dissolved Manganese	9643800		226	233	3.1%	< 2	102%	80%	120%	92%	80%	120%	NA	70%	130%
Dissolved Molybdenum	9643800		<2	<2	NA	< 2	99%	80%	120%	90%	80%	120%	121%	70%	130%
Dissolved Nickel	9643800		<2	<2	NA	< 2	102%	80%	120%	94%	80%	120%	86%	70%	130%
Dissolved Selenium	9643800		<1	<1	NA	< 1	97%	80%	120%	95%	80%	120%	113%	70%	130%
Dissolved Silver	9643800		<0.1	0.3	NA	< 0.1	103%	80%	120%	95%	80%	120%	98%	70%	130%
Dissolved Strontium	9643800		295	309	4.7%	< 5	112%	80%	120%	103%	80%	120%	NA	70%	130%
Dissolved Thallium	9643800		<0.1	<0.1	NA	< 0.1	100%	80%	120%	95%	80%	120%	104%	70%	130%
Dissolved Tin	9643800		<2	<2	NA	< 2	98%	80%	120%	93%	80%	120%	NA	70%	130%
Dissolved Titanium	9643800		<2	<2	NA	< 2	107%	80%	120%	101%	80%	120%	122%	70%	130%
Dissolved Uranium	9643800		2.0	2.6	23.3%	< 0.1	95%	80%	120%	91%	80%	120%	118%	70%	130%
Dissolved Vanadium	9643800		2	<2	NA	< 2	99%	80%	120%	90%	80%	120%	76%	70%	130%
Dissolved Zinc	9643800		<5	<5	NA	< 5	102%	80%	120%	92%	80%	120%	104%	70%	130%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

Josan Coughtry

Method Summary

CLIENT NAME: GHD LIMITED PROJECT: 11178792-02

SAMPLING SITE:

AGAT WORK ORDER: 18K397661 ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

o, 2 o 2		O/ (IVII EED D I .					
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE				
Trace Organics Analysis		•	•				
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION				
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID				
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS				
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID				

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K397661
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis		W	
Dissolved Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Antimony	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Dissolved Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902.468.8718 * F: 902.468.8924

	Laboratory Use Only
	Arrival Condition: ☐Good ☐ Poor (see notes)
	Arrival Temperature: 6.18.6.4.6.4.6
200	AGAT Job Number: 184397661
	Notes:

Chain of Custody Record		Report Info	ormation									Note	es:										
Report Information		1. Name:					Re	por	t Fo	rmat													
Company: GHD Contractors Limited			James O'Neil					Cir	adla														
Contact: James O'Neill			James.Oneill@ghd.com					Sa		per		Turnaround Time Required (TAT)											
Address: 1118 Topsail Road			Robert Perry					pa	_		Ш						-			•			
St. John's NL			Robert.Perry@ghd.com				V] Μι Sa	ıltipl mple	e es pe	.	Regular TAT ✓ 5 to 7 working days											
Phone: 1-709-364-5353 Fax: 1-	709-364-5368			_				pa		,	F	lush	TAT	•		1 da	_		□ 2 €	days			
IOL Site # and Name: Marystown Shipyard			Requirements (Check):						cel rmat						Ш	l3 da	ıys		2				
Project #: 11178792-02		☐ List Guidelines	on Report	idelines o	n Repo	rt			clude			ate i	Real	irer	4								
AGAT Quotation #: 15-115798		☑ Tier 1	□ Gas □ Pot ☑	Coarse							_												=
GHD PO #: 73512762		□Res	,	Fine				nking g. No.	-	er Sa	npie:		Yes	1	☑ No)							
Invoice To Si	ame Yes ☑ / No □	☑ Com	Lube				T	5. 140.		-	_	7	_	-			-	_	=		_	T	_
Company:		□ CCME □ Industria □ Comme □ Res/Par	rcial 🗆 Other		TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE)			☑ Available		(ama)		Canister)										
Address:		□ Agricultı □ FWAL	ural	ပ္ဆ	RBCA T	- I- I	S E	ì		i	;		mma										
Phone: Fax:		□ Sedime	ent ————————————————————————————————————	CONTAINER	ATLANTIC RE	ANTIC RBCA TIE	MTRE (ADDED TO TPH/BTE		otal 🗆 Diss	FOC			NATION (Su									HOLD FOR 1 YEAR (Y/N)	S (Y/N)
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR CONTAINERS	TPH/BTEX - ATLANTIC	TPH/BTEX - ATL/	MTBE (ADDED TO TPH/BTEX)	MTBE ONLY	METALS: □ Total	FOC	PAHs	PCBs	TPH FRACTIONATION (Summa	OTHER:	OTHER:	отнек:						HOLD FOR 1	HAZARDOUS (Y/N)
MASO-MW1-2018	2018/10/12 08:30	Water	3 x 40 mL & 2 x 250 mL	5		Ø			Ш			_	Ш		Ш		_	4		_	_	\perp	L
MLLA-MW3-2018	2018/10/12 09:00	Water	1x120mL	1		_			Ø		4	-			Ш		_	\perp	\perp	_	_	\perp	
MLLA-MW4-2018	2018/10/12 09:10	Water	1x120mL	1		4	4-	-			+	1	_		Ш		+	+	+	\rightarrow	_	\vdash	-
MLLA-MW1-2018	2018/10/12 09:20	Water	3 x 40 mL & 2 x 250 mL	5			+	-		-	+	_	-				_	+	+	_	_	\vdash	-
MLLA-MW2-2018	2018/10/12 10:15	Water	1x120mL	1		_	4	+	Ø		+	-	-				+	+	+	-	+	\vdash	-
MFPA-MW1-2018	2018/10/12 09:30	Water	3 x 40 mL & 2 x 250 mL	5	\vdash		-	+			+	-	Н	_	\vdash	-	+	+	+	-	+	\vdash	-
MSBL-MW1-2018	2018/10/12 09:50	Water	3 x 40 mL & 2 x 250 mL	5			+	+		-	+	-		<u> </u>		-	+	+	+	\dashv	+	\vdash	-
MSBL-MW2-2018	2018/10/12 10:05	Water	3 x 40 mL & 2 x 250 mL	5			+	╆	H	-	+	+-					+	+	+	\dashv	+	+	
MW0	2018/10/12 10:06	Water	3 x 40 mL & 2 x 250 mL 3 x 40 mL & 2 x 250 mL	5				+	\vdash	-	+	-	-				+	+	+	-	+	\vdash	-
MAEB-MW1-2018 MAEB-MW2-2018	2018/10/12 10:30	Water	3x40mL,2x250mL,1x120mL	6	\vdash		+	+	Z	-	+	+					+	+	+	-	+	\vdash	
Samples Retinquished By (Print Name):			ples Received By (Print Name)				1	_	Date/1	ime	1	100	-				#	Port	1		of 2	_	
Robert Perry	Date/Time	40/98	mma to Minon						0	41	01	8						Page	: ' —	— (л <u>~</u>	—	



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902.468.8718 • F: 902.468.8924

Laboratory Use (Only	
Arrival Condition: Arrival Temperature	Good e: 6 \	Poor (see notes)
AGAT Job Number:	- 1	,
Notes:		

Chain of Custody Record		Report Info	ormation									otes			301.							
Report Information		1. Name:					Re	port	t Form	nat												- 1
Company: GHD Contractors Limited			James O'Neil					0:-														
Contact: James O'Neill			James.Oneill@ghd.com					Sa	igle mple p	er	Turnaround Time Required (TAT)											
Address: 1118 Topsail Road			Robert Perry					pa	ge		ll					_	-	-				
St. John's NL		2,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Robert.Perry@ghd.com			_	V	Mu	ıltiple mples	nor	Re	egula	ar IA	II L	∐5 to) / W	vorkir	ng da	/S			
Phone: 1-709-364-5353 Fax: 1	-709-364-5368	÷	,,,,,					pa		hei	Rı	ısh 1	TAT]1 d	lay		\Box 2	days			
IOL Site # and Name: Marystown Shipyard		Regulatory	Requirements (Check):				Exc	cel]3 d	lays						
Project #: 11178792-02		☐ List Guideline:	s on Report 🗵 Do Not Li	st Guidelines o	n Repoi	rt	100	LOI	rmat luded													
AGAT Quotation #: 15-115798		☑ PIRI ☑ Tier 1	□ Gas □ Pot	☑ Coarse			_	1110	Tuubu		Da	ite R	equir	ed:								
		☑ Res	□ Gas □ Pot □ Fue! □ N/Pot	☐ Fine			Drin	nking	Water	Sam	ple:	□Y	es	Ø	No							
GHD PO #:		☑ Com	Lube				Reg	. No.	·										=			
Invoice To	Same Yes ☑ / No ☐ ☐	□ CCME	□ CDWQ			ê l	Т			T					T				TT		T	
Company:		□ Industri				POTAB							-			Н						
Contact:		□ Comme			4	EVEL (ilable				niste									
Address:		□ Res/Pa □ Agricult			빌	LOWL			Ava	pette			a Ca									
		□ FWAL	ulai	- S	BCA	- 181	BTEX		ပ္က	nd Pi			ШШП									
Phone: Fax:		□ Sedime	ent -	CONTAINERS	ATLANTIC RBCA TIER	3CA TII	IPH/		□ Diss □ Available	e a			S) N(S								S S	
There.			-		ĮŽ	TIC RI	2 2			E (Sie			MATIC			Н					YEAR	S N
			0014451770	8	X - A	ATLA	N FR	<u></u>	[]	SIZ											R 1,	Sno
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX -	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE)	MTBE (ADDED TO TPH/BTEX)	MTBE ONLY	METALS: □ Total FOC	PARTICLE SIZE (Sieve and Pipette)	PAHs	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER						HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
MGSB-MW15	2018/10/12 10:40	Water	3 x 40 mL & 2 x 250 mL	5		Ø																
MW00	2018/10/12 10:41	Water	3 x 40 mL & 2 x 250 mL	5		Ø																
MDSA-MW3-2018	2018/10/12 10:50	Water	3 x 40 mL & 2 x 250 mL	5																		
MDSA-MW1-2018	2018/10/12 12:00	Water	3 x 40 mL & 2 x 250 mL	5		Ø								\perp			Ш		\Box			
MW000	2018/10/12 12:01	Water	3 x 40 mL & 2 x 250 mL	5		Ø								_					\perp			
MDSA-MW2-2018	2018/10/12 12:12	Water	3 x 40 mL & 2 x 250 mL	5		Ø					Ш				\perp	Ш	Н		Ш		\perp	↓_
MDSA-MW9	2018/10/12 12:20	Water	3 x 40 mL & 2 x 250 mL	5	-	Ø	-			_	Ш		4	_	_		1	_	1		\perp	_
MGSB-MW17	2018/10/12 11:00	Water	3 x 40 mL & 2 x 250 mL	5			-	_		Н			-	-	\perp		\vdash	_		_	+	₩
					Н	_	+						+	-	4	Н	+	_	\vdash	4	₩	-
				_	\vdash	-	-	-		\perp		-	+	+	+	\vdash	\dashv	+	\vdash	_	+	-
Samples Relinquished By (Print Name):	Date/Time	1 Sam	ples Received By (Print Name):					_	Date/Time			=		_		닏	4				_	
Robert Perry	(6/16/2		mores Received By (Sign)	4					964	-11	0/1	Y					Pag	ge <u>2</u>		of <u>2</u>	_	1
Samples Relinquished By (Signs)	Date/Time	Sam	oples Received By (Sign)						Date/Time	_												

Page 10 of 10



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K403228

TRACE ORGANICS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

DATE REPORTED: Nov 07, 2018

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 5

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.



AGAT WORK ORDER: 18K403228

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Atlantic RBCA Tier 1 Hydrocarbons in Water - Low Level

DATE RECEIVED: 2018-10-30					DATE REPORTED: 2018-11-07
		SAMPLE DESCRIPTION:	RW1	RW2	
		SAMPLE TYPE:	Water	Water	
		DATE SAMPLED:	2018-10-19	2018-10-19	
Parameter	Unit	G/S RDL	9661466	9661478	
Benzene	mg/L	0.001	<0.001	<0.001	
Toluene	mg/L	0.001	< 0.001	<0.001	
Ethylbenzene	mg/L	0.001	< 0.001	<0.001	
Xylene (Total)	mg/L	0.001	< 0.001	<0.001	
C6-C10 (less BTEX)	mg/L	0.01	<0.01	<0.01	
>C10-C16 Hydrocarbons	mg/L	0.05	0.16	0.06	
>C16-C21 Hydrocarbons	mg/L	0.05	0.27	< 0.05	
>C21-C32 Hydrocarbons	mg/L	0.01	0.03	0.02	
Modified TPH (Tier 1)	mg/L	0.1	0.5	<0.1	
Resemblance Comment			WFOF	FR, UC	
Return to Baseline at C32			Υ	Υ	
Surrogate	Unit	Acceptable Limits			
Isobutylbenzene - EPH	%	70-130	92	97	
Isobutylbenzene - VPH	%	70-130	92	88	
n-Dotriacontane - EPH	%	70-130	96	100	

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

9661466-9661478 Resemblance Comment Key:

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K403228
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

		Trac	e Or	ganio	s Ar	alysi	is																							
			UPLICATI	E		REFEREN	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE																
Batch	Sample	Dup #1	Dup #2	RPD	Method Blank			Acceptable Limits		Limite		Limite		Limite		Limite		Limite		Limite		Limite		Limite		Lin		Recovery	Lin	ptable nits
	la					value	Lower	Upper		Lower	Upper		Lower	Upper																
ns in Wat	er - Low Le	evel																												
1	9662095	0.008	0.006	28.6%	< 0.001	94%	70%	130%	87%	70%	130%																			
1	9662095	< 0.001	< 0.001	NA	< 0.001	98%	70%	130%	87%	70%	130%																			
1	9662095	< 0.001	< 0.001	NA	< 0.001	97%	70%	130%	86%	70%	130%																			
1	9662095	< 0.001	< 0.001	NA	< 0.001	101%	70%	130%	92%	70%	130%																			
1	9662095	0.13	0.14	7.4%	< 0.01	96%	70%	130%	112%	70%	130%	113%	70%	130%																
1	9665132	< 0.05	< 0.05	NA	< 0.05	119%	70%	130%	88%	70%	130%	95%	70%	130%																
1	9665132	< 0.05	< 0.05	NA	< 0.05	122%	70%	130%	88%	70%	130%	95%	70%	130%																
1	9665132	0.02	<0.01	NA	< 0.01	125%	70%	130%	88%	70%	130%	95%	70%	130%																
		ns in Water - Low Let 1 9662095 1 9662095 1 9662095 1 9662095 1 9662095 1 9662095 1 9665132 1 9665132	Batch Sample Dup #1 ns in Water - Low Level 1 9662095 0.008 1 9662095 < 0.001 1 9662095 < 0.001 1 9662095 < 0.001 1 9662095 0.13 1 9665132 < 0.05 1 9665132 < 0.05	DUPLICATI Batch Sample Id Dup #1 Dup #2 ns in Water - Low Level 1 9662095 0.008 0.006 1 9662095 < 0.001 < 0.001 1 9662095 < 0.001 < 0.001 1 9662095 < 0.001 < 0.001 1 9662095 0.13 0.14 1 9665132 < 0.05 < 0.05 1 9665132 < 0.05 < 0.05	DUPLICATE Batch Sample Dup #1 Dup #2 RPD	DUPLICATE Method Blank Dup #1 Dup #2 RPD Method Blank No. 1 Pos. 2 RPD Method Blank No. 2 RPD RPD No. 2 RPD RPD No. 2 RPD RPD	DUPLICATE Reference Refe	Batch Sample Dup #1 Dup #2 RPD Method Hank Heaving Acceptance Ling Lower	DUPLICATE REFERENCE MATERIAL Republic Republic	DUPLICATE	DUPLICATE Batch Sample Dup #1 Dup #2 RPD Method Blank Measured Value Acceptable Limits Lower Dup #2 Limits Lower Dup #3 Dup #4 Dup #4 Dup #4 RPD Method Blank Measured Value Acceptable Limits Dower Dup #4 Dower Dower	DUPLICATE Batch Sample Id Dup #1 Dup #2 RPD RPD Method Blank Measured Value Limits Lower Upper Recovery Acceptable Limits Lower Upper Limits Lower Upper Limits Lower Upper Upper No. 130% No. 1	DUPLICATE Batch Sample Id Dup #1 Dup #2 RPD RPD Method Blank Measured Value Limits Lower Upper Recovery Lower Upper Recovery Recove	Batch Sample Id Dup #1 Dup #2 RPD Method Blank Measured Value Limits Lower Upper Dup #2 Limits Lower Upper Dup #3 Dup #4 Dup #4 Dup #4 Dup #4 Dup #4 Recovery Acceptable Limits Lower Upper Dup #4 Dup #5 Dup #6 Dup #6 Dup #6 Dup #7 Dup #7																

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

Kelly Hogue

Method Summary

CLIENT NAME: GHD LIMITED PROJECT: 11178792-02

SAMPLING SITE:

AGAT WORK ORDER: 18K403228 ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis	'	-	
Benzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5010	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID





Dartmouth, NS B3B 1M2

webearth.agatlabs.com · www.agatlabscom

Arrival Condition:	Good	Poor	see note
Arrival Temperature	4.	9 45	

P: 902.468.8718 • F: 902.468.8924

Laboratory Use Only

Chain	of Custody Record		Report Info	ormation								100	otes		inun	mei	1	U		10	0		-0	i
Report Inf	ormation	· F	1. Name:					Re	port	Forn	nat													
Company:	GHD Contractors Limited			James O'Neil																				
Contact:	James O'Neill			James.Oneill@ghd.com			_	=	Sin Sai	gie nple p	er	T	rna	rou	nd '	Tim	o Da	اليمو	red (1	TAT)				i
Address:	1118 Topsail Road			Robert Perry					pag			11						•	•	•				
	St. John's NL			Robert.Perry@ghd.com			===		Mu	ltiple nples	ner	Re	egui	ar I	AI	∠ I 5	o to /	' wor	king	ays				
Phone:	1-709-364-5353 Fax: 1	-709-364-5368					_		pag		рсі	R	ısh '	TAT			1 day] 2 da	ys			
Site	Name: Marystown Shipyard			Requirements (Check)				V	Exc	el							3 day	/S						
Project #:	11178792-02		☐ List Guidelines	s on Report 🗵 Do Not Lis	t Guidelines o	n Report	t		LOL	mat luded		_D	ato B) Oau	irod	200								
AGAT Quot	tation #: GHD "SO"		☑ Tier 1	□ Gas □ Pot	□ Coarse			F					are i	\equ	iii eu.	-							=	
GHD PO #:	To Follow		□ Res	□ Fuel ☑ N/Pot	□ Fine			11	_	Water	Sam	ple:	□Y	'es	7	oN 🗈								
Invoice To	9	Same Yes ☑ / No □	☑ Com	□Lube		1 1] [Re	g. No.			_	,				_		-					
^			□ CCME	□ CDWQ			(POTABLE)																	
			☐ Industri				L (POT			e e				(Ler					1 1					
	¥		□ Res/Pa		- 1	4 1	LOW LEVEL (□ Available	te)			anis					1 1					
Address:			□ Agricult	cural		 ∢ 		2 8			Pipel			ma (4	
			☐ FWAL ☐ Sedime	ent	CONTAINERS	ATLANTIC RBCA TIER	TIER	ATION 4/BT		□ Diss	and			(Sum									ĝ	
Phone:	Fax:		L Ocalini	-	- Ā	N	RBC/	NOIT O			Sieve			NOL									FOR 1 YEAR (Y/N)	-
						JĀ.	LANTIC	FRAC FD T		□ Total) JZE			IONA									1 YE	2
w y	SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS - SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	тРН/ВТЕХ	IPH/BTEX - ATLANTIC RBCA TIER I	TPH/BTEX FRACTIONATION MTRE (ADDED TO TPH/BTEX)	MTBE ONLY	METALS:	PARTICLE SIZE (Sieve and Pipette)	PAHs	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER:						HOLD FOR 1 YEAR (1
RW1		2018/10/19 16:45	Soil	3 x 40 mL & 2 x 250 mL	5		7																	_
RW2		2018/10/19 16:40	Soil	3 x 40 mL & 2 x 250 mL	5	Ħ	Ø	T				1						7	\top					=
													-											
						Ш										1								
											-							_						_
						\vdash	_			-		-							\downarrow		_		-	_
						\vdash	-	-	-	-		1						_			+			_
						\vdash	-	-	-	\vdash	+	-					-	+	+	1	-	\vdash		_
						\vdash			-		+	+			1			+		+	-		-	_
Samples Relinquishe Robert Perry	V	Date/Time		mples Received By (Print Name):	Mu	\x	5			Date/Tim	55	en	<u> </u>						Page	1	of	1		
Samples Relinquisho	ed By (Sign)	Date/Time	5a	mples Received By (Sign):	10/	1	7			Dale/Tir	16			1										-



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02

AGAT WORK ORDER: 18K421242

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Amy Hunter, Trace Organics Supervisor, B.Sc.

WATER ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Jan 09, 2019

PAGES (INCLUDING COVER): 32

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES		

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 32

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. Measurement Uncertainty is not taken into consideration when stating conformity with a specified requirement.



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Available Metals in Soil

DATE RECEIVED: 2018-12-17 **DATE REPORTED: 2019-01-09** 18-MNMA-18-MNMA-18-MNMA-SAMPLE DESCRIPTION: STEP1 STEP2 STEP3 18-MNMA-DUP3 SAMPLE TYPE: Soil Soil Soil Soil DATE SAMPLED: 2018-12-13 2018-12-13 2018-12-13 2018-12-13 9791888 9791898 9791899 9791900 Parameter Unit G/S **RDL** Aluminum 10 4060 7550 8330 9800 mg/kg <1 Antimony mg/kg <1 <1 <1 Arsenic mg/kg 26 13 19 22 14 139 68 Barium mg/kg 74 Beryllium 2 <2 <2 <2 <2 mg/kg 14 12 61 82 Boron mg/kg 0.3 < 0.3 < 0.3 < 0.3 Cadmium mg/kg 0.4 Chromium mg/kg 11 23 24 30 Cobalt 7 12 11 13 mg/kg 1 7 13 62 77 Copper mg/kg Iron mg/kg 50 21000 17600 21400 24600 Lead 0.5 7.8 12.6 38.1 48.3 mg/kg Lithium mg/kg 5 10 19 19 22 Manganese mg/kg 320 350 242 300 7 Molybdenum mg/kg 2 <2 <2 5 Nickel mg/kg 10 19 22 24 Selenium mg/kg <1 <1 <1 <1 Silver 0.5 < 0.5 < 0.5 < 0.5 0.7 mg/kg 5 55 187 71 76 Strontium mg/kg Thallium 0.1 < 0.1 <0.1 < 0.1 < 0.1 mg/kg Tin mg/kg 2 3 4 11 7 Uranium mg/kg 0.1 0.2 0.2 1.6 1.9 Vanadium mg/kg 2 34 41 56 76

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

mg/kg

9791888-9791900 Results are based on the dry weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Zinc

Certified By:

179

190

Josan Coaghtry

51

45



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Grain Size Analysis (Sieve & Pipette)

					(<u>'</u>	
DATE RECEIVED: 2018-12-17							DATE REPORTED: 2019-01-09
Parameter	Unit	SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: G/S RDL	18-MNMA- STEP1 Soil 2018-12-13 9791888	18-MNMA- STEP2 Soil 2018-12-13 9791898	18-MNMA- STEP3 Soil 2018-12-13 9791899	18-MNMA-DUP3 Soil 2018-12-13 9791900	
Particle Size Distribution (<12.5mm,							
-4 PHI)	%	0.1	100	100	86.7	100	
Particle Size Distribution (<9.5mm, -3 PHI)	%	0.1	100	100	81.4	100	
Particle Size Distribution (<4.75mm, -2 PHI	%	0.1	78.4	70.9	63.9	84.5	
Particle Size Distribution (<2mm, -1 PHI)	%	0.1	18.5	31.9	34.9	51.1	
Particle Size Distribution (<1mm, 0 PHI)	%	0.1	10.0	17.6	26.5	39.0	
Particle Size Distribution (<1/2mm, 1 PHI)	%	0.1	9.0	9.8	23.7	34.4	
Particle Size Distribution (<1/4mm, 2 PHI)	%	0.1	8.7	8.0	21.1	29.8	
Particle Size Distribution (<1/8mm, 3 PHI)	%	0.1	8.5	7.9	17.7	25.2	
Particle Size Distribution (<1/16mm, 4 PHI)	%	0.1	8.3	7.8	14.3	20.2	
Particle Size Distribution (<1/32mm, 5 PHI)	%	0.1	8.3	7.7	13.6	19.1	
Particle Size Distribution (<1/64mm, 6 PHI)	%	0.1	8.3	7.7	12.9	17.8	
Particle Size Distribution (<1/128mm, 7 PHI)	%	0.1	8.3	7.7	12.1	16.3	
Particle Size Distribution (<1/256mm, 8 PHI)	%	0.1	8.1	7.6	11.3	15.1	
Particle Size Distribution (<1/512mm, 9 PHI)	%	0.1	7.9	7.6	11.1	14.4	
Particle Size Distribution (Gravel)	%	1	82	68	65	49	
Particle Size Distribution (Sand)	%	1	10	24	21	31	
Particle Size Distribution (Silt)	%	1	<2	<1	3	5	
Particle Size Distribution (Clay)	%	1	8	8	11	15	
Particles >75um	%	1	92	92	85	79	

Certified By:

Josephy



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

	Grain Size Arialysis (Sieve & Pipette)										
DATE RECEIVED: 2018-12-17								DATE REPORTED: 2019-01-09			
				18-MNMA-	18-MNMA-	18-MNMA-					
	:	SAMPLE DES	CRIPTION:	STEP1	STEP2	STEP3	18-MNMA-DUP3				
	SAMPLE TYPE:		Soil	Soil	Soil	Soil					
		DATE SAMPLED:		2018-12-13	2018-12-13	2018-12-13	2018-12-13				
Parameter	Unit	G/S	RDL	9791888	9791898	9791899	9791900				
Classification	Coarse/Fine			Coarse	Coarse	Coarse	Coarse				

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Jasar Coughtry



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

	_		
Mercury	Analy	rsis in	Soil
IVICIOGIA	/ VIII GII y	, 313 III	OUII

Welcury Analysis in 3011											
DATE RECEIVED: 2018-12-17								DATE REPORTED: 2019-01-09			
				18-MNMA-	18-MNMA-	18-MNMA-					
		SAMPLE DES	CRIPTION:	STEP1	STEP2	STEP3	18-MNMA-DUP3				
		SAMPLE TYPE:		Soil	Soil	Soil	Soil				
		DATE SAMPLED:		2018-12-13	2018-12-13	2018-12-13	2018-12-13				
Parameter	Unit	G/S	RDL	9791888	9791898	9791899	9791900				
Mercury	mg/kg		0.05	<0.05	<0.05	0.09	0.22				

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

9791888-9791900 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Josephan Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

SAMPLED BY:

ATTENTION TO: JAMES O'NEILL

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel

DATE RECEIVED: 2018-12-17							DATE REPORTED: 2019-01-09
		SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED:	18-MNMA- STEP1 Soil 2018-12-13	18-MNMA- STEP2 Soil 2018-12-13	18-MNMA- STEP3 Soil 2018-12-13	18-MNMA-DUP3 Soil 2018-12-13	
Parameter	Unit	G/S RDL	9791888	9791898	9791899	9791900	
Benzene	mg/kg	0.03	<0.03	<0.03	< 0.03	<0.03	
Toluene	mg/kg	0.04	<0.04	< 0.04	< 0.04	<0.04	
Ethylbenzene	mg/kg	0.03	< 0.03	< 0.03	< 0.03	<0.03	
Xylene (Total)	mg/kg	0.05	< 0.05	< 0.05	< 0.05	<0.05	
C6-C10 (less BTEX)	mg/kg	3	<3	<3	<3	<3	
>C10-C16 Hydrocarbons - 1X silica gel	mg/kg	15	<15	<15	<15	<15	
>C16-C21 Hydrocarbons - 1X silica gel	mg/kg	15	<15	<15	<15	40	
>C21-C32 Hydrocarbons - 1X silica gel	mg/kg	15	<15	<15	25	33	
Modified TPH (Tier 1) - 1X silica gel	mg/kg	20	<20	<20	25	73	
Resemblance Comment			NR	NR	LR	FR, LR	
Return to Baseline at C32			Υ	Υ	Υ	Υ	
Silica Gel Cleanup			Υ	Υ	Υ	Υ	
Surrogate	Unit	Acceptable Limits					
Isobutylbenzene - EPH	%	60-140	72	80	90	106	
Isobutylbenzene - VPH	%	60-140	84	89	84	85	
n-Dotriacontane - EPH	%	60-140	77	86	96	112	

Certified By:

any Mul

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



RDL - Reported Detection Limit; G / S - Guideline / Standard

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

ATTENTION TO. JAIVIES O NEILI

Atlantic RBCA Tier 1 Hydrocarbons in Soil (Version 3.1) - Field Preserved + 1X Silica Gel

DATE RECEIVED: 2018-12-17 DATE REPORTED: 2019-01-09

9791888-9791900 Results are based on the dry weight of the soil.

Resemblance Comment Key: GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Huj

57 Old Pennywell Road, Unit I

St. John's, NL

CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Atlantic RBCA Tier 1 Hydrocarbons in Water (Version 3.0)

DATE RECEIVED: 2018-12-17 **DATE REPORTED: 2019-01-09** 18-MNMA-W-18-MNMA-W-18-MNMA-W-SAMPLE DESCRIPTION: 18-MNMA-W2 18-MNMA-W6 18-MNMA-W9 18-MNMA-W12 18-MNMA-W14 DUP1 REF2 REF3 SAMPLE TYPE: Water Water Water Water Water Water Water Water DATE SAMPLED: 2018-12-13 2018-12-13 2018-12-14 2018-12-14 2018-12-14 2018-12-13 2018-12-13 2018-12-13 9791865 9791868 9791871 Parameter Unit G/S **RDL** 9791495 9791866 9791867 9791869 9791870 Benzene 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 mg/L Toluene 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 mg/L Ethylbenzene mg/L 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 < 0.001 <0.001 Xylene (Total) ma/L 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 < 0.002 C6-C10 (less BTEX) 0.01 < 0.01 < 0.01 < 0.01 < 0.01 < 0.01 < 0.01 mg/L < 0.01 < 0.01 >C10-C16 Hydrocarbons mg/L 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 < 0.05 0.10 <0.10 >C16-C21 Hydrocarbons mg/L < 0.10 < 0.10 < 0.10 < 0.10 < 0.10 < 0.10 < 0.10 >C21-C32 Hydrocarbons mg/L 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 <0.1 < 0.1 Modified TPH (Tier 1) mg/L 0.1 < 0.1 < 0.1 < 0.1 < 0.1 < 0.1 NR NR NR NR NR NR NR NR Resemblance Comment Return to Baseline at C32 Υ Υ Υ Υ Υ Υ Υ Unit Acceptable Limits Surrogate Isobutylbenzene - EPH % 70-130 89 115 80 98 86 99 110 87 Isobutylbenzene - VPH % 70-130 87 81 88 85 90 90 87 87 % n-Dotriacontane - EPH 70-130 89 108 73 96 80 92 105 81

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

9791495-9791871 Resemblance Comment Key: GF - Gasoline Fraction

WGF - Weathered Gasoline Fraction

GR - Product in Gasoline Range

FOF - Fuel Oil Fraction

WFOF - Weathered Fuel Oil Fraction

FR - Product in Fuel Oil Range

LOF - Lube Oil Fraction

LR - Lube Range

UC - Unidentified Compounds

NR - No Resemblance

NA - Not Applicable

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

any Hus

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

B 4		
1\/I∩	isture	
IVIO	istuit	

					MOISTU	ıre		
DATE RECEIVED: 2018-12-17								DATE REPORTED: 2019-01-09
				18-MNMA-	18-MNMA-	18-MNMA-		
		SAMPLE DES	CRIPTION:	STEP1	STEP2	STEP3	18-MNMA-DUP3	
		SAMPLE TYPE:			Soil	Soil	Soil	
		DATE SAMPLED:		2018-12-13	2018-12-13	2018-12-13	2018-12-13	
Parameter	Unit	G/S	RDL	9791888	9791898	9791899	9791900	
% Moisture	%		0	20	10	39	37	

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-12-17							DATE REPORTED: 2019-01-09
			18-MNMA-	18-MNMA-	18-MNMA-		
		SAMPLE DESCRIPTION:	STEP1	STEP2	STEP3	18-MNMA-DUP3	
		SAMPLE TYPE:	Soil	Soil	Soil	Soil	
		DATE SAMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-13	
Parameter	Unit	G/S RDL	9791888	9791898	9791899	9791900	
1-Methylnaphthalene	mg/kg	0.05	<0.05	< 0.05	< 0.05	<0.05	
2-Methylnaphthalene	mg/kg	0.01	<0.01	<0.01	0.01	0.01	
Acenaphthene	mg/kg	0.00671	< 0.00671	<0.00671	0.0176	0.0469	
Acenaphthylene	mg/kg	0.004	< 0.004	< 0.004	0.025	0.024	
Acridine	mg/kg	0.05	< 0.05	< 0.05	< 0.05	< 0.05	
Anthracene	mg/kg	0.03	< 0.03	< 0.03	0.05	0.13	
Benzo(a)anthracene	mg/kg	0.01	<0.01	<0.01	0.13	0.33	
Benzo(a)pyrene	mg/kg	0.01	<0.01	<0.01	0.13	0.31	
Benzo(b)fluoranthene	mg/kg	0.05	< 0.05	< 0.05	0.14	0.36	
Benzo(b+j)fluoranthene	mg/kg	0.1	<0.1	<0.1	0.20	0.56	
Benzo(e)pyrene	mg/kg	0.05	< 0.05	< 0.05	0.11	0.26	
Benzo(ghi)perylene	mg/kg	0.01	<0.01	<0.01	0.08	0.20	
Benzo(k)fluoranthene	mg/kg	0.01	<0.01	<0.01	0.09	0.24	
Chrysene	mg/kg	0.01	<0.01	<0.01	0.14	0.38	
Dibenzo(a,h)anthracene	mg/kg	0.006	< 0.006	<0.006	< 0.006	<0.006	
Fluoranthene	mg/kg	0.05	< 0.05	< 0.05	0.31	0.84	
Fluorene	mg/kg	0.01	<0.01	<0.01	0.03	0.01	
Indeno(1,2,3)pyrene	mg/kg	0.01	<0.01	<0.01	<0.01	<0.01	
Naphthalene	mg/kg	0.01	<0.01	<0.01	< 0.01	<0.01	
Perylene	mg/kg	0.05	< 0.05	< 0.05	< 0.05	0.09	
Phenanthrene	mg/kg	0.03	< 0.03	< 0.03	0.21	0.57	
Pyrene	mg/kg	0.05	< 0.05	<0.05	0.28	0.61	
Quinoline	mg/kg	0.05	< 0.05	< 0.05	< 0.05	<0.05	
Surrogate	Unit	Acceptable Limits					
Nitrobenzene-d5	%	50-140	125	108	110	111	
2-Fluorobiphenyl	%	50-140	108	101	106	99	
Terphenyl-d14	%	50-140	94	91	94	71	

Certified By:

any Huj



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Polycyclic Aromatic Hydrocarbons in Soil

DATE RECEIVED: 2018-12-17 **DATE REPORTED: 2019-01-09**

RDL - Reported Detection Limit; G / S - Guideline / Standard 9791888-9791900 Results are based on the dry weight of the soil.

Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Polycyclic Aromatic Hydrocarbons in Water - (PAH)

						· .	<u> </u>			
DATE RECEIVED: 2018-12-17							С	ATE REPORTE	ED: 2019-01-09	
								18-MNMA-W-	18-MNMA-W-	18-MNMA-W-
		SAMPLE DESCRIPTION:	18-MNMA-W2	18-MNMA-W6	18-MNMA-W9	18-MNMA-W12	18-MNMA-W14	DUP1	REF2	REF3
		SAMPLE TYPE:	Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	2018-12-13	2018-12-13
Parameter	Unit	G/S RDL	9791495	9791865	9791866	9791867	9791868	9791869	9791870	9791871
1-Methylnaphthalene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	ug/L	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	ug/L	0.012	<0.012	<0.012	<0.012	<0.012	<0.012	< 0.012	<0.012	< 0.012
Benzo(a)anthracene	ug/L	0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018
Benzo(a)pyrene	ug/L	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(ghi)perylene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	ug/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Surrogate	Unit	Acceptable Limits								
Nitrobenzene-d5	%	50-140	82	64	76	80	105	77	76	73
2-Fluorobiphenyl	%	50-140	89	66	79	85	106	81	75	80
Terphenyl-d14	%	50-140	78	51	62	76	87	60	55	53

Certified By:

any Hus



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

Polycyclic Aromatic Hydrocarbons in Water - (PAH)

DATE RECEIVED: 2018-12-17 **DATE REPORTED: 2019-01-09**

RDL - Reported Detection Limit; G / S - Guideline / Standard

9791495-9791871 Benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Total Polychlorinated Biphenyls in Soil - (PCB)	Total Poly	chlorinated	Biphenyls	in	Soil -	(PCB)
---	------------	-------------	------------------	----	--------	-------

				a o., o	,,,,,a,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		(. 02)	
DATE RECEIVED: 2018-12-17								DATE REPORTED: 2019-01-09
				18-MNMA-	18-MNMA-	18-MNMA-		
		SAMPLE DES	CRIPTION:	STEP1	STEP2	STEP3	18-MNMA-DUP3	
		SAMI	PLE TYPE:	Soil	Soil	Soil	Soil	
		DATE SAMPLED:		2018-12-13	2018-12-13	2018-12-13	2018-12-13	
Parameter	Unit	G/S	RDL	9791888	9791898	9791899	9791900	
Total Polychlorinated Biphenyls	mg/kg		0.02	< 0.02	< 0.02	< 0.02	<0.02	
Surrogate	Unit	Acceptab	le Limits					
Decachlorobiphenyl	%	50-1	130	127	119	130	127	

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

9791888-9791900 Results are based on the dry weight of the soil.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

any Mus



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury	Analysis	in Water	(Total)
IVICICALV	/ \	III VVALCI	1 I O Lai 1

					, ,		, ,						
DATE RECEIVED: 2018-12-17													
									18-MNMA-W-	18-MNMA-W-	18-MNMA-W-		
		SAMPLE DES	CRIPTION:	18-MNMA-W2	18-MNMA-W6	18-MNMA-W9	18-MNMA-W12	18-MNMA-W14	DUP1	REF2	REF3		
		SAM	PLE TYPE:	Water	Water	Water	Water	Water	Water	Water	Water		
		DATE	SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	2018-12-13	2018-12-13		
Parameter	Unit	G/S	RDL	9791495	9791865	9791866	9791867	9791868	9791869	9791870	9791871		
Total Mercury	ug/L		0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026		

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Jasan Coughtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-12-17							D	ATE REPORTI	ED: 2019-01-09	
Parameter	Unit	SAMPLE DESCRIPTION: SAMPLE TYPE: DATE SAMPLED: G/S RDL	18-MNMA-W2 Water 2018-12-13 9791495	18-MNMA-W6 Water 2018-12-13 9791865	18-MNMA-W9 Water 2018-12-14 9791866	18-MNMA-W12 Water 2018-12-14 9791867	18-MNMA-W14 Water 2018-12-14 9791868	18-MNMA-W- DUP1 Water 2018-12-13 9791869	18-MNMA-W- REF2 Water 2018-12-13 9791870	18-MNMA-W- REF3 Water 2018-12-13 9791871
pH	Onit	O/O NDE	7.79	7.87	7.89	7.90	7.91	7.93	7.92	7.96
Reactive Silica as SiO2	mg/L	0.5	1.1	0.5	0.8	0.8	0.7	0.6	0.6	<0.5
Chloride	mg/L	200	9390	11200	9540	9520	9940	11600	11400	12900
Fluoride	mg/L	24	<24	<24	<24	<24	<24	<24	<24	<24
Sulphate	mg/L	400	1230	1460	1250	1240	1290	1500	1480	1690
Alkalinity	mg/L	5	77	89	75	79	79	91	88	103
True Color	TCU	5	22	13	22	8	10	12	10	<5
Turbidity	NTU	0.1	0.8	0.7	1.3	0.6	0.9	1.5	0.8	1.4
Electrical Conductivity	umho/cm	1	34100	38800	32700	33700	33900	38300	37900	43500
Nitrate + Nitrite as N	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate as N	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrite as N	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Ammonia as N	mg/L	0.03	0.31	0.11	0.10	0.11	0.13	0.09	0.09	0.10
Total Organic Carbon	mg/L	0.5	3.2	2.2	3.0	2.8	2.9	2.2	2.2	1.4
Ortho-Phosphate as P	mg/L	0.01	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.07
Total Sodium	mg/L	0.1	6820	7930	6530	6900	6570	7630	7140	8350
Total Potassium	mg/L	0.1	257	295	247	259	245	282	267	324
Total Calcium	mg/L	0.1	247	303	228	243	244	275	274	330
Total Magnesium	mg/L	0.1	789	955	800	806	773	897	855	1040
Bicarb. Alkalinity (as CaCO3)	mg/L	5	77	89	75	79	79	91	88	103
Carb. Alkalinity (as CaCO3)	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Hydroxide	mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5
Calculated TDS	mg/L	1	18800	22200	18600	19000	19100	22200	21500	24700
Hardness	mg/L		3870	4690	3860	3930	3790	4380	4210	5110
Langelier Index (@20C)	NA		0.25	0.48	0.31	0.37	0.38	0.51	0.48	0.66
Langelier Index (@ 4C)	NA		-0.07	0.16	-0.01	0.05	0.06	0.19	0.16	0.34
Saturation pH (@ 20C)	NA		7.54	7.39	7.58	7.53	7.53	7.42	7.44	7.30
Saturation pH (@ 4C)	NA		7.86	7.71	7.90	7.85	7.85	7.74	7.76	7.62
Anion Sum	me/L		292	348	297	296	309	360	354	401

Certified By:

Joseph Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Standard Water Analysis + Total Metals

			Otalia i							
DATE RECEIVED: 2018-12-17							D	ATE REPORTE	ED: 2019-01-09	
								18-MNMA-W-	18-MNMA-W-	18-MNMA-W
		SAMPLE DESCRIPTION:	18-MNMA-W2	18-MNMA-W6	18-MNMA-W9	18-MNMA-W12	18-MNMA-W14	DUP1	REF2	REF3
		SAMPLE TYPE:	Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	2018-12-13	2018-12-13
Parameter	Unit	G/S RDL	9791495	9791865	9791866	9791867	9791868	9791869	9791870	9791871
Cation sum	me/L		380	446	367	385	367	426	401	473
% Difference/ Ion Balance	%		13.1	12.3	10.6	13.1	8.7	8.4	6.2	8.2
Total Aluminum	ug/L	5	23	21	30	31	27	22	21	12
Total Antimony	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium	ug/L	5	9	8	9	9	8	8	7	7
Total Beryllium	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron	ug/L	5	3020	3570	2970	3050	3210	3470	3410	3950
Total Cadmium	ug/L	0.09	<0.09	< 0.09	< 0.09	< 0.09	< 0.09	<0.09	< 0.09	< 0.09
Total Chromium	ug/L	1	6	8	8	9	8	8	8	8
Total Cobalt	ug/L	1	3	3	3	3	3	3	3	3
Total Copper	ug/L	1	6	8	8	8	11	11	11	13
Total Iron	ug/L	50	179	180	200	202	210	174	177	157
Total Lead	ug/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Manganese	ug/L	2	13	9	15	14	13	9	9	5
Total Molybdenum	ug/L	2	7	8	6	7	7	8	7	9
Total Nickel	ug/L	2	17	18	15	16	16	19	20	24
Total Phosphorous	mg/L	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Selenium	ug/L	1	<1	1	<1	<1	2	1	<1	<1
Total Silver	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L	5	4210	5080	4200	4410	4270	5040	4620	5690
Total Thallium	ug/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Tin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium	ug/L	2	4	5	4	6	6	10	14	25
Total Uranium	ug/L	0.1	1.8	2.0	1.7	1.9	1.8	2.1	2.0	2.4
Total Vanadium	ug/L	2	1140	1180	1120	1120	1060	1040	944	930
Total Zinc	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5

Certified By:

Joseph Coaghtray



AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

SAMPLED BY:

ATTENTION TO: JAMES O'NEILL

Standard Water Analysis + Total Metals

DATE RECEIVED: 2018-12-17 **DATE REPORTED: 2019-01-09**

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

9791495-9791865 RDL's for Fluoride, Chloride, Nitrate, Nitrite and Sulphate are raised due to sample matrix.

Ion Balance is biased high, contributing parameters have been confirmed.

9791866 RDL's for Fluoride, Chloride, Nitrate, Nitrite and Sulphate are raised due to sample matrix. 9791867 RDL's for Fluoride, Chloride, Nitrate, Nitrite and Sulphate are raised due to sample matrix.

Ion Balance is biased high, contributing parameters have been confirmed.

9791868-9791871 RDL's for Fluoride, Chloride, Nitrate, Nitrite and Sulphate are raised due to sample matrix.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

57 Old Pennywell Road, Unit I

St. John's, NL CANADA A1E 6A8

TEL (709)747-8573 FAX (709 747-2139



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

				Soi	l Ana	alysis	3								
RPT Date: Jan 09, 2019			Г	UPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SP	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery		ptable nits	Recovery		ptable mits
		ld					Value	Lower	Upper		Lower	Upper		Lower	Upper
Available Metals in Soil									•			•			
Aluminum	9791954		3980	3700	7.4%	< 10	90%	80%	120%	104%	80%	120%	130%	70%	130%
Antimony	9791954		<1	<1	NA	< 1	80%	80%	120%	110%	80%	120%	76%	70%	130%
Arsenic	9791954		3	4	NA	< 1	88%	80%	120%	101%	80%	120%	105%	70%	130%
Barium	9791954		17	20	NA	< 5	101%	80%	120%	101%	80%	120%	130%	70%	130%
Beryllium	9791954		<2	<2	NA	< 2	105%	80%	120%	107%	80%	120%	110%	70%	130%
Boron	9791954		<2	2	NA	< 2	96%	80%	120%	108%	80%	120%	112%	70%	130%
Cadmium	9791954		< 0.3	< 0.3	NA	< 0.3	86%	80%	120%	98%	80%	120%	101%	70%	130%
Chromium	9791954		5	6	NA	< 2	81%	80%	120%	98%	80%	120%	119%	70%	130%
Cobalt	9791954		2	3	NA	< 1	87%	80%	120%	99%	80%	120%	112%	70%	130%
Copper	9791954		4	5	NA	< 2	89%	80%	120%	99%	80%	120%	110%	70%	130%
Iron	9791954		5500	5710	3.7%	< 50	82%	80%	120%	95%	80%	120%	110%	70%	130%
Lead	9791954		2.2	2.6	NA	< 0.5	90%	80%	120%	102%	80%	120%	108%	70%	130%
Lithium	9791954		8	9	NA	< 5	94%	70%	130%	109%	70%	130%	115%	70%	130%
Manganese	9791954		185	218	16.4%	< 2	87%	80%	120%	99%	80%	120%	130%	70%	130%
Molybdenum	9791954		<2	<2	NA	< 2	89%	80%	120%	101%	80%	120%	105%	70%	130%
Nickel	9791954		5	6	NA	< 2	87%	80%	120%	101%	80%	120%	112%	70%	130%
Selenium	9791954		<1	<1	NA	< 1	87%	80%	120%	101%	80%	120%	91%	70%	130%
Silver	9791954		< 0.5	< 0.5	NA	< 0.5	91%	80%	120%	104%	80%	120%	107%	70%	130%
Strontium	9791954		<5	<5	NA	< 5	86%	80%	120%	96%	80%	120%	107%	70%	130%
Thallium	9791954		<0.1	<0.1	NA	< 0.1	89%	80%	120%	102%	80%	120%	NA	70%	130%
Tin	9791954		3	3	NA	< 2	90%	80%	120%	101%	80%	120%	101%	70%	130%
Uranium	9791954		0.3	0.4	NA	< 0.1	85%	80%	120%	101%	80%	120%	99%	70%	130%
Vanadium	9791954		9	12	24.7%	< 2	89%	80%	120%	100%	80%	120%	116%	70%	130%
Zinc	9791954		11	13	NA	< 5	87%	80%	120%	96%	80%	120%	103%	70%	130%
Mercury Analysis in Soil															
Mercury	1 9	791900	0.22	0.23	NA	< 0.05	79%	70%	130%		70%	130%	86%	70%	130%

Certified By:

Josan Coughtry

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE:								SAMPL	ED B	Y:					
			Trac	ce Org	gani	cs Ar	alys	is							
RPT Date: Jan 09, 2019				DUPLICATI	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery		ptable nits	Recovery		ptable
		lu lu					value	Lower	Upper		Lower	Upper		Lower	Uppe
Atlantic RBCA Tier 1 Hydrocarbor	s in Wate	er (Version	3.0)												
Benzene	1	9791495	< 0.001	< 0.001	NA	< 0.001	105%	70%	130%	103%	70%	130%			
Toluene	1	9791495	< 0.001	< 0.001	NA	< 0.001	106%	70%	130%	92%	70%	130%			
Ethylbenzene	1	9791495	< 0.001	< 0.001	NA	< 0.001	105%	70%	130%	86%	70%	130%			
Xylene (Total)	1	9791495	< 0.002	< 0.002	NA	< 0.002	103%	70%	130%	86%	70%	130%			
C6-C10 (less BTEX)	1	9791495	< 0.01	< 0.01	NA	< 0.01	111%	70%	130%	113%	70%	130%	108%	70%	130%
>C10-C16 Hydrocarbons	1	9791871	< 0.05	< 0.05	NA	< 0.05	101%	70%	130%	94%	70%	130%	90%	70%	130%
>C16-C21 Hydrocarbons	1	9791871	< 0.10	< 0.10	NA	< 0.10	100%		130%	94%		130%	90%	70%	130%
>C21-C32 Hydrocarbons	1	9791871	< 0.1	< 0.1	NA	< 0.1	78%		130%	94%		130%	90%	70%	130%
	•	0.0.0.					. 0,70	. 0,0	.0070	0.70	. 0 70	.0070	0070	. 0 70	
Comments: If Matrix spike value is NA If RPD value is NA, the results of the								ribution							
Atlantic RBCA Tier 1 Hydrocarbon	ns in Wate	er (Version	3.0)												
>C10-C16 Hydrocarbons	1	9791871	< 0.05	< 0.05	NA	< 0.05	101%	70%	130%	94%	70%	130%	90%	70%	130%
>C16-C21 Hydrocarbons	1	9791871	< 0.10	< 0.10	NA	< 0.10	100%	70%	130%	94%	70%	130%	90%	70%	130%
>C21-C32 Hydrocarbons	1	9791871	< 0.1	< 0.1	NA	< 0.1	78%	70%	130%	94%	70%	130%	90%	70%	130%
If RPD value is NA, the results of the of Atlantic RBCA Tier 1 Hydrocarbon	·						llculated.								
Benzene	1	9791947	< 0.03	< 0.03	NA	< 0.03	85%	60%	140%	117%	60%	140%			
Toluene	1	9791947	< 0.04	< 0.04	NA	< 0.04	101%	60%	140%	102%	60%	140%			
Ethylbenzene	1	9791947	< 0.03	< 0.03	NA	< 0.03	110%	60%	140%	103%	60%	140%			
Xylene (Total)	1	9791947	< 0.05	< 0.05	NA	< 0.05	118%	60%	140%	108%	60%	140%			
C6-C10 (less BTEX)	1	9791947	< 3	< 3	NA	< 3	114%	60%	140%	115%	60%	140%	116%	30%	130%
>C10-C16 Hydrocarbons - 1X silica gel	1	9784540	< 15	< 15	NA	< 15	96%	60%	140%	81%	60%	140%	111%	30%	130%
>C16-C21 Hydrocarbons - 1X silica gel	1	9784540	< 15	< 15	NA	< 15	96%	60%	140%	81%	60%	140%	111%	30%	130%
>C21-C32 Hydrocarbons - 1X silica gel	1	9784540	64	69	NA	< 15	75%	60%	140%	81%	60%	140%	111%	30%	130%
Comments: If Matrix spike value is NA If RPD value is NA, the results of the		,						ribution	-						
Total Polychlorinated Biphenyls in	n Soil - (P	CB)													
Total Polychlorinated Biphenyls	1	9784768	< 0.02	< 0.02	NA	< 0.02	116%	60%	130%	94%	60%	130%	102%	60%	130%
Comments: If Matrix spike value is NA If RPD value is NA, the results of the o	· .	,						ribution	-						
Polycyclic Aromatic Hydrocarbon	s in Soil														
1-Methylnaphthalene	1	9784768	< 0.05	< 0.05	NA	< 0.05	123%	50%	140%	100%	50%	140%	NA	50%	140%
2-Methylnaphthalene	1	9784768	0.03	0.03	NA	< 0.01	120%	50%	140%	96%	50%	140%	NA	50%	140%

AGAT QUALITY ASSURANCE REPORT (V1)

1

1

Acenaphthene

Acenaphthylene

50% 140% Page 20 of 32

50% 140%

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

NA

NA

< 0.00671 137%

< 0.004 125% 50% 140%

50% 140%

102%

95%

50% 140%

50% 140%

NA

9784768 < 0.00671 < 0.00671

9784768 < 0.004 < 0.004

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

	ı	Trace	Orga	anics	Ana	alysis	(Cor	ntin	ued)					
RPT Date: Jan 09, 2019				UPLICATI	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery	1 1 1 1 1	ptable nits	Recovery		ptable nits
		la la		·			value	Lower	Upper	ĺ	Lower	Upper	ĺ	Lower	Upper
Acridine	1	9784768	< 0.05	< 0.05	NA	< 0.05	94%	50%	140%	88%	50%	140%	NA	50%	140%
Anthracene	1	9784768	< 0.03	< 0.03	NA	< 0.03	120%	50%	140%	90%	50%	140%	NA	50%	140%
Benzo(a)anthracene	1	9784768	< 0.01	< 0.01	NA	< 0.01	117%	50%	140%	93%	50%	140%	NA	50%	140%
Benzo(a)pyrene	1	9784768	< 0.01	< 0.01	NA	< 0.01	126%	50%	140%	93%	50%	140%	NA	50%	140%
Benzo(b)fluoranthene	1	9784768	< 0.05	< 0.05	NA	< 0.05	137%	50%	140%	96%	50%	140%	NA	50%	140%
Benzo(b+j)fluoranthene	1	9784768	< 0.1	< 0.1	NA	< 0.1	138%	50%	140%	102%	50%	140%	NA	50%	140%
Benzo(e)pyrene	1	9784768	< 0.05	< 0.05	NA	< 0.05	135%	50%	140%	97%	50%	140%	NA	50%	140%
Benzo(ghi)perylene	1	9784768	< 0.01	< 0.01	NA	< 0.01	136%	50%	140%	95%	50%	140%	NA	50%	140%
Benzo(k)fluoranthene	1	9784768	< 0.01	< 0.01	NA	< 0.01	131%	50%	140%	87%	50%	140%	NA	50%	140%
Chrysene	1	9784768	< 0.01	< 0.01	NA	< 0.01	119%	50%	140%	96%	50%	140%	NA	50%	140%
Dibenzo(a,h)anthracene	1	9784768	< 0.006	< 0.006	NA	< 0.006	128%	50%	140%	93%	50%	140%	NA	50%	140%
Fluoranthene	1	9784768	< 0.05	< 0.05	NA	< 0.05	116%	50%	140%	95%	50%	140%	NA	50%	140%
Fluorene	1	9784768	< 0.01	< 0.01	NA	< 0.01	121%	50%	140%	99%	50%	140%	NA	50%	140%
Indeno(1,2,3)pyrene	1	9784768	< 0.01	< 0.01	NA	< 0.01	120%	50%	140%	94%	50%	140%	NA	50%	140%
Naphthalene	1	9784768	< 0.01	< 0.01	NA	< 0.01	121%	50%	140%	103%	50%	140%	NA	50%	140%
Perylene	1	9784768	< 0.05	< 0.05	NA	< 0.05	121%	50%	140%	99%	50%	140%	NA	50%	140%
Phenanthrene	1	9784768	< 0.03	< 0.03	NA	< 0.03	130%	50%	140%	98%	50%	140%	NA	50%	140%
Pyrene	1	9784768	< 0.05	< 0.05	NA	< 0.05	112%	50%	140%	94%	50%	140%	NA	50%	140%
Quinoline	1	9784768	< 0.05	< 0.05	NA	< 0.05	104%	50%	140%	95%	50%	140%	NA	50%	140%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Polycyclic Aromatic Hydroca	rbons in Wat	ter - (PAH)													
1-Methylnaphthalene	1	9791867	< 0.01	< 0.01	NA	< 0.01	129%	50%	140%	78%	50%	140%	NA	50%	140%
2-Methylnaphthalene	1	9791867	< 0.01	< 0.01	NA	< 0.01	128%	50%	140%	78%	50%	140%	NA	50%	140%
Acenaphthene	1	9791867	< 0.01	< 0.01	NA	< 0.01	125%	50%	140%	78%	50%	140%	NA	50%	140%
Acenaphthylene	1	9791867	< 0.01	< 0.01	NA	< 0.01	121%	50%	140%	77%	50%	140%	NA	50%	140%
Acridine	1	9791867	< 0.01	< 0.01	NA	< 0.01	79%	50%	140%	81%	50%	140%	NA	50%	140%
Anthracene	1	9791867	< 0.012	< 0.012	NA	< 0.012	113%	50%	140%	74%	50%	140%	NA	50%	140%
Benzo(a)anthracene	1	9791867	< 0.018	< 0.018	NA	< 0.018	112%	50%	140%	77%	50%	140%	NA	50%	140%
Benzo(a)pyrene	1	9791867	< 0.010	< 0.010	NA	< 0.010	98%	50%	140%	83%	50%	140%	NA	50%	140%
Benzo(b)fluoranthene	1	9791867	< 0.01	< 0.01	NA	< 0.01	127%	50%	140%	88%	50%	140%	NA	50%	140%
Benzo(e)pyrene	1	9791867	< 0.01	< 0.01	NA	< 0.01	122%	50%	140%	82%	50%	140%	NA	50%	140%
Benzo(ghi)perylene	1	9791867	< 0.01	< 0.01	NA	< 0.01	68%	50%	140%	82%	50%	140%	NA	50%	140%
Benzo(k)fluoranthene	1	9791867	< 0.01	< 0.01	NA	< 0.01	113%	50%	140%	76%	50%	140%	NA	50%	140%
Chrysene	1	9791867	< 0.01	< 0.01	NA	< 0.01	116%	50%	140%	77%	50%	140%	NA	50%	140%
Dibenzo(a,h)anthracene	1	9791867	< 0.01	< 0.01	NA	< 0.01	60%	50%	140%	82%	50%	140%	NA	50%	140%
Fluoranthene	1	9791867	< 0.01	< 0.01	NA	< 0.01	118%	50%	140%	79%	50%	140%	NA	50%	140%
Fluorene	1	9791867	< 0.01	< 0.01	NA	< 0.01	114%	50%	140%	81%	50%	140%	NA	50%	140%
Indeno(1,2,3-cd)pyrene	1	9791867	< 0.01	< 0.01	NA	< 0.01	69%	50%	140%	81%	50%	140%	NA	50%	140%

AGAT QUALITY ASSURANCE REPORT (V1)

Page 21 of 32

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

	Trace Organics Analysis (Continued)														
RPT Date: Jan 09, 2019 DUPLICATE REFERENCE MATERIAL METHOD BLANK SPIKE												MAT	RIX SPI	KE	
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	Lie	ptable nits	Recovery	منا أ	ptable nits
		ld		.,			Value	Lower	Upper	,	Lower	Upper			Upper
Naphthalene	1	9791867	< 0.01	< 0.01	NA	< 0.01	120%	50%	140%	76%	50%	140%	NA	50%	140%
Perylene	1	9791867	< 0.01	< 0.01	NA	< 0.01	108%	50%	140%	81%	50%	140%	NA	50%	140%
Phenanthrene	1	9791867	< 0.01	< 0.01	NA	< 0.01	127%	50%	140%	77%	50%	140%	NA	50%	140%
Pyrene	1	9791867	< 0.01	< 0.01	NA	< 0.01	115%	50%	140%	79%	50%	140%	NA	50%	140%
Quinoline	1	9791867	< 0.01	< 0.01	NA	< 0.01	107%	50%	140%	74%	50%	140%	NA	50%	140%

Comments: If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution. If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

Certified By:

any Hus

Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.								MIVIP	LED B	Ι.					
				Wate	er Ar	alys	is								
RPT Date: Jan 09, 2019				UPLICAT	E		REFEREN	NCE MA	TERIAL	METHOD	BLAN	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value		ptable nits	Recovery	1 1 1 1 1	ptable nits	Recovery	Lir	ptable nits
		lu lu					value	Lower	Upper		Lower	Upper		Lower	Uppei
Standard Water Analysis + Tota	al Metals														
pH	9794608		8.37	8.02	4.3%	<	102%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1 :	9787172	12.7	12.7	0.0%	< 0.5	103%	80%	120%	NA	80%	120%	96%	80%	120%
Chloride	9794608		17	13	23.1%	< 1	90%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	9794608		<0.12	<0.12	NA	< 0.12	114%	80%	120%	NA	80%	120%	96%	80%	120%
Sulphate	9794608		4	4	NA	< 2	106%	80%	120%	NA	80%	120%	92%	80%	120%
Alkalinity	9794608		26	25	5.5%	< 5	94%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	9788296		<5	5	NA	< 5	85%	80%	120%	NA			NA		
Turbidity	9788296		18.1	17.1	5.7%	< 0.1	99%	80%	120%	NA			NA		
Electrical Conductivity	9794608		95	90	5.1%	< 1	101%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	9794608		0.08	<0.05	NA	< 0.05	97%	80%	120%	NA	80%	120%	111%	80%	120%
Nitrite as N	9794608		<0.05	< 0.05	NA	< 0.05	102%	80%	120%	NA	80%	120%	83%	80%	120%
Ammonia as N	1		0.41	0.20	NA	< 0.03	95%	80%	120%	NA	80%	120%	93%	80%	120%
Total Organic Carbon	9792549		2.0	2.0	NA	< 0.5	98%	80%	120%	NA	80%	120%	90%	80%	120%
Ortho-Phosphate as P	1 !	9787172	0.02	0.01	NA	< 0.01	97%	80%	120%		80%	120%	94%	80%	120%
Total Sodium	9793739		179	175	2.7%	< 0.1	104%	80%	120%	108%	80%	120%	NA	70%	130%
Total Potassium	9793739		0.1	0.1	NA	< 0.1	107%	80%	120%	111%	80%	120%	92%	70%	130%
Total Calcium	9793739		0.3	0.4	NA	< 0.1	109%	80%	120%	109%	80%	120%	101%	70%	130%
Total Magnesium	9793739		0.9	0.9	1.6%	< 0.1	102%	80%	120%	105%	80%	120%	102%	80%	120%
Bicarb. Alkalinity (as CaCO3)	9794608		26	25	4.3%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	9794608		<10	<10	NA	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	9794608		<5	<5	NA	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	9793739		8	8	NA	< 5	101%	80%	120%	104%	80%	120%	85%	70%	130%
Total Antimony	9793739		<2	<2	NA	< 2	104%	80%	120%	120%	80%	120%	111%	70%	130%
Total Arsenic	9793739		<2	<2	NA	< 2	96%	80%	120%	96%	80%	120%	NA	70%	130%
Total Barium	9793739		<5	<5	NA	< 5	95%	80%	120%	101%	80%	120%	111%	70%	130%
Total Beryllium	9793739		<2	<2	NA	< 2	107%	80%	120%	107%	80%	120%	112%	70%	130%
Total Bismuth	9793739		<2	<2	NA	< 2	92%	80%	120%	103%	80%	120%	96%	70%	130%
Total Boron	9793739		74	65	13.5%	< 5	100%	80%	120%	107%	80%	120%	NA	70%	130%
Total Cadmium	9793739		<0.09	< 0.09	NA	< 0.09	96%	80%	120%	101%	80%	120%	100%	70%	130%
Total Chromium	9793739		2	1	NA	< 1	95%	80%	120%	98%	80%	120%	93%	70%	130%
Total Cobalt	9793739		<1	<1	NA	< 1	95%	80%	120%	99%	80%	120%	99%	70%	130%
Total Copper	9793739		18	18	0.3%	< 1	97%	80%	120%	100%	80%	120%	NA	70%	130%
Total Iron	9793739		85	81	NA	< 50	95%	80%	120%	97%	80%	120%	96%	70%	130%
Total Lead	9793739		0.5	0.5	NA	< 0.5	94%	80%	120%	101%	80%	120%	97%	70%	130%
Total Manganese	9793739		4	4	NA	< 2	95%	80%	120%	98%	80%	120%	96%	70%	130%
Total Molybdenum	9793739		<2	<2	NA	< 2	96%	80%	120%	100%	80%	120%	86%	70%	130%
•			7	7		< 2	98%	80%	120%	101%	80%	120%	102%	70%	130%
Total Nickel	9793739		1	,	NA	< 2	9070	0070	12070	10170	00 /0	120/0	102/0	10/0	100/0
Total Nickel Total Phosphorous	9793739 9793739		<0.02	<0.02	NA	< 0.02	108%	80%	120%	115%	80%	120%	90%	70%	130%

AGAT QUALITY ASSURANCE REPORT (V1)

Page 23 of 32

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.



Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

		V	Vate	^r Ana	lysis	(Coı	ntinu	ed)							
RPT Date: Jan 09, 2019				UPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SP	IKE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	1 1 1 1 1	ptable nits	Recovery	1 1 1 1	eptable mits
		ld	·	·			Value	Lower	Upper	,	Lower	Upper	ĺ	Lower	Upper
Total Silver	9793739		<0.1	<0.1	NA	< 0.1	93%	80%	120%	100%	80%	120%	70%	70%	130%
Total Strontium	9793739		<5	<5	NA	< 5	94%	80%	120%	96%	80%	120%	93%	70%	130%
Total Thallium	9793739		<0.1	<0.1	NA	< 0.1	95%	80%	120%	101%	80%	120%	95%	70%	130%
Total Tin	9793739		<2	<2	NA	< 2	92%	80%	120%	101%	80%	120%	99%	70%	130%
Total Titanium	9793739		3	3	NA	< 2	102%	80%	120%	107%	80%	120%	110%	70%	130%
Total Uranium	9793739		<0.1	<0.1	NA	< 0.1	94%	80%	120%	101%	80%	120%	94%	70%	130%
Total Vanadium	9793739		29	27	7.5%	< 2	92%	80%	120%	98%	80%	120%	NA	70%	130%
Total Zinc	9793739		20	20	NA	< 5	97%	80%	120%	99%	80%	120%	103%	70%	130%
Comments: If RPD value is NA, th	e results of the	e duplicates	s are less t	han 5x the	RDL and	the RPD	will not be	calcula	ted.						
Mercury Analysis in Water (Tot	al)														
Total Mercury	1	9791865	<0.026	<0.026	NA	< 0.026	96%	80%	120%		80%	120%	90%	80%	120%
Comments: If RPD value is NA, th	e results of the	e duplicates	s are less t	han 5x the	RDL and	the RPD	will not be	calcula	ted.						

< 0.5

88%

80% 120%

Comments: If RPD value is NA, the results of the duplicates are less than 5x the RDL and the RPD will not be calculated.

2.2

9791865 9791865

Certified By:

Josephan Coughtray

80% 120%

89%

80% 120%

Standard Water Analysis + Total Metals

Total Organic Carbon

Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BY.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Aluminum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Barium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Boron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Copper	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Iron	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Lead	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Lithium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Silver	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Tin	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	EPA SW 846 6020A/3050B & SM 3125	ICP/MS
Particle Size Distribution (<12.5mm, -4 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<9.5mm, -3 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<4.75mm, -2 PHI	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<2mm, -1 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1mm, 0 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/2mm, 1 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Particle Size Distribution (<1/4mm, 2 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/8mm, 3 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/16mm, 4 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/32mm, 5 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/64mm, 6 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/128mm, 7 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/256mm, 8 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (<1/512mm, 9 PHI)	INOR-121-6034	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (Gravel)	INOR-121-6031	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (Sand)	INOR-121-6031	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (Silt)	INOR-121-6031	ASTM D-422-63	SIEVE & PIPETTE
Particle Size Distribution (Clay)	INOR-121-6031	ASTM D-422-63	SIEVE & PIPETTE
Particles >75um	INOR-121-6031, INOR-121-6034	ASTM D-422-63	CALCULATED
Classification	INOR-121-6031, INOR-121-6031	Atlantic RBCA	CALCULATED
Mercury	INOR-121-6101 & INOR-121-6107	Based on EPA 245.5 & SM 3112B	CV/AA

Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421242

PROJECT: 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

SAMI LING SITE.		OAIVII EED D1.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Benzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Toluene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Ethylbenzene	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
Xylene (Total)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C10-C16 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
>C21-C32 Hydrocarbons - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Modified TPH (Tier 1) - 1X silica gel	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
Resemblance Comment	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS/FID
Return to Baseline at C32	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Silica Gel Cleanup			GC/FID
Isobutylbenzene - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Isobutylbenzene - VPH	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
n-Dotriacontane - EPH	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
C6-C10 (less BTEX)	VOL-120-5013	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/MS
>C10-C16 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C16-C21 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
>C21-C32 Hydrocarbons	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	GC/FID
Modified TPH (Tier 1)	ORG-120-5101	Atlantic RBCA Guidelines for Laboratories Tier 1	CALCULATION
% Moisture		Calculation	GRAVIMETRIC
1-Methylnaphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
2-Methylnaphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acenaphthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acenaphthylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Acridine	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(a)anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(a)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(b)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(b+j)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(e)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(ghi)perylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Benzo(k)fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

O/ 11111 E1110 O11 E.		O/ (WII EED D I :	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Chrysene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Dibenzo(a,h)anthracene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Fluoranthene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Fluorene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Indeno(1,2,3)pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Naphthalene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Perylene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Phenanthrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Pyrene	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Quinoline	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Nitrobenzene-d5	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
2-Fluorobiphenyl	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
Terphenyl-d14	ORG-120-5104	EPA SW846/3541/3510/8270C	GC/MS
1-Methylnaphthalene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
2-Methylnaphthalene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Acenaphthene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Acenaphthylene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Acridine	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Anthracene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(a)anthracene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(a)pyrene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(b)fluoranthene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(e)pyrene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(ghi)perylene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Benzo(k)fluoranthene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Chrysene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Dibenzo(a,h)anthracene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Fluoranthene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Fluorene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Indeno(1,2,3-cd)pyrene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Naphthalene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Perylene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Phenanthrene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Pyrene	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Quinoline	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Nitrobenzene-d5	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
2-Fluorobiphenyl	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Terphenyl-d14	ORG-120-5104	EPA SW846/3510/8270C	GC/MS
Total Polychlorinated Biphenyls	ORG-120-5106	EPA SW846/8081/8080	GC/ECD
Decachlorobiphenyl	ORG-120-5106	EAP SW846 3510C/8080/8010	GC/ECD

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

o o		O/ (IVII EED D1.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis	·		•
Total Mercury	MET-121-6100 &	SM 3112 B	CV/AA
рH	MET-121-6107 INOR-121-6001	SM 4500 H+B	PC TITRATE
Reactive Silica as SiO2	INOR-121-6027	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Fluoride	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Alkalinity	INOR-121-6001	SM 2320 B	ION OF INCIDIATORIAL TI
True Color	INOR-121-6014	SM 2120 C	NEPHELOMETER
Turbidity	INOR-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INORG-121-6005	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-121-6047	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INOR-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INOR-121-6012	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Calcium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Magnesium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP-MS
Total Arsenic	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Barium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Beryllium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Bismuth	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Boron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421242
PROJECT: 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BY.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Cadmium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Chromium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Cobalt	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Copper	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Iron	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Lead	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Manganese	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Molybdenum	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Nickel	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Phosphorous	MET-121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Selenium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Silver	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Strontium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Thallium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Tin	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Titanium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Uranium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Vanadium	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS
Total Zinc	MET121-6104 & MET-121-6105	modified from SM 3125/SM 3030 B/SM 3030 D	ICP-MS



Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

е	
S	Laboratory Use Only
2	
n	Arrival Condition: ☐ Good ☐ Poor (see notes)
	Arrival Temperature: 1.5, 1.4
4	AGAT Job Number: 18 K421242
	Notes:
ŧ	
- 1	Turnaround Time Required (TAT)

			902.4	168.8	371	8 = F	: 90	2.46	8.89	24	AII	vali	iem	pera	iture	1	8	2	12	12.	47)
Chain of Custody Record	Report Info											tes:		um	er:	-	S		14	1	1 2	$\hat{\exists}$
Report Information	1. Name:						Rep	ort F	orm	at												
Company: GHD Limited		James O'Neill				11	_															
Contact: James O'Neill	11	James.O'Neill@ghd.com				1		Singl Samp	e ole pe	er	Turnaround Time Required (TAT)											
Address: 1118 Topsail Road	1.1	DataNL						page			ll .											
St. John's NL A1B 3N7		datanl@ghd.com				1	v į	Multi Samp	ole	.or	Re	gula	r TA	T [⊿5 t	to 7	work	ing d	ays			
Phone: 1-709-364-5353 Fax: 1-709-364-5368						4		page		Jei	Ru	sh TA	AΤ]10	day			2 days	S		
IOL Site # and Name: Marystown Shipyard Waterlot		Requirements (Check):						Excel]30	days	,					
Project #: 11178792-02	List Guideline	s on Report 🗵 Do Not List Guid	delines o	n Repo	ort		_	Form Inclu				- 5		.00								
AGAT Quotation #: GHD 'Standing Offer"	∏ □ FIRI □ Tier 1	□ Gas ☑ Pot ☑	Coarse			_					Dat	e ke	quir	ea:								=
GHD PO #: To Follow	□Res	□ Fuel □ N/Pot □ I	ine			111		ing W	ater S	Samı	ole:	□ Yes	3	Ø	No							
Invoice To Same Yes ☑ / No □	☑ Com	□Lube				16	≀eg. f	NO.: _	_	,	-		_	_	_							
Company:	☐ CCME ☐ Industri	□ CDWQ			(POTABLE)																	
Contact:	□ Comme				EL (PO			9				1	(ster)				Н					
Address:	□ Res/Pa		1	ER 1	LOW LEVEL (oldelievA (2)		itte)		, in c		₽.			Ш					
	☐ Agricult☐ FWAL	ural	ψ	CA		2	£			J Pipe		8	E G	풀								
Phone: Fax:	☑ Sedime	ent =	NER	IC RB	CA TIEF	NATIC	PH/B	i d	3	re and		9		3							(Z	
		(CONTAINERS	LANT	TIC RB	CTIO	5			Sie,		Į.		Mercino	į						EAR ()	(N)
		COMMENTS -		FA - A	ATLAN	X FR/		ONLY		SIZE		Š		Mercina							7 T X) Snc
SAMPLE IDENTIFICATION DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX - ATLANTIC RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I -	TPH/BTEX FRACTIONATION	MTBE (ADDED TO TPH/BTEX)	MTBE ONI	. PG	PARTICLE SIZE (Sieve and Pipette)	PAHs	PCBs		SHER.		i					HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
18-MNMA-STEP1 2018/12/13 14:38	Sediment	1 x250ml& 2 x40ml &1x120ml	6	Ø				Ø					-	7 2	_	+	\Box				Ŧ	
18-MNMA-STEP2 2018/12/13 15:02	Sediment	1 x250ml& 2 x40ml &1x120ml	6	Ø				Ø	1	П	Ø		6	7 2	3	T	\Box		1		\top	\Box
18-MNMA-STEP3 2018/12/13 15:25	Sediment	1 x250ml& 2 x40ml &1x120ml	6	Ø				Ø	1			Ø	G	7 7	3							
18-MNMA-DUP3 2018/12/13 15:28	Sediment	1 x250ml& 2 x40ml &1x120ml	6			\Box		Ø			Ø		E	2 2	3							
18-MNMA-S4 2018/10/19 11:00	Sediment	Prev. submitted 18K399949			_	=	+	-			_	4	+		-	\perp	\perp		-			
18-MNMA-S8 2018/10/19 12:20	Sediment	Prev. submitted 18K399949				-	+	-	-		-	+	+	-	+-	+	+	-	_	\vdash		+
18-MNMA-S13 2018/10/19 13:55	Sediment	Prev. submitted 18K399949				-	\dashv	-	+		-	-	-	-	+	+		+	-	\vdash	-	
18-MNMA-REF2 2018/10/19 14:45	Sediment	Prev. submitted 18K399949					+		+	V		+	+	+	+	+		-	+		+	\vdash
									1			+	\dagger		+	+	\forall	\top	-		+	+
Samples Relinquished By (Print Name): Date/Time																	\Box					
INGLID LAWLOR DEL	7/18	Mr. 1550 Harris	977						e/Time	12	118	٦,					Pa	age <u>1</u>		of 2		
Samples Reinquished Bussigni Juni 9.2	San	Melissa Harriso Westerelyd By (Sign) Westeren						Da	D4.			2.0										



Chain of Custody Record



Dartmouth, NS

B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902.468.8718 • F: 902.468.8924

Laboratory Use Only
Arrival Condition: Good Poor (see notes) Arrival Temperature: 1.5, 1.4 AGAT Job Number: 18 K 42 12 42 Notes:
Turnaround Time Required (TAT)

Chain of Custody Recor	a	Report Information											s:										
Report Information		1. Name:					R	poi	t Fo	rma	t												
Company: GHD Limited		Email:	James O'Neill					Si	ngle														\perp
Contact: James O'Neill		2. Name:	James.O'Neill@ghd.com					Sa	mple	e per	١Ē	urn	arou	ınd	Tim	e A	en.	uired	(TA)	7)			=
Address: 1118 Topsail Road		Email:	DataNL				Н		ige										•	•			
St. John's NL A1B 3N7			datanl@ghd.com				1	M	ultipl Imple	e oo no		≀egu	ıar ı	ΑI	M.	o to	7 W	orkin	g day	S			
Phone: 1-709-364-5353 Fax	1-709-364-5368							pa	ige	35 pe	" ı	Rush	TAT			1 da	ay		□2	days			
IOL Site # and Name: Marystown Shipya	rd Waterlot	Regulatory	Requirements (Check)):			[7 E>	cel							3 da	ays						
Project #: 11178792-02		List Guidelines	on Report 🗹 Do Not Lis	t Guidelines o	n Repo	rt	"		rmat clude														
AGAT Quotation #: GHD 'Standing Off	er"	☐ PIRI ☑ Tier 1	□ Gas ☑ Pot	☑ Coarse			L		ora a c			Date	Requ	iired	: :=								-
GHD PO #: To Follow		□Res	□ Fuel □ N/Pot	□ Fine	;		1111		_	ter Sa	mple	nple: □ Yes ☑ No											
Invoice To	Same Yes ☑ / No □		□Lube				Re	g. No	-	60 127										3			
Company:	,	✓ CCME ☐ Industria				(POTABLE)			0				-										
Contact:		□ Comme			4	EVE			ilable		<u></u>		niste										
Address:		□ Res/Pai □ Agriculti		띪	LOW LEVEL		-	☑ Available	Н	pette		a Ca	身		<u></u>								
		TION BIES BY BEECH BIES BY									nd Pi		E	ean		Leve							
Phone: Fax:		□ Sedime	ent	CONTAINERS	- ATLANTIC RBCA	NTIC RBCA TI	RACTIONAL	71.0	otal 🗆 Diss		E (Sieve a		FRACTIONATION (Summa Canister)	ca Gel Clean-up	Mercury	PAHs (Low Level)	emistry					1 YEAR (Y/N)	(Y/N)
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	COMMENTS – SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX - A	TPH/BTEX - ATLANTIC RBCA TIER	TPH/BTEX FRACTIONATION	MTBE ONLY	METALS: Total	FOC	PARTICLE SIZE (Sieve and Pipette)	PCBs	TPH FRACTIO	OTHER: Silica		отнек: РА	General Chemistry					HOLD FOR 1	HAZARDOUS
8-MNMA-W2	2018/12/13 09:08	SW	18-MNMA-S1	10	Ø				Ø							\rightarrow	Ø		7				
18-MNMA-W6	2018/12/13 10:16	sw	18-MNMA-S6	10	Ø										Ø	Ø							
8-MNMA-W9	2018/12/14 10:20	SW	18-MNMA-S9	10	Ø				Ø						Ø	Ø	Ø						
18-MNMA-W12	2018/12/14 08:50	SW	18-MNMA-S12	10	Ø				V						Ø	Ø	Ø		T				Т
18-MNMA-W14	2018/12/14 09:28	SW	18-MNMA-S14	10	Ø				Ø						Ø	Ø							
18-MNMA-W-DUP1	2018/12/13 10:18	SW	Field Dup	10	Ø				V						Ø	Ø	Ø						
18-MNMA-W-REF2	2018/12/13 13:12	SW	18-MNMA-REF2	10	Ø										Ø	Ø	Ø						
18-MNMA-W-REF3	2018/12/13 13:51	SW	18-MNMA-REF3	10	Ø				Ø						Ø	Ø	Ø						
Samptes Relinquished By (Print Name).	Date/Time	Texas	sples Received By (Print Name):																	Ш			
NURID LAWLOR	Dec F	1182	Welissa Harri	5/92					Date/		17	110						Pag	e 2	(of 2		



CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: 11178792-02 Marystown Shipyard MSSP

AGAT WORK ORDER: 18K421824

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

TRACE ORGANICS REVIEWED BY: Kelly Hogue, B.Sc, P.Chem, Operations Manager

ULTRA TRACE REVIEWED BY: Anastasia Kazakova, chimiste

DATE REPORTED: Dec 31, 2018

PAGES (INCLUDING COVER): 21

VERSION*: 2

Should you require any information regarding this analysis please contact your client services representative at (709)747-8573

*NOTES
VERSION 2:This report supersedes all previous reports and had been updated to include the complete list of metals.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V2)

Page 1 of 21

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. Measurement Uncertainty is not taken into consideration when stating conformity with a specified requirement.



Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Mercury Analysis in Tissue

				10101	July / tiluly J	10 111 11000	•				
DATE RECEIVED: 2018-12-18								[DATE REPORT	ED: 2018-12-31	
				18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-		
		SAMPLE DES	CRIPTION:	COMP1	COMP2	COMP3	COMP4	REF1B	REF3B	18-MNMA-TIS1A	18-MNMA-TIS
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13
Parameter	Unit	G/S	RDL	9796093	9796104	9796105	9796108	9796109	9796110	9796111	9796115
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
						18-MNMA-		18-MNMA-	18-MNMA-	18-MNMA-TIS-	
		SAMPLE DES	CRIPTION:	18-MNMA-TIS5A	18-MNMA-TIS6A	TIS10A	18-MNMA-TIS11	TIS12A	TIS14A	REF3A	
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	
Parameter	Unit	G/S	RDL	9796116	9796117	9796118	9796119	9796120	9796121	9796122	
Mercury in Tissue	mg/kg		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	

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

9796093-9796122 Results are based on the wet weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

SAMPLING SITE:

Certified By:

Josephan Coughtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Metals in Tissue

DATE RECEIVED: 2018-12-18	3							Ε	DATE REPORT	ED: 2018-12-31	
		SAMPLE DES	CRIPTION: PLE TYPE:	18-MNMA-TIS- COMP1 Tissue	18-MNMA-TIS- COMP2 Tissue	18-MNMA-TIS- COMP3 Tissue	18-MNMA-TIS- COMP4 Tissue	18-MNMA-TIS- REF1B Tissue	18-MNMA-TIS- REF3B Tissue	18-MNMA-TIS1A Tissue	18-MNMA-TIS3 Tissue
_			SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13
Parameter	Unit	G/S	RDL	9796093	9796104	9796105	9796108	9796109	9796110	9796111	9796115
Aluminum	mg/kg		10	15	<10	<10	<10	<10	29	<10	<10
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg		2	3	4	4	3	5	4	2	3
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	<5
Boron	mg/kg		2	<2	<2	<2	6	2	6	4	5
Cadmium	mg/kg		0.3	2.9	1.3	2.3	4.8	<0.3	3.5	2.7	6.0
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	mg/kg		2	20	14	18	9	19	<2	<2	<2
Iron	mg/kg		50	125	63	132	<50	52	95	<50	146
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	0.7	<0.4	1.1	<0.4	<0.4
Manganese	mg/kg		2	4	<2	<2	43	2	23	<2	<2
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	mg/kg		1	<1	<1	<1	<1	1	<1	<1	<1
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium	mg/kg		5	113	49	36	33	210	8	5	5
Thallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	mg/kg		2	2	4	3	5	4	6	4	6
Zinc	mg/kg		5	25	28	27	108	27	74	10	10

Certified By:

Joseph Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Metals in Tissue

					Metals III I	13346					
DATE RECEIVED: 2018-12-18									DATE REPORT	ED: 2018-12-31	
		SAMPLE DESC	RIPTION: 1	8-MNMA-TIS5A	. 18-MNMA-TIS6A	18-MNMA- TIS10A	18-MNMA-TIS11	18-MNMA- TIS12A	18-MNMA- TIS14A	18-MNMA-TIS- REF3A	
		SAMPI	LE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	
		DATE SA	AMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	
Parameter	Unit	G/S	RDL	9796116	9796117	9796118	9796119	9796120	9796121	9796122	
Aluminum	mg/kg		10	<10	<10	<10	<10	<10	14	<10	
Antimony	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Arsenic	mg/kg		2	3	2	3	3	3	3	2	
Barium	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	
Beryllium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Bismuth	mg/kg		5	<5	<5	<5	<5	<5	<5	<5	
Boron	mg/kg		2	5	4	5	5	5	5	4	
Cadmium	mg/kg		0.3	5.6	6.3	17.8	6.6	10.2	8.7	4.9	
Chromium	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Cobalt	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	
Copper	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
ron	mg/kg		50	70	115	142	66	58	74	<50	
_ead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
Manganese	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Molybdenum	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Nickel	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Selenium	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	
Silver	mg/kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Strontium	mg/kg		5	6	<5	5	<5	5	6	5	
Γhallium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Γin	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Uranium	mg/kg		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
/anadium	mg/kg		2	5	3	6	4	4	5	4	
Zinc	mg/kg		5	12	7	12	10	9	10	9	

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

9796093-9796122 Results are based on the wet weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Josephan Coaghtray



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Metals in Tissue - As.Pb.Cu.Zn

				ivietais	s in Tissue -	AS,Pb,Cu,	Z N				
DATE RECEIVED: 2018-12-18								[DATE REPORT	ED: 2018-12-31	
				18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-		
		SAMPLE DES	CRIPTION:	COMP1	COMP2	COMP3	COMP4	REF1B	REF3B	18-MNMA-TIS1A	18-MNMA-TIS3
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13
Parameter	Unit	G/S	RDL	9796093	9796104	9796105	9796108	9796109	9796110	9796111	9796115
Arsenic	mg/kg		2	3	4	4	3	5	4	2	3
Copper	mg/kg		2	20	14	18	9	19	<2	<2	<2
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	0.7	<0.4	1.1	<0.4	<0.4
Zinc	mg/kg		5	25	28	27	108	27	74	10	10
						18-MNMA-		18-MNMA-	18-MNMA-	18-MNMA-TIS-	
		SAMPLE DES	CRIPTION:	18-MNMA-TIS5A	18-MNMA-TIS6A	TIS10A	18-MNMA-TIS11	TIS12A	TIS14A	REF3A	
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	
Parameter	Unit	G/S	RDL	9796116	9796117	9796118	9796119	9796120	9796121	9796122	
Arsenic	mg/kg		2	3	2	3	3	3	3	2	
Copper	mg/kg		2	<2	<2	<2	<2	<2	<2	<2	
Lead	mg/kg		0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
Zinc	mg/kg		5	12	7	12	10	9	10	9	

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

9796093-9796122 Results are based on the wet weight of the sample.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Jasan Coaghtry



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

Total Polychlorinated Biphenyls in Tissue

				- · · · · · · · · · · · · · · · · · · ·							
DATE RECEIVED: 2018-12-18								Ī	DATE REPORT	ED: 2018-12-31	
				18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-		
		SAMPLE DES	CRIPTION:	COMP1	COMP2	COMP3	COMP4	REF1B	REF3B	18-MNMA-TIS1A	18-MNMA-TIS3
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13	2018-12-14	2018-12-13	2018-12-13
Parameter	Unit	G/S	RDL	9796093	9796104	9796105	9796108	9796109	9796110	9796111	9796115
PCB in Tissue, Total	mg/Kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate	Unit	Acceptab	le Limits								
Decachlorobiphenyl	%	50-1	130	111	116	95	76	108	111	105	90
						18-MNMA-		18-MNMA-	18-MNMA-	18-MNMA-TIS-	
		SAMPLE DES	CRIPTION:	18-MNMA-TIS5A	18-MNMA-TIS6A	TIS10A	18-MNMA-TIS11	TIS12A	TIS14A	REF3A	
		SAMI	PLE TYPE:	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	Tissue	
		DATES	SAMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-14	2018-12-14	2018-12-14	2018-12-13	
Parameter	Unit	G/S	RDL	9796116	9796117	9796118	9796119	9796120	9796121	9796122	
PCB in Tissue, Total	mg/Kg		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Surrogate	Unit	Acceptab	le Limits								
Decachlorobiphenyl	%	50-1	130	108	114	100	108	95	91	78	

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

9796093 Results are based on the wet weight of the tissue.MS not available due to limited sample availability.

9796104-9796122 Results are based on the wet weight of the tissue.

Analysis performed at AGAT Halifax (unless marked by *)

Certified By:

Kelly Hogue



SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

					o y 1 11 (11 o (11 g/ ;	9/				
DATE RECEIVED: 2018-12-18							DA	ATE REPOR	TED: 2018-12-31	
			18-MNMA-TIS-		18-MNMA-TIS-		18-MNMA-TIS-		18-MNMA-TIS-	
	S	SAMPLE DESCRIPTION:	COMP1		COMP2		COMP3		COMP4	
		SAMPLE TYPE:	Tissue		Tissue		Tissue		Tissue	
		DATE SAMPLED:	2018-12-13		2018-12-13		2018-12-14		2018-12-13	
Parameter	Unit	G/S RDL	9796093	RDL	9796104	RDL	9796105	RDL	9796108	
1,3-Dimethylnaphthalene	ng/g	0.6	36.9	0.4	25.4	0.4	27.5	0.3	22.3	
1-Chloronaphthalene	ng/g	1	<1	0.7	<0.7	0.5	<0.5	0.6	<0.6	
1-Methylnaphthalene	ng/g	1	20	0.9	13.3	0.9	12.9	0.8	14.1	
2,3,5-Trimethylnaphthalene	ng/g	0.9	2.3	0.3	1.0	0.3	1.1	0.7	1.7	
2,6-Dimethylnaphthalene	ng/g	0.6	47.5	0.4	32.7	0.4	22.3	0.3	36.1	
2-Chloronaphthalene	ng/g	0.8	<0.8	0.6	<0.6	0.5	<0.5	0.5	<0.5	
2-Methylnaphthalene	ng/g	1	34	0.9	23.7	0.9	25.0	0.8	26.5	
Acenaphthylene	ng/g	0.1	1.6	0.1	1.6	0.1	0.9	0.1	1.3	
Acenaphthene	ng/g	0.1	5.3	0.1	12.7	0.1	6.3	0.1	10.7	
Acridine	ng/g	0.3	<0.3	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Anthracene	ng/g	0.4	1.3	0.1	0.3	0.2	0.3	0.3	1.8	
Benzo[a]Anthracene	ng/g	0.1	4.3	0.1	0.2	0.1	0.1	0.1	0.4	
Benzo[a]Pyrene	ng/g	0.1	1.2	0.1	0.6	0.1	0.8	0.1	0.8	
Benzo(b+j)fluoranthene	ng/g	0.2	0.9	0.1	0.2	0.1	0.2	0.2	0.6	
Benzo(e)pyrene	ng/g	0.1	3.6	0.1	1.4	0.1	1.6	0.1	2.7	
Benzo[g,h,i]Perylene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Benzo[k]Fluoranthene	ng/g	0.1	0.8	0.1	<0.1	0.1	0.2	0.1	0.7	
Chrysene	ng/g	0.1	4.9	0.1	0.3	0.1	0.3	0.1	0.4	
Dibenzo[a,h]Anthracene	ng/g	0.1	<0.1	01	<01	0.1	<0.1	0.1	<0.1	
Fluoroanthene	ng/g	0.1	22.0	0.1	1.3	0.1	1.2	0.1	10.7	
Fluorene	ng/g	0.5	3.5	0.2	1.8	0.2	1.3	0.5	1.8	
Indeno[1,2,3,c-d]Pyrene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Naphthalene	ng/g	0.6	22.1	0.3	15.3	0.3	14.0	0.3	16.4	
Perylene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Phenanthrene	ng/g	0.3	17.8	0.1	2.3	0.1	2.4	0.2	4.1	
Pyrene	ng/g	0.1	43.3	0.1	1.3	0.1	1.1	0.1	7.4	
Quinoline	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Lipid Content	%		0.55		1.23		0.58		0.46	





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18					DATE RI	EPORTED: 2018-12-31
			18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-	18-MNMA-TIS-
		SAMPLE DESCRIPTION:	COMP1	COMP2	COMP3	COMP4
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue
		DATE SAMPLED:	2018-12-13	2018-12-13	2018-12-14	2018-12-13
Surrogate	Unit	Acceptable Limits	9796093	9796104	9796105	9796108
3C Naphthalene	%	30-140	32	37	38	31
13C Acenaphthtylene	%	30-140	102	103	111	111
I3C Acenaphthene	%	30-140	103	65	123	71
I3C Fluorene	%	30-140	35	41	49	51
3C Phenanthrene	%	30-140	70	88	90	126
I3C Anthracene	%	30-140	66	79	85	127
I3C Fluoroanthene	%	30-140	32	30	30	45
13C Pyrene	%	30-140	49	60	57	106
13C Benzo[a]Anthracene	%	30-140	50	79	78	96
I3C Chrysene	%	30-140	74	110	102	123
I3C Benzo[b]Fluoranthene	%	30-140	32	41	46	52
3C Benzo[k]Fluoranthene	%	30-140	52	60	62	84
3C Benzo[a]Pyrene	%	30-140	48	84	80	55
3C Indeno[1,2,3,c-d]Pyrene	%	30-140	68	67	75	93
3C Benzo[g,h,i]Perylene	%	30-140	68	108	106	98
I3C Dibenzo[a,h]Anthracene	%	30-140	48	54	67	69





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.aqatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18 **DATE REPORTED: 2018-12-31** 18-MNMA-TIS-18-MNMA-TIS-SAMPLE DESCRIPTION: REF1B REF3B 18-MNMA-TIS1A 18-MNMA-TIS3 SAMPLE TYPE: Tissue Tissue Tissue Tissue DATE SAMPLED: 2018-12-13 2018-12-14 2018-12-13 2018-12-13 9796109 RDL 9796110 RDL 9796111 9796115 Parameter Unit G/S **RDL** RDL 1,3-Dimethylnaphthalene 0.3 22.9 0.4 22.4 0.4 48.0 0.4 36.0 ng/g 0.5 < 0.5 0.7 < 0.7 0.7 < 0.7 0.5 <0.5 1-Chloronaphthalene ng/g 1-Methylnaphthalene 0.7 12.2 1 15 1 28 0.9 16.4 ng/g 0.6 1.5 0.4 3.1 2.2 2,3,5-Trimethylnaphthalene ng/g 3 <3 0.7 2,6-Dimethylnaphthalene 0.3 19.0 0.4 34.3 0.4 73.0 0.4 34.5 ng/g 0.4 0.6 <0.6 <0.4 2-Chloronaphthalene ng/g < 0.4 0.6 <0.6 0.4 2-Methylnaphthalene 0.7 27 51 0.9 30.2 ng/g 21.4 1 1 Acenaphthylene 0.1 1.8 0.1 1.7 0.1 2.1 0.1 1.2 ng/g Acenaphthene 0.1 18.4 0.1 12.1 0.1 16.4 10.5 ng/g 0.1 Acridine 0.3 < 0.3 0.2 < 0.2 0.1 < 0.1 0.2 <0.2 ng/g Anthracene 0.6 0.9 0.2 0.5 0.2 1.1 0.3 1.1 ng/g Benzo[a]Anthracene 0.1 15.6 0.1 0.6 0.1 5.0 0.1 5.6 ng/g Benzo[a]Pyrene 0.1 3.4 0.1 0.3 0.1 2.9 0.1 1.1 ng/g Benzo(b+j)fluoranthene ng/g 0.1 2.3 0.1 0.4 0.1 2.6 0.1 1.7 Benzo(e)pyrene ng/g 0.1 10.6 0.1 1.9 0.1 7.1 0.1 2.5 Benzo[g,h,i]Perylene ng/g 0.1 < 0.1 0.1 < 0.1 0.1 4.0 0.5 < 0.5 Benzo[k]Fluoranthene 0.1 0.4 3.1 ng/g 0.1 3.9 0.1 0.1 1.7 Chrysene 0.1 37.8 0.1 1.5 0.1 5.3 0.5 3.8 ng/g Dibenzo[a,h]Anthracene 0.1 <0.1 0.1 < 0.1 0.1 <0.1 0.1 <0.1 ng/g Fluoroanthene 0.3 0.1 5.8 14.9 12.3 14.6 0.1 0.1 ng/g Fluorene 8.0 2.9 0.3 2.1 0.4 2.3 0.3 1.8 ng/g Indeno[1,2,3,c-d]Pyrene ng/g 0.1 < 0.1 0.1 < 0.1 0.1 0.9 0.1 <0.1 Naphthalene ng/g 0.2 14.0 0.4 17.4 0.4 31.6 0.3 19.3 0.1 0.1 < 0.1 < 0.1 Perylene ng/g < 0.1 0.1 1.7 0.1 0.1 Phenanthrene 0.5 7.7 5.2 0.2 6.1 0.2 5.1 ng/g Pyrene ng/g 0.1 11.7 0.1 7.2 0.1 8.0 0.1 6.8 Quinoline 0.1 <0.1 0.1 <0.1 <0.1 ng/g 0.1 < 0.1 0.1 Lipid Content % 0.22 0.42 0.37 1.31





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18					DATE REPORTED: 2018-12-31				
			18-MNMA-TIS-	18-MNMA-TIS-					
		SAMPLE DESCRIPTION:	REF1B	REF3B	18-MNMA-TIS1A	18-MNMA-TIS3			
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue			
		DATE SAMPLED:	2018-12-13	2018-12-14	2018-12-13	2018-12-13			
Surrogate	Unit	Acceptable Limits	9796109	9796110	9796111	9796115			
I3C Naphthalene	%	30-140	53	45	31	41			
I3C Acenaphthtylene	%	30-140	98	104	112	116			
13C Acenaphthene	%	30-140	62	75	62	79			
13C Fluorene	%	30-140	48	47	44	47			
I3C Phenanthrene	%	30-140	124	102	108	98			
I3C Anthracene	%	30-140	127	95	97	84			
13C Fluoroanthene	%	30-140	36	34	38	37			
13C Pyrene	%	30-140	95	66	67	67			
13C Benzo[a]Anthracene	%	30-140	110	74	73	74			
I3C Chrysene	%	30-140	126	115	117	119			
I3C Benzo[b]Fluoranthene	%	30-140	109	53	46	47			
3C Benzo[k]Fluoranthene	%	30-140	119	92	73	75			
3C Benzo[a]Pyrene	%	30-140	119	88	53	97			
3C Indeno[1,2,3,c-d]Pyrene	%	30-140	96	91	111	80			
3C Benzo[g,h,i]Perylene	%	30-140	96	127	112	119			
13C Dibenzo[a,h]Anthracene	%	30-140	128	62	70	69			





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18					- (3		D	ATE REPOR	TED: 2018-12-31	
5, (12 (12 62 (V 25), 20 10 12 10							18-MNMA-	THE REPORT	123. 2010 12 01	
	S	SAMPLE DESCRIPTION	ON: 18-MNMA-TIS5A		18-MNMA-TIS6A		TIS10A		18-MNMA-TIS11	
		SAMPLE TY			Tissue		Tissue		Tissue	
		DATE SAMPL			2018-12-13		2018-12-13		2018-12-14	
Parameter	Unit	G/S RDL	. 9796116	RDL	9796117	RDL	9796118	RDL	9796119	
1,3-Dimethylnaphthalene	ng/g	0.5	21.5	0.5	28.5	0.4	16.8	0.4	16.5	
1-Chloronaphthalene	ng/g	0.8	<0.8	0.7	<0.7	0.7	<0.7	0.7	<0.7	
1-Methylnaphthalene	ng/g	1	20	1	17	0.8	12.2	1	12	
2,3,5-Trimethylnaphthalene	ng/g	0.4	1.5	0.4	1.7	0.4	0.6	0.4	1.5	
2,6-Dimethylnaphthalene	ng/g	0.6	36.5	0.5	42.9	0.4	25.3	0.4	29.9	
2-Chloronaphthalene	ng/g	0.7	<0.7	0.6	<0.6	0.6	<0.6	0.6	<0.6	
2-Methylnaphthalene	ng/g	1	35	1	32	0.8	23.3	1	23	
Acenaphthylene	ng/g	0.1	1.3	0.1	1.3	0.1	1.1	0.1	1.5	
Acenaphthene	ng/g	0.1	16.3	0.1	14.7	0.1	14.6	0.1	9.8	
Acridine	ng/g	0.1	<0.1	0.2	<0.2	0.2	<0.2	0.2	<0.2	
Anthracene	ng/g	0.2	0.5	0.2	0.9	0.3	0.5	0.2	0.7	
Benzo[a]Anthracene	ng/g	0.1	1.7	0.1	3.3	0.1	6.2	0.1	3.4	
Benzo[a]Pyrene	ng/g	0.1	1.2	0.1	2.2	0.1	1.2	0.1	1.2	
Benzo(b+j)fluoranthene	ng/g	0.1	0.8	0.1	1.6	0.1	1.2	0.2	1.5	
Benzo(e)pyrene	ng/g	0.1	2.9	0.1	4.1	0.1	4.4	0.1	3.7	
Benzo[g,h,i]Perylene	ng/g	0.1	<0.1	0.1	2.6	0.1	<0.1	0.1	<0.1	
Benzo[k]Fluoranthene	ng/g	0.1	1.2	0.1	1.8	0.1	1.4	0.1	1.4	
Chrysene	ng/g	0.1	0.9	0.1	2.4	0.1	3.9	0.1	2.6	
Dibenzo[a,h]Anthracene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Fluoroanthene	ng/g	0.1	5.3	0.1	12.0	0.1	7.6	0.1	11.3	
Fluorene	ng/g	0.3	1.7	0.2	1.9	0.3	1.6	0.3	2.2	
Indeno[1,2,3,c-d]Pyrene	ng/g	0.1	<0.1	0.1	0.5	0.1	<0.1	0.1	<0.1	
Naphthalene	ng/g	0.4	26.1	0.4	19.5	0.3	17.1	0.4	13.0	
Perylene	ng/g	0.1	0.7	0.1	2.1	0.1	1.4	0.1	<0.1	
Phenanthrene	ng/g	0.2	3.8	0.1	4.8	0.2	4.2	0.2	6.0	
Pyrene	ng/g	0.1	3.0	0.1	8.0	0.1	4.5	0.1	10.7	
Quinoline	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Lipid Content	%		0.27		0.32		0.36		0.47	





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18 DATE REPORTED: 2018-12-31									
					18-MNMA-				
		SAMPLE DESCRIPTION: 1	8-MNMA-TIS5A	18-MNMA-TIS6A	TIS10A	18-MNMA-TIS11			
		SAMPLE TYPE:	Tissue	Tissue	Tissue	Tissue			
		DATE SAMPLED:	2018-12-13	2018-12-13	2018-12-13	2018-12-14			
Surrogate	Unit	Acceptable Limits	9796116	9796117	9796118	9796119			
13C Naphthalene	%	30-140	34	39	43	43			
13C Acenaphthtylene	%	30-140	105	109	99	94			
13C Acenaphthene	%	30-140	56	56	58	87			
13C Fluorene	%	30-140	50	49	47	42			
13C Phenanthrene	%	30-140	105	100	97	89			
13C Anthracene	%	30-140	95	90	87	78			
13C Fluoroanthene	%	30-140	34	33	36	30			
13C Pyrene	%	30-140	60	60	63	56			
13C Benzo[a]Anthracene	%	30-140	66	93	64	64			
13C Chrysene	%	30-140	98	118	108	83			
13C Benzo[b]Fluoranthene	%	30-140	45	42	50	34			
13C Benzo[k]Fluoranthene	%	30-140	73	72	71	58			
13C Benzo[a]Pyrene	%	30-140	75	55	69	55			
13C Indeno[1,2,3,c-d]Pyrene	%	30-140	66	88	96	68			
13C Benzo[g,h,i]Perylene	%	30-140	66	106	85	90			
13C Dibenzo[a,h]Anthracene	%	30-140	44	67	46	44			





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/g)

DATE RECEIVED: 2018-12-18							D	ATE REPORTED: 2018-12-31
			18-MNMA-		18-MNMA-		18-MNMA-TIS-	
		SAMPLE DESCRIPTION:	TIS12A		TIS14A		REF3A	
		SAMPLE TYPE:	Tissue		Tissue		Tissue	
		DATE SAMPLED:	2018-12-14		2018-12-14		2018-12-13	
Parameter	Unit	G/S RDL	9796120	RDL	9796121	RDL	9796122	
1,3-Dimethylnaphthalene	ng/g	0.4	19.6	0.4	21.5	0.4	11.1	
1-Chloronaphthalene	ng/g	0.8	<0.8	0.6	<0.6	0.6	<0.6	
1-Methylnaphthalene	ng/g	1	12	0.9	19.7	1	8	
2,3,5-Trimethylnaphthalene	ng/g	0.4	1.2	0.9	1.3	0.5	1.0	
2,6-Dimethylnaphthalene	ng/g	0.4	33.4	0.4	40.1	0.4	15.3	
2-Chloronaphthalene	ng/g	0.7	<0.7	0.5	<0.5	0.5	<0.5	
2-Methylnaphthalene	ng/g	1	22	0.9	35.4	1	15	
Acenaphthylene	ng/g	0.1	1.3	0.1	1.4	0.1	0.9	
Acenaphthene	ng/g	0.1	8.7	0.1	6.1	0.1	13.7	
Acridine	ng/g	0.2	<0.2	0.2	<0.2	0.1	<0.1	
Anthracene	ng/g	0.2	0.4	0.7	1.3	0.2	0.4	
Benzo[a]Anthracene	ng/g	0.1	2.0	0.4	5.1	0.1	1.6	
Benzo[a]Pyrene	ng/g	0.1	1.0	0.1	1.2	0.1	1.4	
Benzo(b+j)fluoranthene	ng/g	0.1	1.4	0.1	2.1	0.1	0.7	
Benzo(e)pyrene	ng/g	0.1	4.2	0.1	4.1	0.1	3.5	
Benzo[g,h,i]Perylene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Benzo[k]Fluoranthene	ng/g	0.1	1.0	0.1	1.9	0.1	0.5	
Chrysene	ng/g	0.1	1.8	0.3	20.4	0.1	1.1	
Dibenzo[a,h]Anthracene	ng/g	0.6	<0.6	0.1	<0.1	0.1	<0.1	
Fluoroanthene	ng/g	0.1	7.0	0.1	9.1	0.1	3.2	
Fluorene	ng/g	0.4	1.5	0.6	1.9	0.3	1.6	
Indeno[1,2,3,c-d]Pyrene	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Naphthalene	ng/g	0.3	13.3	0.3	24.6	0.3	10.2	
Perylene	ng/g	0.1	1.0	0.1	1.1	0.1	1.4	
Phenanthrene	ng/g	0.2	3.3	0.5	6.2	0.1	3.1	
Pyrene	ng/g	0.1	4.0	0.1	3.8	0.1	2.1	
Quinoline	ng/g	0.1	<0.1	0.1	<0.1	0.1	<0.1	
Lipid Content	%		1.97		0.35		0.38	





SAMPLING SITE:

Certificate of Analysis

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLED BY:

57 Old Pennywell Road, Unit I St. John's, NL CANADA A1E 6A8 TEL (709)747-8573 FAX (709 747-2139 http://www.agatlabs.com

PAHs in Tissue by HRMS (ng/a)

			FAUS III	rissue by fixivis (rig/g)		
DATE RECEIVED: 2018-12-18					DATE RE	PORTED: 2018-12-31
		SAMPLE DESCRIPTION:	18-MNMA- TIS12A	18-MNMA- TIS14A	18-MNMA-TIS- REF3A	
		SAMPLE TYPE: DATE SAMPLED:	Tissue 2018-12-14	Tissue 2018-12-14	Tissue 2018-12-13	
Surrogate	Unit	Acceptable Limits	9796120	9796121	9796122	
13C Naphthalene	%	30-140	42	32	48	
13C Acenaphthtylene	%	30-140	94	117	85	
13C Acenaphthene	%	30-140	80	112	42	
13C Fluorene	%	30-140	45	48	39	
13C Phenanthrene	%	30-140	88	94	83	
13C Anthracene	%	30-140	79	87	75	
13C Fluoroanthene	%	30-140	31	41	35	
13C Pyrene	%	30-140	50	129	57	
13C Benzo[a]Anthracene	%	30-140	66	86	63	
13C Chrysene	%	30-140	100	110	89	
13C Benzo[b]Fluoranthene	%	30-140	36	43	41	
13C Benzo[k]Fluoranthene	%	30-140	63	77	63	
13C Benzo[a]Pyrene	%	30-140	63	88	48	
13C Indeno[1,2,3,c-d]Pyrene	%	30-140	41	78	58	
13C Benzo[g,h,i]Perylene	%	30-140	64	63	83	
13C Dibenzo[a,h]Anthracene	%	30-140	55	52	43	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard 9796093-9796122 The results were corrected based on the surrogate percent recoveries. Analysis performed at AGAT Montreal (unless marked by *)





Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

				Soi	l Ana	alysis	3								
RPT Date: Dec 31, 2018				UPLICAT	E	REFEREN	ICE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	IKE	
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits				ptable nits	Recovery	Lir	eptable mits
		la la	·	,				Upper	ĺ	Lower	Upper		Lower	Upper	
Metals in Tissue - As,Pb,Cu,Zn															
Arsenic	9796122 9	9796122	2	3	NA	< 2	90%	70%	130%	106%	70%	130%	NA	70%	130%
Copper	9796122 9	9796122	<2	<2	NA	< 2	94%	70%	130%	111%	70%	130%	NA	70%	130%
Lead	9796122 9	9796122	< 0.4	< 0.4	NA	< 0.4	94%	70%	130%	113%	70%	130%	NA	70%	130%
Zinc	9796122 9	9796122	9	11	NA	< 5	90%	70%	130%	112%	70%	130%	NA	70%	130%
Metals in Tissue															
Aluminum	9796122 9	9796122	<10	<10	NA	< 10	92%	70%	130%	109%	70%	130%	NA	70%	130%
Antimony	9796122 9	9796122	<2	<2	NA	< 2	81%	70%	130%	111%	70%	130%	NA	70%	130%
Arsenic	9796122 9	9796122	2	3	NA	< 2	90%	70%	130%	106%	70%	130%	NA	70%	130%
Barium	9796122 9	9796122	<5	<5	NA	< 5	92%	70%	130%	111%	70%	130%	NA	70%	130%
Beryllium	9796122 9	9796122	<2	<2	NA	< 2	100%	70%	130%	113%	70%	130%	NA	70%	130%
Bismuth	9796122 9	9796122	<5	<5	NA	< 5	93%	70%	130%	114%	70%	130%	NA	70%	130%
Boron	9796122 9	9796122	4	6	NA	< 2	93%	70%	130%	114%	70%	130%	NA	70%	130%
Cadmium	9796122 9	9796122	4.9	6.3	23.8%	< 0.3	90%	70%	130%	110%	70%	130%	NA	70%	130%
Chromium	9796122 9	9796122	<2	<2	NA	< 2	82%	70%	130%	102%	70%	130%	NA	70%	130%
Cobalt	9796122 9	9796122	<1	<1	NA	< 1	92%	70%	130%	111%	70%	130%	NA	70%	130%
Copper	9796122 9	9796122	<2	<2	NA	< 2	94%	70%	130%	115%	70%	130%	NA	70%	130%
Iron	9796122 9	9796122	<50	56	NA	< 50	86%	70%	130%	110%	70%	130%	NA	70%	130%
Lead	9796122 9	9796122	<0.4	<0.4	NA	< 0.4	94%	70%	130%	113%	70%	130%	NA	70%	130%
Manganese	9796122 9	9796122	<2	<2	NA	< 2	89%	70%	130%	111%	70%	130%	NA	70%	130%
Molybdenum	9796122 9	9796122	<2	<2	NA	< 2	89%	70%	130%	112%	70%	130%	NA	70%	130%
Nickel	9796122 9	9796122	<2	<2	NA	< 2	91%	70%	130%	114%	70%	130%	NA	70%	130%
Selenium	9796122 9	9796122	<1	<1	NA	< 1	89%	70%	130%	113%	70%	130%	NA	70%	130%
Silver	9796122 9	9796122	<0.5	<0.5	NA	< 0.5	91%	70%	130%	116%	70%	130%	NA	70%	130%
Strontium	9796122 9	9796122	5	6	NA	< 5	91%	70%	130%	109%	70%	130%	NA	70%	130%
Thallium	9796122 9	9796122	<0.1	<0.1	NA	< 0.1	93%	70%	130%	112%	70%	130%	NA	70%	130%
Tin	9796122 9	9796122	<2	<2	NA	< 2	91%	70%	130%	107%	70%	130%	NA	70%	130%
Uranium	9796122 9	9796122	<0.1	<0.1	NA	< 0.1	91%	70%	130%	113%	70%	130%	NA	70%	130%
Vanadium	9796122 9	9796122	4	6	NA	< 2	85%	70%	130%	104%	70%	130%	NA	70%	130%
Zinc	9796122 9	9796122	9	11	NA	< 5	91%	70%	130%	112%	70%	130%	NA	70%	130%

Certified By:

Josan Cought

AGAT QUALITY ASSURANCE REPORT (V2)

Page 15 of 21



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

Trace Organics Analysis															
RPT Date: Dec 31, 2018			С	UPLICAT	E		REFEREN	NCE MAT	ΓERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPII	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		table its	Recovery	Lin	ptable nits	Recovery		ptable nits
		ld	.,	.,			Value	Lower	Upper	,	Lower	Upper		Lower	Upper

Total Polychlorinated Biphenyls in Tissue

PCB in Tissue, Total 1 9796999 < 0.5 < 0.5 NA < 0.5 109% 70% 130% 88% 60% 140% NA 60% 140%

Certified By:

Kelly Hogue



Quality Assurance

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421824

PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

			UI	tra T	race	Anal	ysis										
RPT Date: Dec 31, 2018				UPLICAT	E		REFEREN	ICE MA	ATERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE		
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured Value			leasured Limits		Recovery		ptable nits	Recovery	1 1 1 1 1	eptable nits
		lu lu					value	Lower	Upper		Lower	Upper		Lower	Upper		
PAHs in Tissue by HRMS (ng/g)																	
1,3-Dimethylnaphthalene	1	9796108	22.3	24.7	10.2%	< 0.1	124%	70%	130%	NA	70%	130%	NA	70%	130%		
1-Chloronaphthalene	1	9796108	< 0.6	< 0.6	NA	< 0.1	111%	70%	130%	NA	70%	130%	NA	70%	130%		
1-Methylnaphthalene	1	9796108	14.1	13.4	5.1%	< 0.1	92%	70%	130%	NA	70%	130%	NA	70%	130%		
2,3,5-Trimethylnaphthalene	1	9796108	1.7	1.5	12.5%	< 0.1	76%	70%	130%	NA	70%	130%	NA	70%	130%		
2,6-Dimethylnaphthalene	1	9796108	36.1	35.6	1.4%	< 0.1	86%	70%	130%	NA	70%	130%	NA	70%	130%		
2-Chloronaphthalene	1	9796108	< 0.5	< 0.5	NA	< 0.1	123%	70%	130%	NA	70%	130%	NA	70%	130%		
2-Methylnaphthalene	1	9796108	26.5	24.1	9.5%	< 0.1	105%	70%	130%	NA	70%	130%	NA	70%	130%		
Acenaphthylene	1	9796108	1.3	1.5	14.3%	< 0.1	107%	70%	130%	NA	70%	130%	NA	70%	130%		
Acenaphthene	1	9796108	10.7	13.0	19.4%	< 0.1	100%	70%	130%	NA	70%	130%	NA	70%	130%		
Acridine	1	9796108	< 0.1	< 0.1	NA	< 0.1	99%	70%	130%	NA	70%	130%	NA	70%	130%		
Anthracene	1	9796108	1.8	1.6	11.8%	< 0.1	89%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo[a]Anthracene	1	9796108	0.4	0.4	0.0%	< 0.1	110%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo[a]Pyrene	1	9796108	0.8	0.9	11.8%	< 0.1	85%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo(b+j)fluoranthene	1	9796108	0.6	0.6	0.0%	< 0.1	105%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo(e)pyrene	1	9796108	2.7	2.7	0.0%	< 0.1	91%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo[g,h,i]Perylene	1	9796108	< 0.1	< 0.1	NA	< 0.1	92%	70%	130%	NA	70%	130%	NA	70%	130%		
Benzo[k]Fluoranthene	1	9796108	0.7	0.7	0.0%	< 0.1	103%	70%	130%	NA	70%	130%	NA	70%	130%		
Chrysene	1	9796108	0.4	0.4	0.0%	< 0.1	112%	70%	130%	NA	70%	130%	NA	70%	130%		
Dibenzo[a,h]Anthracene	1	9796108	< 0.1	< 0.1	NA	< 0.1	97%	70%	130%	NA	70%	130%	NA	70%	130%		
Fluoroanthene	1	9796108	10.7	11.0	2.8%	< 0.1	124%	70%	130%	NA	70%	130%	NA	70%	130%		
Fluorene	1	9796108	1.8	1.9	5.4%	< 0.1	80%	70%	130%	NA	70%	130%	NA	70%	130%		
Indeno[1,2,3,c-d]Pyrene	1	9796108	< 0.1	< 0.1	NA	< 0.1	116%	70%	130%	NA	70%	130%	NA	70%	130%		
Naphthalene	1	9796108	16.4	16.7	1.8%	< 0.1	81%	70%	130%	NA	70%	130%	NA	70%	130%		
Perylene	1	9796108	< 0.1	< 0.1	NA	< 0.1	104%	70%	130%	NA	70%	130%	NA	70%	130%		
Phenanthrene	1	9796108	4.1	4.6	11.5%	< 0.1	88%	70%	130%	NA	70%	130%	NA	70%	130%		
Pyrene	1	9796108	7.4	7.1	4.1%	< 0.1	104%	70%	130%	NA	70%	130%	NA	70%	130%		
Quinoline	1	9796108	< 0.1	< 0.1	NA	< 0.1	104%	70%	130%	NA	70%	130%	NA	70%	130%		



Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 18K421824
PROJECT: 11178792-02 Marystown Shipyard MSSP ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE:		SAMPLED BY:	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Mercury in Tissue	MET-121-6101, MET-121-6107	modified from EPA 245.6	CV/AA
Aluminum	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Antimony	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Arsenic	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Barium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Beryllium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Bismuth	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP-MS
Boron	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Cadmium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Chromium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Cobalt	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Copper	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Iron	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Lead	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP-MS
Manganese	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Molybdenum	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Nickel	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Selenium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Silver	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Strontium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Thallium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Tin	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Uranium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Vanadium	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Zinc	MET-121-6105 & MET-121-6103	modified from EPA 200.8 and EPA 3050	ICP/MS
Trace Organics Analysis			
PCB in Tissue, Total	ORG-120-5117	EPA SW-846 3510C & 8082A	GC/ECD
Decachlorobiphenyl	ORG-120-5106, ORG-120-5108	EPA SW846 3510C/8080/8010, 8081A	A GC/ECD

Method Summary

CLIENT NAME: GHD LIMITED

AGAT WORK ORDER: 18K421824
PROJECT: 11178792-02 Marystown Shipyard MSSP

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

SAMPLING SITE.		SAMPLED BT.	
PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Ultra Trace Analysis		-	
1,3-Dimethylnaphthalene	HR-151-5403	EPA 8270	HRMS
1-Chloronaphthalene	HR-151-5403	EPA 8270	HRMS
1-Methylnaphthalene	HR-151-5403	EPA 8270	HRMS
2,3,5-Trimethylnaphthalene	HR-151-5403	EPA 8270	HRMS
2,6-Dimethylnaphthalene	HR-151-5403	EPA 8270	HRMS
2-Chloronaphthalene	HR-151-5403	EPA 8270	HRMS
2-Methylnaphthalene	HR-151-5403	EPA 8270	HRMS
Acenaphthylene	HR-151-5403	EPA 8270	HRMS
Acenaphthene	HR-151-5403	/EPA 8270	HRMS
Acridine	HR-151-5403	EPA 8270	HRMS
Anthracene	HR-151-5403	EPA 8270	HRMS
Benzo[a]Anthracene	HR-151-5403	EPA 8270	HRMS
Benzo[a]Pyrene	HR-151-5403	EPA 8270	HRMS
Benzo(b+j)fluoranthene	HR-151-5403	EPA 8270	HRMS
Benzo(e)pyrene	HR-151-5403	EPA 8270	HRMS
Benzo[g,h,i]Perylene	HR-151-5403	EPA 8270	HRMS
Benzo[k]Fluoranthene	HR-151-5403	EPA 8270	HRMS
Chrysene	HR-151-5403	EPA 8270	HRMS
Dibenzo[a,h]Anthracene	HR-151-5403	EPA 8270	HRMS
Fluoroanthene	HR-151-5403	EPA 8270	HRMS
Fluorene	HR-151-5403	EPA 8270	HRMS
Indeno[1,2,3,c-d]Pyrene	HR-151-5403	EPA 8270	HRMS
Naphthalene	HR-151-5403	EPA 8270	HRMS
Perylene	HR-151-5403	EPA 8270	HRMS
Phenanthrene	HR-151-5403	EPA 8270	HRMS
Pyrene	HR-151-5403	EPA 8270	HRMS
Quinoline	HR-151-5403	EPA 8270	HRMS
13C Naphthalene	HR-151-5403	EPA 8270	HRMS
13C Acenaphthtylene	HR-151-5403	EPA 8270	HRMS
13C Acenaphthene	HR-151-5403	EPA 8270	HRMS
13C Fluorene	HR-151-5403	EPA 8270	HRMS
13C Phenanthrene	HR-151-5403	EPA 8270	HRMS
13C Anthracene	HR-151-5403	EPA 8270	HRMS
13C Fluoroanthene	HR-151-5403	EPA 8270	HRMS
13C Pyrene	HR-151-5403	EPA 8270	HRMS
13C Benzo[a]Anthracene	HR-151-5403	EPA 8270	HRMS
13C Chrysene	HR-151-5403	EPA 8270	HRMS
13C Benzo[b]Fluoranthene	HR-151-5403	EPA 8270	HRMS
13C Benzo[k]Fluoranthene	HR-151-5403	EPA 8270	HRMS
13C Benzo[a]Pyrene	HR-151-5403	EPA 8270	HRMS
13C Indeno[1,2,3,c-d]Pyrene	HR-151-5403	EPA 8270	HRMS
13C Benzo[g,h,i]Perylene	HR-151-5403	EPA 8270	HRMS
13C Dibenzo[a,h]Anthracene	HR-151-5403	EPA 8270	HRMS
Lipid Content	HR-151-5400		HRMS

 	Unit 122 • 11 Morris Drive
	Dartmouth, NS
	B3B 1M2
Laboratories	webearth.agatlabs.com • www.agatlabscom
	D- 000 400 0749 - E- 000 400 0004

P: 902.468.8718 • F: 902.468.8924

Arrival	Condition:	□Good
Arrival	Temperature:	10

Poor	(see	notes'
------	------	--------

Laboratory Use Only

AGAT Job Number:

Chain of Custody Record	i e	Report Info	ormation								I	lotes	3:			-	A.						
Report Information		1. Name:					R	por	For	nat	Ш												į,
Company: GHD Limited			James O'Neill				11	C:-	-d -		IIL												
Contact: James O'Neill			James.O'Neill@ghd.com					Sa Sa	gle mple	per	I,	irna	LEO II	nd '	Tim	A P	aui	rad	(TAT			-	
Address: 1118 Topsail Road			Troy Small & DataNL					pa	-											,			
St. John's NL A1B 3N7			troy.small@ghd.com & datanl@	ghd.c	om			Mu	ltiple mples	nor	R	egul	ar T	AT	□ 5	5 to 7	WO	rking	g days	à			
Phone: 1-709-364-5353 Fax:	1-709-364-5368						4	pa		per	R	ush	TAT			1: day		[□2¢	lays			
IOL Site # and Name: Marystown Shipyard		Regulator	y Requirements (Check):					Ex								3 day	s	Ru	sh 5	to 6	days		
Project #: 11178792-02		List Guideline	s on Report 🗵 Do Not List Guid	dellnes o	n Repo	ort	11 "	LO	mat luded		_	.4. F	.	1									
AGAT Quotation #: GHD 'Standing Offe	τ"	□ PIRI □ Tier 1	□ Gas □ Pot □ 0	Coarse			1				D	эте н	requi	irea:									=
GHD PO #: To Follow		□ Res		Fine					Wate	r Sam	ple:	ΠY	es	Z	o NE								
	Same Yes ☑ / No □	□ Com	□Lube				Re	g. No	_	_	_	_		_					_				
31170100 10	Carrie 16327 NOD	☑ CCME	□ CDWQ			al.E)								ంర									П
Company:		□Industr	ial			POTA			n				-	Zinc	- 1	<u>@</u>				5			
Contact:		□ Comme	IISSUE		+4	EVEL			ilabi	2			niste	ad,		NAME OF THE PROPERTY OF THE PR	i.	;		Derc			
Address:		☐ Res/Pa ☐ Agricult			TIER 1	LOWL		,	□Available	pette			B Ca	ارّ		Ĭ.	Jour Live	<u>;</u>		J.			
		□ FWAL		S.	BCA	E	NO			nd Pi			umu	obei		AH	<u>a</u>	,		met			
Phone: Fax:		□ Sedim	ent	AINE	ATLANTIC RBCA	ECA T	SNAT		□ Diss	e a			N (S	Arsenic, Copper, Lead, Zinc		lel P	i i	bles	.	ia i		S/N	
				LNOC	NS.	TICR	ACTIC	2	1 1	S) E			AATIC	inic,	Mercury	ج ا آج	Spl Spl	Sam		oten		EAR	S N
		1	COMMENTS -	, a	1 1	AILA	XFR	<u> </u>	[2]	SIZI			OTTO	Arse	Mer	Low	an Line	ie		or p		RIY	Sno
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR CONTAINERS	тРН/втех	TPH/BTEX - ATLANTIC RBCA TIER I – LOW LEVEL (POTABLE)	TPH/BTEX FRACTIONATION	MTBE ONLY	METALS: I Total	FOC PARTICLE SIZE (Sieve and Pipette)	PAHs	PCBs			OTHER:	OTHER: Low Level PAHs (HRMS)	GTITEN: Lipids Remove/analyze fissue nortion	Composite Samples		HOLD for potential methyl mercury		HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
18-MNMA-TIS-COMP1	2018/12/13 08:45	Tissue	Ziplok bag - Rock Crabs from	3								Ø		Ø	Ø		7 2			Ø			
			S1, S2 and S4																			П	
18-MNMA-TIS-COMP2	2018/12/13 10:04	Tissue	Ziplok bag - Rock Crabs from	6								Ø		Ø	Ø		0 2] Ø		Ø			
			S5, S6, S7, S8, S9 and S10																				
18-MNMA-TIS-COMP3	2018/12/14 08:53	Tissue	Ziplok bag - Rock Crabs from	4								Ø		Ø	Ø		7 2			Ø			
174			S12, S13, S14 and S15															1					
18-MNMA-TIS-COMP4	2018/12/13 11:03	Tissue	Ziplok bag - Mussels from	2								Ø		Ø	Ø	Ø 6		Ø		Ø			
-			S8 and S9							-								L					
18-MNMA-TIS-REF1B	2018/12/13 13:02	Tissue	Ziplok bag - Rock Crab	1			_	1		_		Ø	-	-	Ø	_	7 2	1		Ø	\perp	Ш	
18-MNMA-TIS-REF3B	2018/12/13 14:00	Tissue	Ziplok bag - Mussels	1				_		-		Ø		Ø	Ø		1	1		Ø		Ш	
Symples Falinquished By (Print Name)	Date/Time	Team	nples Received By (Print Name):											-									
NORID LAWLOR	Dec 18	1190	and the contract of the contra						Date/Tin	16							J	Page	<u>, 1</u>	0	f_2_		
Samples Relinquished By (Sign):	9:50) Sar	npies Received By (Sign);						Date/Tir	10						,		79					



Fax: 1-709-364-5368

Report Information

☐ List Guidelines on Report

Email: James O'Neill

James.O'Neill@ghd.com

troy.small@ghd.com & datanl@ghd.com

☑ Do Not List Guidelines on Report

Troy Small & DataNL

Regulatory Requirements (Check):

1. Name:

2. Name:

webearth.agatlabs.com * www.agatlabso

	٥.	902,468,8718	F: 902.468.8924
--	----	--------------	-----------------

Unit 12	2 = 1	1 Morris Drive					
		Partmouth, NS	Laboratory	Use Only			
		B3B 1M2					
.com * 1	www	agatlabscom	Arrival Condit	tion: LIGO	ood	☐ Poor (see notes	;)
0740	E 0	400 000 4	Arrival Tempe	erature:			_
3.87181	F: 9	02.468.8924	AGAT Job Nur	mber:			_
			Notes:				
	Re	port Format					
		Single					_
	_	Sample per page	Turnaround	Time Requ	ıired (TAT)	
		Multiple	Regular TAT	\Box 5 to 7 w	orking o	days	
		Samples per page	Rush TAT	\square 1 day		2 days	
eport	V	Excel Format		☐3 days	Rus	h 5 to 6 days	
		Included	Date Required	d:			_5

Project #: 11178792-02		☐ PIR!	s on Report 🗵 Do Not Lis	st Guidelines o	n Report			Incl	uded		Dat	e Re	quire	d:							
AGAT Quotation #: GHD 'Standing C	Offer"	□Tier 1	□ Gas □ Pot	□ Coarse				-		77	_										=
GHD PO #: To Follow		□Res	□ Fuel □ N/Pot	□Fine		1		king No.:	Water	Samp	le:	□ Yes	i	Ø No	0						
Invoice To	Same Yes ☑ / No □	□ Com	Lube			_	Tree.	110	=			_	7								=
Company: Contact: Address: Phone:Fax		□ CCME □ Industr □ Comme □ Res/Pa □ Agricult □ FWAL □ Sedime	ercial 🗹 Other <u>Tissue</u> urk ural	CONTAINERS	RBCA TIER 1	TPH/BTEX - ATLANTIC RBCA TIER I - LOW LEVEL (POTABLE) TPH/BTEX FRACTIONATION	МТВЕ (АDDED TO ТРН/ВТЕХ)		tal 🗆 Díss 🗀 Available	SIZE (Sleve and Pipette)		EDACTIONATION (Summa Conjeter)	Arsenic, Copper, Lead, Zinc &		Low Level PAHs (HRMS)	Lipids	i .	potential methyl mercury		1 YEAR (Y/N)	
SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SAMPLE	COMMENTS – SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER OR	TPH/BTEX - A	TPH/BTEX - ATLANTIC RBCA TPH/BTEX FRACTIONA	MTBE (ADDEL	MTBE ONLY	METALS: El Total	1CLE	PAHs	PCBs TPH EPACTION	OTHER: Arse		отнея: Low	OTHER: Lip		HOLD for po		HOLD FOR 1 Y	U
18-MNMA-TIS1A	2018/12/13 08:45	Tissue	Ziplok bag - Scallops	1								Ø	Ø								
18-MNMA-TIS3	2018/12/13 09:23	Tissue	Ziplok bag - Scallops	1								Ø	Ø	0	Ø	Ø		2			
18-MNMA-TIS5A	2018/12/13 10:04	Tissue	Ziplok bag - Scallops	1								Ø	Ø	_	0	Ø		Ø			
18-MNMA-TIS6A	2018/12/13 10:32	Tissue	Ziplok bag - Scallops	1								2		Ø	Ø	0		Ø	\neg		-
18-MNMA-TIS10A	2018/12/13 11:43	Tissue	Ziplok bag - Scallops	1								0	Ø	Ø	0	Ø		Ø			
18-MNMA-TIS11	2018/12/14 08:35	Tissue	Ziplok bag - Scallops	1								0		Ø		0		Ø			
18-MNMA-TIS12A	2018/12/14 08:53	Tissue	Ziplok bag - Scallops	1								Ø	Ø	Ø	Ø	Ø		Ø			
18-MNMA-TIS14A	2018/12/14 09:31	Tissue	Ziplok bag - Scallops	1								Ø	Ø	Ø	Ø	Ø		Ø			
18-MNMA-TIS-REF3A	2018/12/13 14:00	Tissue	Ziplok bag - Scallops	1								7	Ø	Ø	0	Ø		0			
						_															
Samples Relinquished By (Print Name): WOLL Samples Relinquished By (Sign):	Date/Time Dec 18	3/18	nples Received By (Print Name): nples Received By (Sign):						Date/Time				1				Page 2		of 2		
Inop deur	9:50)																			

Report Information

Contact:

Phone:

Address:

Company: GHD Limited

James O'Neill

1-709-364-5353

1118 Topsail Road

St. John's NL A1B 3N7

IOL Site # and Name: Marystown Shipyard MSSP

11178792-02



11 Morris Drive, Unit 122 Dartmouth, Nova Scotia CANADA B3B 1M2 TEL (902)468-8718 FAX (902)468-8924 http://www.agatlabs.com

CLIENT NAME: GHD LIMITED

1118 TOPSAIL ROAD ST. JOHN'S , NL A1B3N7

(709) 364-5353

ATTENTION TO: JAMES O'NEILL

PROJECT: Marystown Shipyard Waterlot 11178792-02

AGAT WORK ORDER: 19X426031

SOIL ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Jan 15, 2019

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories (V1)

Page 1 of 6

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA) AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. Measurement Uncertainty is not taken into consideration when stating conformity with a specified requirement.



Certificate of Analysis

AGAT WORK ORDER: 19X426031

PROJECT: Marystown Shipyard Waterlot 11178792-02

ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

11 Morris Drive, Unit 122 Dartmouth, Nova Scotia CANADA B3B 1M2 TEL (902)468-8718 FAX (902)468-8924 http://www.agatlabs.com

TCLP Leachable Metals -	- As.Cu.Pb.Se.Zn
-------------------------	------------------

					Table Metal	o , .o, o a,	o,oo, <u>-</u>		
DATE RECEIVED: 2019-01-08								D	ATE REPORTED: 2019-01-15
		SAMPLE DES	CRIPTION:	18-MNMA-S1	18-MNMA-S9	18-MNMA-S12	18-MNMA-S14	18-MNMA-S15	
		SAM	PLE TYPE:	Soil	Soil	Soil	Soil	Soil	
		DATE	SAMPLED:	2018-10-19	2018-10-19	2018-10-19	2018-10-19	2018-10-19	
Parameter	Unit	G/S	RDL	9821580	9821594	9821595	9821596	9821597	
Arsenic Leachate	mg/L		0.02	<0.02	0.03	0.02	0.02	<0.02	
Copper Leachate	mg/L		0.02	< 0.02	< 0.02	<0.02	< 0.02	0.03	
Lead Leachate	mg/L		0.005	0.085	<0.005	<0.005	0.026	0.122	
Selenium Leachate	mg/L		0.02	<0.02	< 0.02	< 0.02	<0.02	<0.02	
Zinc Leachate	mg/L		0.02	1.76	0.61	0.05	6.25	7.38	

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

Analysis performed at AGAT Halifax (unless marked by *)

CLIENT NAME: GHD LIMITED

Certified By:

Joseph Coaghtry



11 Morris Drive, Unit 122 Dartmouth, Nova Scotia CANADA B3B 1M2 TEL (902)468-8718 FAX (902)468-8924 http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 19X426031
PROJECT: Marystown Shipyard Waterlot 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

				Soi	l Ana	alysis	6								
RPT Date: Jan 15, 2019			D	UPLICATI	E		REFEREN	ICE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	Lin	ptable nits	Recovery	منا ا	ptable nits
		ld	.,				Value	Lower	Upper	,	Lower	Upper	,	Lower	Upper
TCLP Leachable Metals - As,Cu,I	Pb,Se,Zn														
Arsenic Leachate	9821597	9821597	< 0.02	< 0.02	NA	< 0.02	107%	80%	120%	111%	80%	120%	96%	70%	130%
Copper Leachate	9821597	9821597	0.03	0.03	NA	< 0.02	110%	80%	120%	120%	80%	120%	96%	70%	130%
Lead Leachate	9821597	9821597	0.122	0.121	0.4%	< 0.005	113%	80%	120%	115%	80%	120%	95%	70%	130%
Selenium Leachate	9821597	9821597	< 0.02	< 0.02	NA	< 0.02	105%	80%	120%	120%	80%	120%	85%	70%	130%
Zinc Leachate	9821597	9821597	7.38	6.74	9.1%	< 0.02	109%	80%	120%	116%	80%	120%	89%	70%	130%

Certified By:

Josan Coaghtry



11 Morris Drive, Unit 122 Dartmouth, Nova Scotia CANADA B3B 1M2 TEL (902)468-8718 FAX (902)468-8924 http://www.agatlabs.com

Method Summary

CLIENT NAME: GHD LIMITED AGAT WORK ORDER: 19X426031
PROJECT: Marystown Shipyard Waterlot 11178792-02 ATTENTION TO: JAMES O'NEILL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis	·		
Arsenic Leachate	MET-121-6108, MET-121-6105	EPA SW-846 6020A/SM1325 In-house leachate	
Copper Leachate	MET-121-6108, MET-121-6105	EPA SW-846 6020A/SM1325 In-house leachate	
Lead Leachate	MET-121-6108, MET-121-6105	EPA SW-846 6020A/SM1325 In-house leachate	
Selenium Leachate	MET-121-6108, MET-121-6105	EPA SW-846 6020A/SM1325 In-house leachate	
Zinc Leachate	MET-121-6108, MET-121-6105	EPA SW-846 6020A/SM1325 In-house leachate	CP-MS



AGAT Laboratories

Dartmouth, NS B3B 1M2

webearth.agatlabs.com • www.agatlabscom

P: 902,468,8718 • F: 902,468,8924

Laboratory Use Only 19x42603
Arrival Condition: ☐ Good ☐ Poor (see notes)
Arrival Temperature: 318386
AGAT Job Number: 188399999
Notes:

Chain	of Custody Recor	d	Report Info	rmation										otes	_	14411	1001	1,000	_	1_1_			-1	-	Ē
Report Inf	formation		1. Name:					T R	epo	rt F	orma	ıt I		·											
Company:	GHD Limited			James O'Neill					•			- 1													
Contact:	James O'Neill		_	James.O'Neill@ghd.com		-	-		ך א ב	ingle amp	e le pe	r I	Turnaround Time Required (TAT)												
Address:	1118 Topsail Road		Email: DataNL								page						Regular TAT 05 to 7 working days								
	St. John's NL A1B 3N7			datanl@ghd.com			===		Z \	1ultip	ole Ies p		Re	gula	ar TA	1	TÁ	5 to	7 100	irking	g days	S		(60)
Phone:	1-709-364-5353 Fax	1-709-364-5368						4		amp	ies p	er	Ru	sh 1	AT	1	4	day	/			days	110	H	П
IOL Site #	and Name: Marystown Shipya	ard Waterlot	Regulatory	Requirements (Check):				11	Z E	xcel								3 day	/S	1	1	2	15	n	il a
Project #:	11178792-02		☐ List Guldelines	on Report 🛮 Do Not List Guid	lelines o	n Repo	rt	1		orma										1	X	7			2
AGAT Quo	tation #: GHD 'Standing Off	fer"	□ PIRI □ Tier 1	□ Gas ☑ Pot ☑ C	Coarse			1					Da	te R	equi	irea:					4				_
GHD PO#			□Res		ine			11		_	ater S	amp	le:	□Ye	es	Z	Ø No								
Invoice To		Same Yes ☑ / No □	☑ Com	□ Lube				R	eg. N	0.:									-0.00			d .			
		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	☑ CCME	□ CDWQ			BLE)																		
Company:			□ Industri				LOW LEVEL (POTABLE)	П		0				- 1	<u></u>						1				
Contact:			□ Comme □ Res/Pai			е.	EVEL	1		liabl		(a)			miste	-1	1							ļi	
Address:			□ Agricult			TIER	MOT:		2	☐ Available		ipett			a Ca	Clean-up			Ť.						
8	· · · · · · · · · · · · · · · · · · ·		☐ FWAL		ERS	4BCA	199	NO.	816			and P			LE N	lear		. 1				П		- I	ĺ
Phone:	Fax:		☑ Sedime	ent	TAIN	JE I	3BCA T	ONA	(ADDED TO TPH/BTEX)	Diss		SIZE (Sieve and Pipette)		-1	S) NO	~	_		- 6		1			3	_
					0 N	II A	MICE	3ACT	2	otal		E (Si		- 1	NATI	Sa O	Mercury	. 1						YEAR	3
- 68			SAMPLE	COMMENTS -	R OR	K-1	(-ATL	KE	4DDE			E SIZ			CTIC									NR 1	SOOR
	SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER	TPH/BTEX - ATLANTIC RBCA	TPH/BTEX - ATLANTIC RBCA TIER I -	TPH/BTEX FRACTIONATION	MTBE (METALS: Total	FOC	PARTICLE	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER:						HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
18-MNMA-S	S1	2018/10/19 09:30	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Z	Ø		Ø	Ø		Ø	Ø				1		T		П
18-MNMA-S	32	2018/10/19 09:45	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Ø	Ø		0	包			Ø								
18-MNMA-S		2018/10/19 10:30	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				Z	Ø		Ø			Ø	Ø								V.
18-MNMA-S		2018/10/19 11:00	Sediment	2 x250ml& 2 x40ml &2x120ml		Ø				7	Ø		Ø	_		Ø	Ø								
18-MNMA-S		2018/10/19 11:20		2 x250ml& 2 x40ml &2x120ml		Ø				Ø	Ø		Ø	Ø		Ø	Ø								
18-MNMA-S		2018/10/19 11:45	Sediment	2 x250ml& 2 x40ml &2x120ml	-	Ø				Z	7		Ø	Ø			Ø								
18-MNMA-S		2018/10/19 12:00	Sediment	2 x250ml& 2 x40ml &2x120ml	-	Ø				Į. C	Ø		Ø	Ø		Ø	Ø		_		a him				
18-MNMA-S		2018/10/19 12:20	Sediment	2 x250mi& 2 x40ml &2x120ml		Ø			4	Ø	-		7		\rightarrow	-	Ø		4						
18-MNMA-S		2018/10/19 12:40		2 x250ml& 2 x40ml &2x120ml		Ø				Ø	-		Ø	7			☑		_						
18-MNMA-S		2018/10/19 13:05		2 x250ml& 2 x40ml &2x120ml		Ø		4	4	Z			Ø	Ø	_	_	Ø		_			Ш			
Samples Relinquish	- (B. (B) V	Date/Time	1 Sav	2 x250ml& 2 x40ml &2x120ml		Ø			1	100	e/Time		☑	Ø	_1	Ø	Ø								
Santples Retinquish	Astron Astron) 1 Forth	2010	Summer	LVX	っし	4		6	Ĺ	JIC	10	7							Page	₽	(of 2		
7	61 / C27	15:0	C	nples Roceived Brisign	11	1.				Da	o/Time	100													

AGAT Laboratories

B3B 1M

webearth.agatlabs.com • www.agatlabscor

P: 902,468.8718 • F: 902,468.892

9	
S	Laboratory Use Only 9x426031
2	
n	Arrival Condition: ☐ Good ☐ Poor (see notes)
	Arrival Temperature: 0183,80
4	AGAT Job Number: 188399999
	Notes:
t	

Chain	of Custody Re	cord	Report Info	ormation										otes	_	10111	120								٦
Report Inf			1. Name:					R	lep	ort F	orm	at													
Company:	GHD Limited		1	James O'Neill						اب <u>.</u> ا	_		L												
Contact:	James O'Neill		1 -	James.O'Neill@ghd.com						Singl Samj	e ole pe	er	Turnaround Time Required (TAT)												
Address:	1118 Topsail Road			DataNL						oage						1	-			-			- 71	0	
	St. John's NL A1B 3N7	7	-	datanl@ghd.com					7	Multi Sami	ple ples p	or		_	ar TA	1	- 1	/		rking			(6	Co)	
Phone:	1-709-364-5353	Fax: 1-709-364-5368			=			4		oage		, ,	Ru	sh T	AT			1 day		<u>_</u>		lays		3	1
IOL Site #	and Name: Marystown S		Regulatory	Requirements (Check):					7	Exce								3 day	/S			1 1	0	41	
Project #:	11178792-0		☐ List Guldelines	s on Report	elines o	n Repo	rt	11.	100	Form nclu				. D									21	# e	
AGAT Quo	tation #: GHD 'Standi	ing Offer"	□ PIRI □ Tier 1	□ Gas ☑ Pot ☑ C	coarse								Da	te K	equi	rea:		ш,		-3	X				
GHD PO#			□Res	□ Fuel □ N/Pot □ F						-	ater s	Samp	le:	□Ye	es	Ø	l No								
Invoice To		Same Yes ☑ / No □	☑ Com	□ Lube				J R	eg. l	No.: _						- 1									
		,	☑ CCME	□ CDWQ			BLE)				Ī		1												П
			□ Industri	- 11			(POTABLE)				<u>v</u>				<u>F</u>								1.7		
Contact:			☐ Comme			17	LOW LEVEL			1	alla	(e)			anist			- 1			Н		1		
Address:			□ Agricult			TE	MOT-		8	1	- Available	ipett			na C	d-r							1		
3			☐ FWAL		ERS	3BC	ER!	S N	/BTE			and F	- 1	- 1	J. J.	lear								3	
Phone:		Fax:	☑ Sedime	ent	TAIN	ATLANTIC RBCA TIER 1	BCA T	ONA	FF.	1	- Indias	eve			NO (S	Gel Clean-up	_							3	0
			L		S	ILA	NTICE	ACTI	D T0		orall or	E (Si		П	NATI	ga	Mercury							YEAF	3
				COMMENTS -	R OR	1 1	-ATLA	X X	ODE	ONLY		E SIZ			CTIC								1	1 분	SOUS
	SAMPLE IDENTIFICATION	DATE/TIME SAMPLED	SÁMPLE MATRIX	SITE/SAMPLE INFO, TYPE OF CONTAMINANT	NUMBER	TPH/BTEX	TPH/BTEX - ATLANTIC RBCA TIER ! -	TPH/BTEX FRACTIONATION	МТВЕ (АDDED ТО ТРН/ВТЕХ)	MTBE 0	MEIALS: Iotal	PARTICLE SIZE (Sieve and Pipette)	PAHS	PCBs	TPH FRACTIONATION (Summa Canister)	OTHER:	OTHER:	OTHER:						HOLD FOR 1 YEAR (Y/N)	HAZARDOUS (Y/N)
18-MNMA-S	512	2018/10/19 13:40	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				1	0 0		Ø	Ø		7	Ø	1							
18-MNMA-S	513	2018/10/19 13:55	Sediment	2 x250mt& 2 x40ml &2x120ml	6	V				1	7 0		Ø	Ø		Ø	Ø								
18-MNMA-S	514	2018/10/19 14:05	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				1	3 0		Ø	Ø		0	Ø								
18-MNMA-S		2018/10/19 14:15	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø				ı	7 7		Ø	Ø		Ø	Ø								
18-MNMA-D		2018/10/19 11:46	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø					7 0			Ø		0	Ø								
18-MNMA-D		2018/10/19 13:26	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø					7 0		Ø	Ø		Ø	Ø								
18-MNMA-R		2018/10/19 14:30	Sediment	2 x250ml& 2 x40ml &2x120ml	6	Ø					7 7		Ø			Ø	Ø								
18-MNMA-R		2018/10/19 14:45	Sediment	2 x250ml& 2 x40ml &2x120ml	-	Ø					7 0		Ø	Ø		Ø	Ø								
18-MNMA-R	REF3	2018/10/19 15:00	Sediment	2 x250ml& 2 x40ml &2x120ml	6						7 0		Ø	Ø		Ø	Ø								
			_		_	-			1	_	_	-			_			\perp	4		\perp		1		
Sarriples Ralinguisti	ed By (Print Name):	T o Toperton	188	nums Received of Print flame!		L		1		1	ate/Time								1	N.					
0 0 08 867	Kebe	HRIM 10/2	7/20/8	SILL	in	VI	/				- New (HINE)									Page	, 2	c	of _2_	_	
Samples Reliequish	11/20	Date/finte	5:00	mpies floconed by (been)	,	///				D	ate/Time													_,_,	

Appendix D Statistical Analyses and Supporting Data

GHD | Supplemental Phase II ESA and HHERA | 11178792 (1)

	Α	В	С	D	E	F	G	Н		J	K	L
1					UCL Statis	tics for Data	Sets with N	lon-Detects				
2				T								
3			ected Options									
4	Da	te/Time of C			11/14/2018 3	3:06:31 PM						
5			From File	WorkSheet_	_a.xls							
6			III Precision	OFF								
7		Confidence	Coefficient	95%								
8	Number o	of Bootstrap	Operations	2000								
9												
10	F1											
11												
12							Statistics					
13			Total	Number of C		37			Numbe	er of Distinct C		
14					er of Detects	19					Non-Detects	_
15			N	umber of Dist					Numbe	er of Distinct		
16					mum Detect						Non-Detect	
17					mum Detect						Non-Detect	
18					nce Detects					Percent	Non-Detects	
19					ean Detects						SD Detects	-
20					dian Detects						CV Detects	
21					ess Detects	1.175					osis Detects	
22				Mean of Log	ged Detects	5.888				SD of Log	ged Detects	1.67
23												
24							t on Detects	Only				
25				Shapiro Wilk T					•	ilk GOF Test		
26			5% S	hapiro Wilk C		0.901		Detected Da		al at 5% Sign	ificance Leve	el
27					est Statistic	V.—				GOF Test		
28			5	5% Lilliefors C		0.197				al at 5% Sign	ificance Leve	el
29					etected Dat	a Not Norma	ıl at 5% Sign	ificance Lev	/el			
30			l/anlan	Maiar (IZM) C	Nasiatiaa	n a Nama al C	misi a a l Mala a		Mannanana	tria LIOLa		
31			Kapian-	Meier (KM) S			riticai vaiue	s and otner	•			101 5
32					KM Mean				Ki	M Standard E		
33				050/	KM SD				050/ 1/14 /5		1 (BCA) UCL	
34					KM (t) UCL	860.9 853			•	Percentile Boo	• •	
35					KM (z) UCL						<u>'</u>	
36				90% KM Che 7.5% KM Che	-	1099 1688				95% KM Che 99% KM Che		
37			97	.5 % KIVI CITE	bysnev occ	1000			,	99 % KWI CHE	bysnev occ	2300
38				G	amma GOE	Teete on De	etected Obse	anyations Or	Ny			
39					est Statistic				<u> </u>	rling GOF Te		
40					citical Value	0.796	Detect			stributed at 59		e I evel
41					est Statistic		Detect			-Smirnov GO		-C LCVCI
42					critical Value		Detected		<u> </u>	istributed at 5		nce Level
43							Distribution :					
44						pr. samma	5	• .• • • • • • • • • • • • • • • • •				
45					Gamma	Statistics or	Detected D	ata Only				
46					k hat (MLE)				k	star (bias cor	rected MI F)	0.518
47					ta hat (MLE)					star (bias cor		
48					nu hat (MLE)				111010	•	as corrected)	
49					an (detects)					5101 (510		.0.,
50				1410								
51												

	Α	В	С		D	Е	F	G	Н	I		J		K	L
52								sing Imputed							
53				•				6 NDs with m	•			•			
54		GROS ma						s <1.0, espe					(e.g., <	15-20)	
55			ļ	For suc				yield incorre			nd BT\	/s			
56								en the sample							
57		For ga	mma distrib	outed de	etected da			y be comput	ed using g	jamma dis	tributio	on on KM	estimat		
58						Minimum								Mean	547.1
59						Maximum							ľ	Median	27
60						SD								CV	1.998
61						hat (MLE)						ar (bias c			0.147
62						hat (MLE)				Th		ar (bias c		,	3719
63						hat (MLE)						nu star (t	ias cor	rected)	10.89
64			•		•	icance (β)									
65		Apı	proximate C	Chi Squ	are Value	(10.89, α)	4.504			Adjusted	d Chi S	Square V	alue (10).89, β)	4.326
66	Ś	95% Gamma	a Approxim	nate UC	L (use wh	en n>=50)	1323		95% (Gamma Ad	djusted	d UCL (us	se when	า n<50)	1377
67															
68								meters using	KM Estin	nates					
69						lean (KM)								D (KM)	1075
70					Varia	ance (KM)	1154822					SE	of Mea	n (KM)	181.5
71						k hat (KM)							k sta	ar (KM)	0.263
72					nı	u hat (KM)	19.7						nu sta	ar (KM)	19.43
73					theta	a hat (KM)	2083					t	heta sta	ar (KM)	2111
74			8	0% gan	nma perce	ntile (KM)	818.8				90%	gamma p	ercentil	e (KM)	1658
75			9.	5% gan	nma perce	ntile (KM)	2644				99%	gamma p	ercentil	e (KM)	5252
76															
77								eier (KM) Sta	atistics						
78			proximate C			, ,						Square V	•	,	10.15
79	95%	Gamma Ap	proximate l	KM-UC	L (use wh	en n>=50)	1033		95% Gam	ıma Adjust	ted KM	1-UCL (us	se when	า n<50)	1062
80															
81								etected Obs	ervations						
82						st Statistic				•		GOF Te			
83			5%			ical Value		Dete	ected Data	appear Lo			Signific	cance L	evel
84						st Statistic						OF Test			
85				5% Lill		ical Value				appear Lo	ognorr	mal at 5%	Signific	cance L	evel
86					Detect	ed Data a	ppear Logno	rmal at 5% S	Significand	e Level					
87															
88				= =				Using Impute	ed Non-De	etects					
89						inal Scale							_	g Scale	3.677
90						inal Scale					E 0' =		O in Log		2.802
91		95% t	UCL (assur			•				9	5% Pe	ercentile E			856.3
92						strap UCL						95% B	ootstrap	t UCL	973.1
93				95%	6 H-UCL (Log ROS)	20173								
94															
95			Sta	atistics				Data and Ass	suming Lo	gnormal C	Distrib				
96						n (logged)							KM Ged		76.77
97						O (logged)				9:	5% Cr	ritical H V	•	٠,	3.686
98			KM Stand	dard Err		n (logged)						95% H-L			1795
99						O (logged)				9:	5% Cr	ritical H V	alue (Kl	M-Log)	3.686
100			KM Stand	dard Err	or of Mea	n (logged)	0.333								
101															

	Α	В	С		D		Е	F	G tatistics	Н	l		J		K	L	
102			DI	L/2 No	rmal			0023	lausucs		DL/2 Lo	a_Trar	eforme	d			
103			Di		Mean in C	riging	ol Coolo	550.8			DL/2 LO	y-11ai			g Scale	4.0	104
104							al Scale								g Scale	2.2	
105			050)/ + LIC	L (Assum			853.7							stat UCL	3696	
106									ded for com	naricone and	Lhietorica	l rose		/0 П - З	iai UCL	3090	
107			, Di	L/Z 15 1	ilot a rect		nucu m	eulou, provi	ueu ioi com	Jansons and	THSOTICA	II I Gasi	UIIS				
108						Nor	narama	atric Dietribu	tion Free UC	1 Statistics							
109				Detec	ted Data		•		nma Distribu		anificano	e l eve	<u> </u>				
110 111					nou Duttu	аррос	и дри	Amato da			91111104110						
112								Suggested	UCL to Use								-
113	Adjusted KN	M-UCL (use	when k<	=1 and	d 15 < n <	50 bu	ıt k<=1)	1062									
114									1								
115			Wher	n a dat	a set follo	ws an	approx	imate (e.g.,	normal) distri	ibution passi	ng one of	the G	OF test				
116		When app	olicable, it	is sug	gested to	use a	UCL b	ased upon a	distribution ((e.g., gamma) passing	both (GOF tes	ts in P	roUCL		
117																	
118	N	Note: Sugge	estions reg	gardin	g the sele	ction o	of a 95%	UCL are pr	ovided to he	p the user to	select the	e most	approp	riate 9	5% UCL		
119				Red	commend	ations	are bas	sed upon da	ta size, data	distribution, a	and skewi	ness.					
120		These reco	mmendat	tions a	re based	upon	the resu	Its of the sin	nulation studi	es summariz	ed in Sin	gh, Ma	ichle, ar	nd Lee	e (2006).		
121	Ho	wever, simu	ulations re	esults v	will not co	ver all	l Real W	orld data se	ts; for addition	onal insight th	ne user m	ay war	nt to con	sult a	statistici	an.	
122																	
123	F2																
124																	
125									Statistics								
126			Т	otal N	umber of			37			Num				rvations	30	
127							Detects	29							Detects	8	
128				Num	ber of Dis			29			Nun	nber o			Detects	1	
129							Detect Detect								n-Detect	15 15	
130								1124905							n-Detect		62%
131							Detects	699.4					reiceii		Detects	1061	JZ /0
132							Detects	183							Detects	1.5	16
133							Detects	1.947					Kıı		Detects	3.2	
134				М	ean of Lo			5.354							Detects	1.6	
135						ggou .		0.001					00 0, 20	,ggcu	Dottoolo		
136							Norm	nal GOF Tes	t on Detects	Only							
137 138				Sha	piro Wilk	Test S				•	Shapiro	Wilk C	OF Tes	st			
139			59		piro Wilk			0.926		Detected Da					nce Leve	:I	
140					Lilliefors	Test S	Statistic	0.284			Lilliefo	ors GC	F Test				
141				5%	Lilliefors	Critica	al Value	0.161	I	Detected Da	ta Not No	rmal at	t 5% Sig	nificar	nce Leve	ı	
142					l	Detec	ted Data	a Not Norma	al at 5% Sign	ificance Lev	el						
143																	
144			Kapl	lan-Me	eier (KM)	Statis	tics usi	ng Normal C	critical Value	s and other	Nonparar	netric	UCLs				
145						KN	M Mean	551.5				KM S	tandard	Error	of Mean	161.4	4
146							KM SD	964.7							A) UCL	842.4	4
147							(t) UCL	824			95% KM	-				828.9	
148							(z) UCL	816.9					6 KM Bc		•	933.	
149					% KM Che	-		1036					KM Ch	-		1255	
150				97.59	% KM Che	ebysh	ev UCL	1559				99%	KM Ch	ebysh	nev UCL	2157	
151																	

	A B C D E	F	G H I J K	L								
152	Gamma GOF	Tests on De	etected Observations Only									
153	A-D Test Statistic	1.146	Anderson-Darling GOF Test									
154	5% A-D Critical Value	0.809	Detected Data Not Gamma Distributed at 5% Significance	Level								
155	K-S Test Statistic	0.195	Kolmogorov-Smirnov GOF									
156	5% K-S Critical Value	0.172	Detected Data Not Gamma Distributed at 5% Significance Leve									
157	Detected Data Not 0	Gamma Dist	ributed at 5% Significance Level									
158												
159			n Detected Data Only									
160	k hat (MLE)	0.527	k star (bias corrected MLE)	0.495								
161	Theta hat (MLE)	1328	Theta star (bias corrected MLE)	1413								
162	nu hat (MLE)	30.55	nu star (bias corrected)	28.72								
163	Mean (detects)	699.4										
164												
165			sing Imputed Non-Detects									
166	•		6 NDs with many tied observations at multiple DLs									
167			s <1.0, especially when the sample size is small (e.g., <15-20)									
168			yield incorrect values of UCLs and BTVs									
169	•	-	en the sample size is small.									
170			ay be computed using gamma distribution on KM estimates									
171	Minimum	0.01	Mean	548.2								
172	Maximum	3940	Median	86								
173	SD	979.9	CV	1.787								
174	k hat (MLE)	0.232	k star (bias corrected MLE)	0.231								
175	Theta hat (MLE)		Theta star (bias corrected MLE)	2376								
176	nu hat (MLE)	17.13	nu star (bias corrected)	17.08								
177	Adjusted Level of Significance (β)	0.0431	Adjusted Obj Osusus Value (47.00.0)	0.407								
178	Approximate Chi Square Value (17.08, α) 95% Gamma Approximate UCL (use when n>=50)	8.727	Adjusted Chi Square Value (17.08, β)	8.467								
179	95% Gamma Approximate UCL (use when n>=50)	1073	95% Gamma Adjusted UCL (use when n<50)	1106								
180	Estimates of C	amma Dara	meters using KM Estimates									
181	Mean (KM)	551.5	SD (KM)	964.7								
182	Variance (KM)		SE of Mean (KM)	161.4								
183	k hat (KM)	0.327	k star (KM)	0.318								
184	nu hat (KM)	24.18	nu star (KM)	23.55								
185	theta hat (KM)	1688	theta star (KM)	1733								
186	80% gamma percentile (KM)	857.3	90% gamma percentile (KM)	1614								
187	95% gamma percentile (KM)	2475	99% gamma percentile (KM)	4695								
188	33 /3 gariina personale (KW)		20% gamma porconina (ruw)									
189	Gamm	a Kaplan-M	eier (KM) Statistics									
190	Approximate Chi Square Value (23.55, α)	13.51	Adjusted Chi Square Value (23.55, β)	13.18								
191	95% Gamma Approximate KM-UCL (use when n>=50)	961.5	95% Gamma Adjusted KM-UCL (use when n<50)	985.6								
192	,,		3.,									
193 194	Lognormal GC	F Test on D	Petected Observations Only									
	Shapiro Wilk Test Statistic		Shapiro Wilk GOF Test									
195 196	5% Shapiro Wilk Critical Value	0.926	Detected Data appear Lognormal at 5% Significance Le	evel								
197	Lilliefors Test Statistic	0.11	Lilliefors GOF Test									
198	5% Lilliefors Critical Value	0.161	Detected Data appear Lognormal at 5% Significance Le	evel								
199	Detected Data ap	ppear Logno	rmal at 5% Significance Level									
200	<u> </u>		-									
200												

	Α	В	С		D		E	F	G		Н		I		J		K	L
201						-		OS Statistics	Using Impu	ted No	n-Dete	ects						
202						-	nal Scale										g Scale	4.509
203						•	al Scale										g Scale	2.228
204		95% t l	JCL (assume										95%		entile Bo		•	832
205							rap UCI							9	5% Boo	otstra	p t UCL	937.4
206				95%	6 H-UC	L (L	og ROS) 4924										
207																		
208			Stati	stics	_			on Logged	Data and As	ssumin	g Logr	norma	l Distr	ributio				
209							(logged										o Mean	119.3
210							(logged	´					95%				(M-Log)	3.456
211			KM Standa	ard Eri												•	M -Log)	1748
212							(logged						95%	Critica	al H Val	ue (K	(M-Log)	3.456
213			KM Standa	ard Eri	or of M	ean	(logged	0.303										
214																		
215								DL/2 S	Statistics									
216			DL/2									DL/2	Log-	Transf	formed			
217						_	nal Scale										g Scale	4.632
218						-	al Scale										g Scale	2.024
219				•			ormality									H-St	tat UCL	2836
220			DL/2	is not	a reco	mm	ended n	nethod, prov	ided for com	pariso	ns and	l histo	rical r	eason	ıs			
221																		
222							•	etric Distrib										
223				De	tected I	Data	appear	Lognormal	Distributed a	at 5% S	Signific	ance	Level					
224																		
225									UCL to Use	•								
226			9!	5% KI	И (Chel	bysh	ev) UCI	1255										
227																		
228	ļ	Note: Sugge						% UCL are p		•					ppropri	ate 9	5% UCL	
229						mendations are based upon data size, data distribution, and skewness.												
230						•		ults of the sir					•				,	
231	Но	wever, simu	ılations resul	lts will	not cov	ver a	ıll Real \	Norld data se	ets; for additi	onal in	sight th	ne use	r may	want	to cons	ult a	statistici	an.
232																		

				-	0				1 1/	т .
-	A B	С	D E	F stics for Data	G Sets with N	n-Detects		J	K	L
1			001 0101	5000 101 Date	- COW WIGHT 14	DOLOGIC				
2	Hear S	elected Options								
3		Computation	ProUCL 5.111/14/2018	2:36:06 DM						
4	Date/Time of	From File	WorkSheet.xls	2.00.001 W						
5		Full Precision	OFF							
6		ce Coefficient	95%							
7	Number of Bootstra		2000							
8	Number of Bootstra	ар Орегацопъ	2000							
9										
10	Aluminum									
11	Adminum									
12				General	Statistics					
13		Total	Number of Observations		Otationes		Numbe	er of Dietino	t Observations	17
14		Total	Trumber of Observations	17					Observations	
15			Minimum	4900			IVUITIO	CI OI WIISSIII	Mear	
16			Maximum						Mediar	
17			SE					Std	Error of Mear	
18			Coefficient of Variation					Olu.	Skewness	-
19			Occincion of Variation	0.020					OKCWIICSC	1.042
20				Normal (GOF Test					
21		S	hapiro Wilk Test Statistic		101 1631		Shaniro V	Vilk GOF Te	net .	
22			hapiro Wilk Critical Value			Data No	•	t 5% Signific		
23			Lilliefors Test Statistic			Data No		s GOF Test		
24			% Lilliefors Critical Value			Data No		t 5% Signific		
25				t Normal at 5	 % Significal					
26 27										
28			A:	suming Nor	nal Distribut	ion				
29		95% N	ormal UCL			95%	UCLs (Ad	justed for S	kewness)	
30			95% Student's-t UCL	17024			95% Adjust	ted-CLT UC	L (Chen-1995)	17528
31							95% Modif	fied-t UCL (Johnson-1978	17134
32										
33				Gamma	GOF Test					
34			A-D Test Statistic	0.552		Ander	son-Darlin	g Gamma (GOF Test	
35			5% A-D Critical Value	0.745	Detected	d data appea	ır Gamma I	Distributed a	nt 5% Significa	nce Level
36			K-S Test Statistic	0.19		Kolmog	orov-Smirr	nov Gamma	GOF Test	
37			5% K-S Critical Value	0.21	Detected	d data appea	ır Gamma I	Distributed a	nt 5% Significa	nce Level
38			Detected data appea	r Gamma Di	stributed at	5% Significa	nce Level			
39										
40				Gamma	Statistics					
41			k hat (MLE	3.309			k	star (bias c	corrected MLE	2.764
42			Theta hat (MLE	4068			Theta	`	corrected MLE	
43			nu hat (MLE	112.5				nu star (l	bias corrected	93.99
44		M	LE Mean (bias corrected	13460				,	bias corrected	
45									re Value (0.05)	
46		Adjus	sted Level of Significance	0.0346				Adjusted Ch	i Square Value	70.66
47										
48			As	suming Gam	ma Distribu	tion				
49	95% Appr	oximate Gamm	a UCL (use when n>=50)	17418		95% Ad	justed Gam	nma UCL (u	se when n<50	17903
50										

	Α	В	С	D	E	F	G	Н		J	K	L
51							GOF Test					
52				•	Test Statistic			•	•	normal GOF		
53			5% SI	•	Critical Value	0.892				at 5% Signifi		
54					Test Statistic					ormal GOF T		
55			5'		Critical Value					at 5% Signifi	icance Level	
56					Data appear	r Lognormal	at 5% Signif	icance Leve	əl			
57												
58							l Statistics					I
59					Logged Data	8.497					logged Data	9.349
60			N	Maximum of	Logged Data	10.37				SD of I	logged Data	0.566
61												
62							rmal Distrib	ution				T
63					95% H-UCL					Chebyshev (I	,	19053
64					MVUE) UCL				97.5%	Chebyshev (I	MVUE) UCL	25237
65			99% (Chebyshev (MVUE) UCL	32297						
66												
67							tion Free UC					
68				Data appea	r to follow a	Discernible	Distribution :	at 5% Signii	ricance Leve	el		
69							=					
70				-	-		tribution Fre	e UCLS		050/ 1	alderif- 1101	17004
71			0501		5% CLT UCL						ckknife UCL	17024
72					otstrap UCL	16743			0E0/ 1		tstrap-t UCL	18268
73					ootstrap UCL				95%	Percentile Bo	oisirap UCL	16954
74					ootstrap UCL				050/ 01	abuat /84	0-1/1/07	22257
75					an, Sd) UCL					nebyshev(Mea		22357
76			97.5% Cn	ebysnev(ivie	an, Sd) UCL	26207			99% Cr	nebyshev(Mea	an, Sa) UCL	33769
77						Cussessed	LICI to Line					
78			050	0/ ^ 4:	Gamma UCL		UCL to Use				-	
79			90	% Aujusteu (Janina UCL	17903						
80		loto: Suggo	stions rogard	ing the color	tion of a 05%	(LICL are pr	ovidad ta hal	n the user to	s coloct the r	nost appropri	ata 05% LICI	ı
81	IN .	Note. Sugges						•			ate 95% UCI	L.
82												
		These recon					a size, data				(2006)	
83			nmendations	are based u	ipon the resu	lts of the sim	ulation studi	es summariz	zed in Singh	, Maichle, and	, ,	
83 84			nmendations	are based u	ipon the resu	lts of the sim	ulation studi	es summariz	zed in Singh		, ,	
83 84 85			nmendations	are based u	ipon the resu	lts of the sim	ulation studi	es summariz	zed in Singh	, Maichle, and	, ,	
83 84 85 86	Hov		nmendations	are based u	ipon the resu	lts of the sim	ulation studi	es summariz	zed in Singh	, Maichle, and	, ,	
83 84 85 86 87			nmendations	are based u	ipon the resu	lts of the sim	ulation studi	es summariz	zed in Singh	, Maichle, and	, ,	
83 84 85 86 87 88	Hov		nmendations	are based u	ipon the resu	llts of the sim	ulation studi	es summariz	zed in Singh	, Maichle, and	, ,	
83 84 85 86 87 88	Hov		mmendations lations result	s are based u	ipon the resu	llts of the sim /orld data se	nulation studi	es summariz	zed in Singh	, Maichle, and	ult a statistic	
83 84 85 86 87 88 89	Hov		mmendations lations result	s are based u	ipon the resurer all Real W	llts of the sim /orld data se	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	ult a statistic	ian.
83 84 85 86 87 88 89 90	Hov		mmendations lations result	s are based u	ipon the resurer all Real W	Jord data se General	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	ult a statistic	ian.
83 84 85 86 87 88 89 90 91	Hov		mmendations lations result	s are based u	pon the resurer all Real W	Jord data se General	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	ult a statistic	11 0
83 84 85 86 87 88 89 90 91 92	Hov		mmendations lations result	s are based u	pon the resurer all Real W	General 17 8 23	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	observations Mean	11 0 12.94
83 84 85 86 87 88 89 90 91	Hov		mmendations lations result	s are based uses will not cover a second of the second of	pon the resulter all Real Williams Observations Minimum Maximum	General 17 8 23	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	Observations Mean Median	11 0 12.94
83 84 85 86 87 88 89 90 91 92 93	Hov		mmendations lations result	s are based uses will not cover a second of the second of	open the resulter all Real Williams Observations Minimum Maximum SD	General 17 8 23 4.145	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	Observations Observations Mean Median rror of Mean	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94	Hov		mmendations lations result	s are based uses will not cover a second of the second of	open the resulter all Real Williams Observations Minimum Maximum SD	General 17 8 23 4.145 0.32	nulation studi	es summariz	zed in Singh he user may Numbe	, Maichle, and want to cons	Observations Observations Mean Median rror of Mean	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96	Hov		mmendations lations result: Total	s are based us s will not cover Number of C	open the resulter all Real Williams Observations Minimum Maximum SD	General 17 8 23 4.145 0.32 Normal (sulation studition studition studition studition studition studition studition studies statistics	es summariz	ved in Singh he user may Number Number	, Maichle, and want to cons	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96	Hov		mmendations lations result: Total	are based us will not cover a will not c	open the resulter all Real Williams Observations Minimum Maximum SD t of Variation	Section Control Cont	sulation studition studition studition studition studition studition studition studies statistics	es summariz	Number Number Shapiro Wiear Normal a	want to cons r of Distinct O of Missing O Std. En	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97	Hov		Total S S S S S S S S S S S S S	are based uses will not cover a will not	Deservations Minimum Maximum SD t of Variation Fest Statistic Critical Value	General 17	sulation studition studition studition studition studition studition studition studies statistics	es summariz nal insight the nal insight the Data appe	Number Number Shapiro Wiear Normal a	want to cons or of Distinct O or of Missing O Std. En	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97	Hov		Total S S S S S S S S S S S S S	are based uses will not cover a will not	Deservations Minimum Maximum SD t of Variation Test Statistic Critical Value Critical Value Critical Value	General 17 8 23 4.145 0.32 0.914 0.892 0.178 0.207	Statistics GOF Test	es summariz nal insight the nal insight the Data appe	Number Number Shapiro Wiear Normal a	want to cons r of Distinct O of Missing O Std. En	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98	Hov		Total S S S S S S S S S S S S S	are based uses will not cover a will not	Deservations Minimum Maximum SD t of Variation Test Statistic Critical Value Critical Value Critical Value	General 17 8 23 4.145 0.32 0.914 0.892 0.178 0.207	sulation studition studition studition studition studition studition studition studies statistics	es summariz nal insight the nal insight the Data appe	Number Number Shapiro Wiear Normal a	want to cons or of Distinct O or of Missing O Std. En	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101	Hov		Total S S S S S S S S S S S S S	are based uses will not cover a will not	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 0.914 0.892 0.178 0.207	sulation studition studition studition studition studition studition studition studies. Statistics GOF Test	Data appe	Number Number Shapiro Wiear Normal a	want to cons or of Distinct O or of Missing O Std. En	Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102	Hov		Total S 5% Si 5% Si	are based uses will not cover a will not	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 0.914 0.892 0.178 0.207	Statistics GOF Test	Data appeance Level	Number Number Number Number Number Number Number Number Number	Maichle, and want to cons r of Distinct O of Missing O Std. En	Observations Observations Observations Mean Median rror of Mean Skewness	11 0 12.94 12 1.005
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103	Hov		Total S 5% Si 5% Si	are based uses will not cover a will not cover a will not cover a will not cover a will be a wil	Dbservations Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 Normal 0.914 0.892 0.178 0.207 ar Normal at suming Normal (suming Normal (s	sulation studition studition studition studition studition studition studition studies. Statistics GOF Test	Data appeance Level	Number Shapiro Wiear Normal a Lilliefors ear Normal a	Maichle, and want to cons r of Distinct O of Missing O Std. En	Observations Observations Observations Mean Median rror of Mean Skewness ance Level	11 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104	Hov		Total S 5% Si 5% Si	are based uses will not cover a will not cover a will not cover a will not cover a will be a wil	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 0.914 0.892 0.178 0.207	sulation studition studition studition studition studition studition studition studies. Statistics GOF Test	Data appeance Level	Number Shapiro Wiear Normal a Lilliefors ear Normal a	Maichle, and want to cons r of Distinct O of Missing O Std. En Ilk GOF Test t 5% Significa GOF Test t 5% Significa isted for Ske	Observations Observations Observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995)	111 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105	Hov		Total S 5% Si 5% Si	are based uses will not cover a will not cover a will not cover a will not cover a will be a wil	Dbservations Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 Normal 0.914 0.892 0.178 0.207 ar Normal at suming Normal (suming Normal (s	sulation studition studition studition studition studition studition studition studies. Statistics GOF Test	Data appeance Level	Number Shapiro Wiear Normal a Lilliefors ear Normal a	Maichle, and want to cons r of Distinct O of Missing O Std. En	Observations Observations Observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995)	11 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106	Hov		Total S 5% Si 5% Si	are based uses will not cover a will not cover a will not cover a will not cover a will be a wil	Dbservations Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data appe	General 17 8 23 4.145 0.32 Normal (0.892 0.178 0.207 ar Normal at 14.7 14.7	Statistics Statistics GOF Test t 5% Signific mal Distribut	Data appeance Level	Number Shapiro Wiear Normal a Lilliefors ear Normal a	Maichle, and want to cons r of Distinct O of Missing O Std. En Ilk GOF Test t 5% Significa GOF Test t 5% Significa isted for Ske	Observations Observations Observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995)	111 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107	Hov		Total S 5% Si 5% Si	care based uses will not cover when the cover of the cove	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data appe As	General 17	sulation studition studition studition studition studition studition studition studies. Statistics GOF Test	Data appeance Level	Number Nu	Maichle, and want to cons r of Distinct O r of Missing O Std. En	Observations Observations Observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995) nnson-1978)	111 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108	Hov		Total S 5% Si 5% Si	are based us will not cover swill not cover sw	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data appe As dent's-t UCL	General 17	Statistics Statistics GOF Test GOF Test	Data appeance Level	Number	want to cons r of Distinct O of Missing O Std. En Std	Observations Observations Observations Mean Median Fror of Mean Skewness Ance Level Ance Level Chen-1995) Ochen-1995) Ochen-1978)	111 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109	Hov		Total S 5% Si 5% Si	are based us will not cover swill not cover sw	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe As dent's-t UCL	General 17	Statistics Statistics GOF Test GOF Test	Data appearance Level ion 95% Ander	Number Nu	Maichle, and want to cons r of Distinct O r of Missing O Std. En	observations observations observations Mean Median rror of Mean Skewness ance Level ance Level chen-1995) onson-1978)	111 0 12.94 12 1.005 1.008
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110	Hov		Total S 5% Si 5% Si	Number of C Coefficien hapiro Wilk hapiro Wilk C Lilliefors C Some A-D C K-S	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe As dent's-t UCL Test Statistic Critical Value Test Statistic Critical Value Test Statistic Critical Value	General 17 8 23 4.145 0.32 Normal (1.000) 0.914 0.892 0.178 0.207 ar Normal at 14.7 Gamma (1.000) 0.348 0.739 0.149 0.149	Statistics Statistics Statistics Sof Test and Distribut Gof Test Detected	Data appearance Level ion 95% Ander d data appear Kolmog	Number Number Number Number Number Number Number Number Number Normal a Lilliefors ear Normal a	Maichle, and want to cons r of Distinct O of Missing O Std. En	observations observations observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995) onson-1978) F Test own Significan OF Test	11 0 12.94 12 1.005 1.008 14.86 14.74
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111	Hov		Total S 5% Si 5% Si	A-D Swill not covered to the swill not covere	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe As dent's-t UCL Test Statistic Critical Value	General 17 8 23 4.145 0.32 Normal 0.914 0.892 0.178 0.207 ar Normal at 14.7 Gamma 0.348 0.739 0.149 0.209 0.209	Statistics Statistics GOF Test Detected Detected	Data appearance Level ion 95% Ander d data appearance Kolmog	Number Number Shapiro Williefors ear Normal a Lilliefors ear Normal a CUCLs (Adjuster 95% Adjuster 95% Modifier Gamma D orov-Smirno ar Gamma D	Maichle, and want to cons r of Distinct O r of Missing O Std. En	observations observations observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995) onson-1978) F Test own Significan OF Test	11 0 12.94 12 1.005 1.008 14.86 14.74
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 111	Hov		Total S 5% Si 5% Si	A-D Swill not covered to the swill not covere	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe As dent's-t UCL Test Statistic Critical Value Test Statistic Critical Value Test Statistic Critical Value	General 17 8 23 4.145 0.32 Normal 0.914 0.892 0.178 0.207 ar Normal at 14.7 Gamma 0.348 0.739 0.149 0.209 0.209	Statistics Statistics GOF Test Detected Detected	Data appearance Level ion 95% Ander d data appearance Kolmog	Number Number Shapiro Williefors ear Normal a Lilliefors ear Normal a CUCLs (Adjuster 95% Adjuster 95% Modifier Gamma D orov-Smirno ar Gamma D	Maichle, and want to cons r of Distinct O of Missing O Std. En	observations observations observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995) onson-1978) F Test own Significan OF Test	11 0 12.94 12 1.005 1.008 14.86 14.74
83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113	Hov		Total S 5% Si 5% Si	A-D Swill not covered to the swill not covere	Disservations Minimum Maximum SD t of Variation Test Statistic Critical Value Data appe As dent's-t UCL Test Statistic Critical Value	General 17 8 23 4.145 0.32 Normal 0.914 0.892 0.178 0.207 ar Normal at 14.7 Gamma 0.348 0.739 0.149 0.209	Statistics Statistics GOF Test Detected Detected	Data appearance Level ion 95% Ander d data appearance Kolmog	Number Number Shapiro Williefors ear Normal a Lilliefors ear Normal a CUCLs (Adjuster 95% Adjuster 95% Modifier Gamma D orov-Smirno ar Gamma D	Maichle, and want to cons r of Distinct O of Missing O Std. En	observations observations observations Mean Median rror of Mean Skewness ance Level ance Level wness) Chen-1995) onson-1978) F Test own Significan OF Test	111 0 12.9- 1.00 1.00

	A B C D E	F	G H I J K	L
116		Gamma	Statistics	
117	k hat (MLE)	11.39	k star (bias corrected MLE)	9.417
118	Theta hat (MLE)	1.136	Theta star (bias corrected MLE)	1.374
119	nu hat (MLE)	387.2	nu star (bias corrected)	320.2
120	MLE Mean (bias corrected)	12.94	MLE Sd (bias corrected)	4.217
121			Approximate Chi Square Value (0.05)	279.7
122	Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	275.8
123				
124	Ass	uming Gam	nma Distribution	
125	95% Approximate Gamma UCL (use when n>=50))	14.81	95% Adjusted Gamma UCL (use when n<50)	15.03
126				
127		Lognorma	I GOF Test	
128	Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Lognormal GOF Test	
129	5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
130	Lilliefors Test Statistic	0.129	Lilliefors Lognormal GOF Test	
131	5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level	
132	Data appear	Lognormal	at 5% Significance Level	
133				
134			I Statistics	
135	Minimum of Logged Data	2.079	Mean of logged Data	2.516
136	Maximum of Logged Data	3.135	SD of logged Data	0.303
137				
138	Assu	ming Logno	ormal Distribution	
139	95% H-UCL	14.92	90% Chebyshev (MVUE) UCL	15.81
140	95% Chebyshev (MVUE) UCL	17.12	97.5% Chebyshev (MVUE) UCL	18.93
141	99% Chebyshev (MVUE) UCL	22.5		
142				
143	<u> </u>		tion Free UCL Statistics	
144	Data appear to follow a D	Discernible	Distribution at 5% Significance Level	
145				
146	<u> </u>		tribution Free UCLs	
147	95% CLT UCL	14.59	95% Jackknife UCL	14.7
148	95% Standard Bootstrap UCL	14.53	95% Bootstrap-t UCL	15.11
149	95% Hall's Bootstrap UCL	15.16	95% Percentile Bootstrap UCL	14.53
150	95% BCA Bootstrap UCL	14.88		
151	90% Chebyshev(Mean, Sd) UCL	15.96	95% Chebyshev(Mean, Sd) UCL	17.32
152	97.5% Chebyshev(Mean, Sd) UCL	19.22	99% Chebyshev(Mean, Sd) UCL	22.94
. –				

	Α	В	- 1	С	Т	D	T	E	F	G	Гн	_	1	T	J	T	K	г	$\overline{}$
154	7.						•	_		UCL to Use			•						
155						95% St	udent's	-t UCL	14.7										
156																			
157		Note: Sug	gesti	ons rega	arding	the sele	ection o	f a 95%	UCL are pr	ovided to he	lp the user	to se	lect the	mos	st approp	priate	95% UC	L.	
158					Rec	ommend	dations	are bas	sed upon dat	a size, data	distribution	n, and	skewne	ess.					
159		These re	comn	nendatio	ons ar	e based	upon th	ne resu	Its of the sim	ulation studi	es summa	rized	in Singl	h, M	aichle, a	and Le	ee (2006)		
160	Н	lowever, si	mulat	ions res	ults w	ill not co	over all	Real W	orld data set	ts; for addition	nal insigh	t the u	iser ma	y wa	int to coi	nsult a	a statistic	ian.	
161																			
162																			
163	Barium																		
164									0	04-41-41									
165				т.	tal Ni		Ohaam		General 17	Statistics			Niconala		Distinct	Ob			
166				10	tai ivi	ımber of	Observ	valions	17								ervations		17 0
167							M	nimum	34				Numbe	er or	iviissing	Obse	ervations		05.2
168								nimum ximum	343								Mean Median		75.2
169							ivia	SD	86.77						Std	Frror	of Mean		21.04
170					-	Coefficie	nt of \/s		0.825						Siu.		kewness		1.685
171						JOE HICIEI	III OI Võ	a i a di Ui l	0.020							اد	VCM11G99	<u> </u>	1.000
172									Normal (GOF Test									
173					Sha	piro Wilk	Test S	tatistic		1001		Sh	aniro V	Vilk (GOF Te	st			
174				5%		oiro Wilk			0.892		Data I				Signific		Level		
175						Lilliefors									OF Test				
176 177						Lilliefors			0.207		Data I				Signific		Level		
178									Normal at 5	 Significa					- 3				
179																			
180								As	suming Norr	nal Distribut	tion								
181				95%	Norn	nal UCL					95	% UC	Ls (Ad	juste	ed for SI	kewne	ess)		
182						95% St	udent's	-t UCL	142			95%	6 Adjust	ted-0	CLT UCI	L (Che	en-1995)	14	19
183												95	% Modif	fied-	t UCL (J	lohnso	on-1978)	14	13.4
184																			
185									Gamma (GOF Test									
186							Test S								amma G				
187						5% A-D			0.749	Detected	d data app						•	nce L	.evel
188							Test S		0.211						Gamma				
189						5% K-S			0.212		d data app				ibuted a	t 5% S	Significar	ıce L	.evel
190						Detecte	d data	appea	r Gamma Di	stributed at	5% Signifi	cance	e Level						
191										01-11-21									
192							la biss	/NA! = \		Statistics					/h.:		N41 C'		1 777
193						T1-		(MLE)	2.11						•		ed MLE)		1.777
194							eta hat	, ,	49.87 71.75				ıneta		•		ed MLE)		59.21 50.42
195					MI F	Mean (b	nu hat								•		orrected)		
196					IVILE	ivieafi (D	ids CON	eciea)	105.2			Ann	rovimo		`		ue (0.05)		78.94 13.55
197				ΔΑ	inster	d Level o	of Signif	icanco	0.0346			Ahh					re Value		12.05
198				Λu	justet	revei 0	, oigiill	carice	0.0340					ujus	JIGU CIII	oqua	ii o vaiue	4	-2.00
199								Δοι	suming Gam	ma Distribu	tion								
200		95% Appi	roxim	ate Gam	ıma I	ICI (usa	when r		146	2/30/100		Adjuet	ed Gam	nma	UCL (us	se wh	en n<50)	15	51.2
201		30 /0 /Appi	JAIIII	alo dall		JE (436	71110111	. 50)			33707	.ujusi	Ju Juli		30L (us	WIT			
シロン																			

	Α	В	С	D	Е	F	G	Н		J	K	L
203							GOF Test					
204				<u>'</u>	Test Statistic	0.931		•		normal GOF		
205			5% SI	•	Critical Value	0.892				at 5% Signific		
206					Test Statistic	0.165				ormal GOF Te		
207			5		Critical Value	0.207	. =0/ 01 1/		•	at 5% Signific	cance Level	
208					Data appear	Lognormal	at 5% Signif	icance Leve	el .			
209												
210							I Statistics					4 404
211					Logged Data	3.526					ogged Data	4.401
212			IN.	/laximum or	Logged Data	5.838				2D 01 10	ogged Data	0.703
213					Δεει	ımina Loana	rmal Distrib	ution				
214					95% H-UCL	155.4	Aillai Distrib	ution	90%	Chebyshev (M	/IV/LIE) LICI	158.3
215			95%	Chebyshev (MVUE) UCL	183.5				Chebyshev (N	,	218.5
216					MVUE) UCL	287.3			07.070		02, 002	2.0.0
217 218					,, , , , , ,							
219					Nonparame	etric Distribu	tion Free UC	L Statistics				
220				Data appea	r to follow a					l		
221												
222					Nonpa	rametric Dis	tribution Fre	e UCLs				
223				95	5% CLT UCL	139.9				95% Jac	ckknife UCL	142
224			95%	Standard Bo	otstrap UCL	138.5				95% Boots	strap-t UCL	166.7
225			9	5% Hall's Bo	otstrap UCL	154.9			95% F	Percentile Boo	otstrap UCL	140.2
226			,	95% BCA Bo	otstrap UCL	146.9						
227			90% Ch	ebyshev(Me	an, Sd) UCL	168.4			95% Ch	ebyshev(Mea	n, Sd) UCL	197
228			97.5% Ch	ebyshev(Me	an, Sd) UCL	236.7			99% Ch	ebyshev(Mea	n, Sd) UCL	314.6
229												
230							UCL to Use					
231			95	% Adjusted (Gamma UCL	151.2						
232		lata: Cuana		: 46	+:f - OF0/	LICL ava vu					-+- OE0/ LICI	
233	IN.	lote: Sugges			ation of a 95%			•		nost appropria	ate 95% UCL	
234		These recom				· ·				Maichle, and	11 00 (2006)	
235					•					want to consu	, ,	
236		· ·										
207												
238 239	Chromium											
238	Chromium											
238 239	Chromium						Statistics					
238 239 240	Chromium		Total	Number of (Dbservations	General	Statistics			of Distinct Ol		15
238 239 240 241	Chromium		Total	Number of (17	Statistics			of Distinct Ol	bservations	0
238 239 240 241 242	Chromium		Total	Number of C	Minimum	17 9	Statistics				bservations Mean	0 34.47
238 239 240 241 242 243 244 245	Chromium		Total	Number of (Minimum Maximum	9 107	Statistics			of Missing Ol	bservations Mean Median	0 34.47 21
238 239 240 241 242 243 244 245 246	Chromium		Total		Minimum Maximum SD	9 107 27.96	Statistics			of Missing Ol	bservations Mean Median ror of Mean	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247	Chromium		Total		Minimum Maximum	9 107	Statistics			of Missing Ol	bservations Mean Median	0 34.47 21
238 239 240 241 242 243 244 245 246 247 248	Chromium		Total		Minimum Maximum SD	9 107 27.96 0.811				of Missing Ol	bservations Mean Median ror of Mean	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249	Chromium			Coefficien	Minimum Maximum SD t of Variation	9 107 27.96 0.811	Statistics GOF Test		Number	of Missing Ol	bservations Mean Median ror of Mean	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249	Chromium		S	Coefficien hapiro Wilk	Minimum Maximum SD	9 107 27.96 0.811		Data No	Number	of Missing Ol	Mean Median ror of Mean Skewness	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251	Chromium		S	Coefficien hapiro Wilk o	Minimum Maximum SD t of Variation	9 107 27.96 0.811 Normal C		Data No	Number Shapiro Wi	of Missing Ol Std. En	Mean Median ror of Mean Skewness	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251	Chromium		\$ 5% SI	Coefficien hapiro Wilk Chapiro	Minimum Maximum SD t of Variation Test Statistic	9 107 27.96 0.811 Normal 0 0.791 0.892			Number Shapiro Wi t Normal at 5 Lilliefors	of Missing Ol Std. Err	Mean Median ror of Mean Skewness	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251	Chromium		\$ 5% SI	Coefficien hapiro Wilk Chapiro	Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207		Data No	Number Shapiro Wi t Normal at 5 Lilliefors	of Missing OI Std. Err Ik GOF Test 5% Significance GOF Test	Mean Median ror of Mean Skewness	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254	Chromium		\$ 5% SI	Coefficien hapiro Wilk Chapiro	Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207	GOF Test	Data No	Number Shapiro Wi t Normal at 5 Lilliefors	of Missing OI Std. Err Ik GOF Test 5% Significance GOF Test	Mean Median ror of Mean Skewness	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252	Chromium		\$ 5% SI	Coefficien hapiro Wilk Chapiro	Minimum Maximum SD t of Variation Test Statistic Critical Value Fest Statistic Critical Value Data Not	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207	GOF Test	Data Nonce Level	Shapiro Wi t Normal at 5	of Missing OI Std. Err Ik GOF Test 5% Significance GOF Test 5% Significance	Mean Median ror of Mean Skewness ce Level	0 34.47 21 6.782
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255	Chromium		\$ 5% SI	Coefficien hapiro Wilk hapiro Wilk (Lilliefors (Kulliefors (Lilliefors (Lilliefors (Lilliefors (Lilliefors (Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data Not As	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207 Normal at 5	GOF Test	Data Nonce Level	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5	of Missing Ol Std. Err Ik GOF Test 5% Significance GOF Test 5% Significance sted for Skew	Mean Median ror of Mean Skewness Ce Level Ce Level	0 34.47 21 6.782 1.637
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 256	Chromium		\$ 5% SI	Coefficien hapiro Wilk hapiro Wilk (Lilliefors (Kulliefors (Lilliefors (Lilliefors (Lilliefors (Lilliefors (Minimum Maximum SD t of Variation Test Statistic Critical Value Fest Statistic Critical Value Data Not	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207	GOF Test	Data Nonce Level	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju	Std. Err	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995)	0 34.47 21 6.782 1.637
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257	Chromium		\$ 5% SI	Coefficien hapiro Wilk hapiro Wilk (Lilliefors (Kulliefors (Lilliefors (Lilliefors (Lilliefors (Lilliefors (Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data Not As	9 107 27.96 0.811 Normal 0 0.791 0.892 0.229 0.207 Normal at 5	GOF Test	Data Nonce Level	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju	of Missing Ol Std. Err Ik GOF Test 5% Significance GOF Test 5% Significance sted for Skew	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995)	0 34.47 21 6.782 1.637
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258	Chromium		\$ 5% SI	Coefficien hapiro Wilk hapiro Wilk (Lilliefors (Kulliefors (Lilliefors (Lilliefors (Lilliefors (Lilliefors (Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data Not As	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Normal	GOF Test % Significan mal Distribut	Data Nonce Level	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju	Std. Err	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995)	0 34.47 21 6.782 1.637
238 239 240 241 242 243 244 245 246 247 248 250 251 252 253 254 255 256 257 258 260 261	Chromium		\$ 5% SI	Coefficien hapiro Wilk Company	Minimum Maximum SD t of Variation Fest Statistic Critical Value Fest Statistic Critical Value Data Not As dent's-t UCL	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31	GOF Test	Data Nonce Level ion 95%	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie	Std. Errillik GOF Test 5% Significance GOF Test 5% Significance sted for Skew d-CLT UCL (Ced-t UCL (John	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995) nson-1978)	0 34.47 21 6.782 1.637
238 239 240 241 242 243 244 245 246 247 248 250 251 252 253 254 255 256 257 258 260 261 262	Chromium		\$ 5% SI	Coefficien hapiro Wilk Company Commany Lilliefors Commany Comm	Minimum Maximum SD t of Variation Fest Statistic Critical Value Test Statistic Critical Value Data Not As dent's-t UCL	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31 Gamma C 0.64	GOF Test S% Significal mal Distribut GOF Test	Data Nonce Level ion 95%	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie	Std. Errillia Std. Significant St	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995) nson-1978)	0 34.47 21 6.782 1.637 48.5 46.76
238 239 240 241 242 243 244 245 246 247 248 250 251 252 253 254 255 256 257 258 260 261 262 263	Chromium		\$ 5% SI	Coefficien hapiro Wilk (Lilliefors (% Lilliefors (pormal UCL 95% Stu A-D (5% A-D (Minimum Maximum SD t of Variation Fest Statistic Critical Value Fest Statistic Data Not As dent's-t UCL Fest Statistic	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31 Gamma C 0.64 0.749	GOF Test S% Significal mal Distribut GOF Test	Data Nonce Level ion 95% Ander d data appea	Shapiro Wi It Normal at 5 Lilliefors It Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie	Std. Erri Ik GOF Test 5% Significance GOF Test 5% Significance steed for Skew d-CLT UCL (Ced-t UCL (John Gamma GOF stributed at 50	Mean Median ror of Mean Skewness ce Level ce Level wness) Chen-1995) nson-1978) F Test % Significan	0 34.47 21 6.782 1.637 48.5 46.76
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 260 261 262 263	Chromium		\$ 5% SI	Coefficien hapiro Wilk hapiro Wilk (Lilliefors (**Lilliefors (**Dormal UCL 95% Stu A-D (K-S	Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Data Not As dent's-t UCL Test Statistic Critical Value	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31 Gamma C 0.64 0.749 0.195	GOF Test GOF Test GOF Test Detected	Data Nonce Level ion 95% Ander i data appea	Shapiro Wi t Normal at 5 Lilliefors t Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie 95% Modifie son-Darling orov-Smirno	Std. Erroll Std.	Mean Median ror of Mean Skewness ce Level ce Level Mean Skewness ce Level ror Level ror Level syness Chen-1995) nson-1978)	0 34.47 21 6.782 1.637 48.5 46.76
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 260 261 262 263 264 265	Chromium		\$ 5% SI	Coefficien hapiro Wilk C hapiro Wilk C Lilliefors C ST A-D 5% A-D C K-S 5% K-S C	Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Critical Value Data Not As dent's-t UCL Test Statistic Critical Value Test Statistic	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31 Gamma (0.64 0.749 0.195 0.212	GOF Test GOF Test Detected Detected	Data Nonce Level ion 95% Ander I data appea	Shapiro Wi It Normal at 5 Lilliefors It Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie son-Darling or Gamma Di orov-Smirno or Gamma Di	Std. Erri Ik GOF Test 5% Significance GOF Test 5% Significance steed for Skew d-CLT UCL (Ced-t UCL (John Gamma GOF stributed at 50	Mean Median ror of Mean Skewness ce Level ce Level Mean Skewness ce Level ror Level ror Level syness Chen-1995) nson-1978)	0 34.47 21 6.782 1.637 48.5 46.76
238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 260 261 262 263 264	Chromium		\$ 5% SI	Coefficien hapiro Wilk C hapiro Wilk C Lilliefors C ST A-D 5% A-D C K-S 5% K-S C	Minimum Maximum SD t of Variation Test Statistic Critical Value Test Statistic Data Not As dent's-t UCL Test Statistic Critical Value	9 107 27.96 0.811 Normal C 0.791 0.892 0.229 0.207 Normal at 5 suming Norm 46.31 Gamma (0.64 0.749 0.195 0.212	GOF Test GOF Test Detected Detected	Data Nonce Level ion 95% Ander I data appea	Shapiro Wi It Normal at 5 Lilliefors It Normal at 5 UCLs (Adju 95% Adjuste 95% Modifie son-Darling or Gamma Di orov-Smirno or Gamma Di	Std. Erroll Std.	Mean Median ror of Mean Skewness ce Level ce Level Mean Skewness ce Level ror Level ror Level syness Chen-1995) nson-1978)	0 34.47 21 6.782 1.637 48.5 46.76

	Α	В	С	D	E	F	G	Н	1		J	K	L
268							Statistics		-			<u> </u>	
269					k hat (MLE)	2.125				k s	tar (bias cor	rected MLE)	1.789
270				The	a hat (MLE)	16.22			Th	neta s	tar (bias cor	rected MLE)	19.27
271					u hat (MLE)	72.25					•	as corrected)	60.83
272			ML	.E Mean (bia	s corrected)	34.47					,	s corrected)	25.77
273									Approxir			Value (0.05)	43.9
274			Adjus	ted Level of	Significance	0.0346				Ad	ljusted Chi S	Square Value	42.39
275													
276							ma Distribut	tion					
277	ç	95% Approxii	mate Gamma	a UCL (use v	/hen n>=50)	47.77		95% Ad	when n<50)	49.47			
278													
279							GOF Test						
280				hapiro Wilk T		0.947		•			normal GOI		
281			5% SI	napiro Wilk C		0.892						icance Level	
282					est Statistic	0.163					ormal GOF 1		
283			5'	% Lilliefors C		0.207				rmal	at 5% Signif	icance Level	
284					Data appear	Lognormal	at 5% Signif	icance Leve	el				
285													
286							l Statistics						
287				Minimum of L		2.197						logged Data	3.287
288			N	laximum of L	ogged Data	4.673					SD of	logged Data	0.709
289													
290							rmal Distrib	ution					
291					95% H-UCL	51.39						MVUE) UCL	52.27
292				Chebyshev (60.64			97.	.5% (Chebyshev (MVUE) UCL	72.26
293			99% (Chebyshev (MVUE) UCL	95.09							
294													
295					•		tion Free UC						
296				Data appear	to follow a l	Discernible	Distribution a	at 5% Signif	ficance	Leve	l		
297													
298					•		tribution Fre	e UCLs					
299					% CLT UCL	45.63						ckknife UCL	46.31
300				Standard Bo		45.67						tstrap-t UCL	51
301				5% Hall's Bo		53.36			9	5% F	Percentile Bo	otstrap UCL	46
302				95% BCA Bo		48.71							
303				ebyshev(Me		54.82					• •	an, Sd) UCL	64.03
304			97.5% Ch	ebyshev(Me	an, Sd) UCL	76.83			999	% Ch	ebyshev(Me	an, Sd) UCL	102
305													

	A B C D E	F	GHIJK	
306			UCL to Use	
307	95% Adjusted Gamma UCI	49.47		
308				
309	Note: Suggestions regarding the selection of a 95	% UCL are pr	ovided to help the user to select the most appropriate 95% UCL	
310	Recommendations are ba	sed upon dat	a size, data distribution, and skewness.	
311	These recommendations are based upon the res	ults of the sim	nulation studies summarized in Singh, Maichle, and Lee (2006).	
312	However, simulations results will not cover all Real \	Vorld data se	ts; for additional insight the user may want to consult a statisticia	an.
313				
314				
315	Cobalt			
316				
317		General	Statistics	
318	Total Number of Observations	17	Number of Distinct Observations	13
319			Number of Missing Observations	0
320	Minimun	n 6	Mean	16.29
321	Maximun	n 34	Median	15
322	SI	8.571	Std. Error of Mean	2.079
323	Coefficient of Variation	0.526	Skewness	0.912
324				
325		Normal (GOF Test	
326	Shapiro Wilk Test Statistic	0.888	Shapiro Wilk GOF Test	
327	5% Shapiro Wilk Critical Value		Data Not Normal at 5% Significance Level	
328	Lilliefors Test Statistic	0.186	Lilliefors GOF Test	
329	5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level	
	Data annear An			
330	рака арреак Ар	proximate No	rmal at 5% Significance Level	
330 331			•	
	A		mal Distribution	
331	A: 95% Normal UCL	ssuming Nor	mal Distribution 95% UCLs (Adjusted for Skewness)	
331 332	A	ssuming Nor	mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995)	20.21
331 332 333	A: 95% Normal UCL	ssuming Nor	mal Distribution 95% UCLs (Adjusted for Skewness)	20.21
331 332 333 334	A: 95% Normal UCL	ssuming Non	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	
331 332 333 334 335	95% Normal UCL 95% Student's-t UCL	19.92	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	
331 332 333 334 335 336	95% Normal UCL 95% Student's-t UCl	19.92 Gamma 0.38	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test	20
331 332 333 334 335 336 337	A-D Test Statistic 5% A-D Critical Value	19.92 Gamma 0.38 0.743	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance	20
331 332 333 334 335 336 337 338	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic	Gamma 0.38 0.743 0.132	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test	20 ce Level
331 332 333 334 335 336 337 338 339 340	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	Gamma : 0.38 : 0.743 : 0.132 : 0.21	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance	20 ce Level
331 332 333 334 335 336 337 338 339 340 341 342	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	Gamma : 0.38 : 0.743 : 0.132 : 0.21	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test	20 ce Level
331 332 333 334 335 336 337 338 339 340 341 342 343	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	Gamma 0 0.38 0 0.743 0 0.132 0 0.21 Gamma Di	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Stributed at 5% Significance Level	20 ce Level
331 332 333 334 335 336 337 338 340 341 342 343	A-D Test Statistic S** A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	Gamma 0 0.38 0.743 0.132 0.21 ar Gamma Di	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Stributed at 5% Significance Level Statistics	20 ce Level
331 332 333 334 335 336 337 338 340 341 342 343 344 345	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appea	Gamma 19.92 Gamma 0.38 0.743 0.132 0.21 Gamma Di Gamma Di 4.162	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE)	20 ce Level
331 332 333 334 335 336 337 338 340 341 342 343 344 345 346	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	Gamma 19.92 Gamma 0.38 0.743 0.132 0.21 Gamma Di Gamma Di 4.162 3.915	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE) Theta star (bias corrected MLE)	20 ce Level 3.466 4.7
331 332 333 334 335 336 337 338 340 341 342 343 344 345 346 347	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	Gamma 0.38 0.743 0.132 0.21 ar Gamma Di Gamma 4.162 3.915 141.5	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE) Theta star (bias corrected MLE) nu star (bias corrected)	20 ce Level 3.466 4.7 117.9
331 332 333 334 335 336 337 338 340 341 342 343 344 345 346 347 348	A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	Gamma 0.38 0.743 0.132 0.21 ar Gamma Di Gamma 4.162 3.915 141.5	### Page 12 Pa	20 ce Level 3.466 4.7 117.9 8.752
331 332 333 334 335 336 337 340 341 342 343 344 345 346 347 348	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appea k hat (MLE Theta hat (MLE nu hat (MLE MLE Mean (bias corrected	Gamma 0.38 0.743 0.132 0.21 ar Gamma Di Gamma Di 4.162 0.3.915 141.5	### Page 2015 Page 2015 ### Page 20	20 ce Level 3.466 4.7 117.9 8.752 93.79
331 332 333 334 335 336 337 340 341 342 343 344 345 346 347 348 349 350	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	Gamma 0.38 0.743 0.132 0.21 ar Gamma Di Gamma Di 4.162 0.3.915 141.5	### Page 12 Pa	20 ce Level 3.466 4.7 117.9 8.752
331 332 333 334 335 336 337 340 341 342 343 344 345 346 347 348 349 350 351	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appea k hat (MLE Theta hat (MLE nu hat (MLE MLE Mean (bias corrected Adjusted Level of Significance	Gamma 0.038 0.743 0.132 0.21 ar Gamma Di 4.162 0.3.915 141.5 16.29	### Page 12 Pa	20 ce Level 3.466 4.7 117.9 8.752 93.79
331 332 333 334 335 336 337 340 341 342 343 344 345 346 347 348 349 350 351 352	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear k hat (MLE Theta hat (MLE nu hat (MLE MLE Mean (bias corrected) Adjusted Level of Significance	Gamma 0.038 0.743 0.132 0.21 ar Gamma Di Gamma 0.4.162 0.3.915 0.141.5 0.16.29 0.0346 Gamma Gamma Di G	### Page 2015 Page 2015 ### Page 20	20 ce Level 3.466 4.7 117.9 8.752 93.79 91.54
331 332 333 334 335 336 337 340 341 342 343 344 345 346 347 348 349 350 351	A-D Test Statistic A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appea k hat (MLE Theta hat (MLE Theta hat (MLE MLE Mean (bias corrected Adjusted Level of Significance As 95% Approximate Gamma UCL (use when n>=50)	Gamma 0.038 0.743 0.132 0.21 ar Gamma Di Gamma 0.4.162 0.3.915 0.141.5 0.16.29 0.0346 Gamma Gamma Di G	### Page 12 Pa	20 ce Level 3.466 4.7 117.9 8.752 93.79

	A B C D E	F	G H I J K	L
355		Lognorma	GOF Test	
356	Shapiro Wilk Test Statistic	0.962	Shapiro Wilk Lognormal GOF Test	
357	5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
358	Lilliefors Test Statistic	0.11	Lilliefors Lognormal GOF Test	
359	5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level	
360	Data appear	Lognormal	at 5% Significance Level	
361				
362		Lognorma	I Statistics	
363	Minimum of Logged Data	1.792	Mean of logged Data	2.666
364	Maximum of Logged Data	3.526	SD of logged Data	0.515
365				
366	Assu	ming Logno	ormal Distribution	
367	95% H-UCL	21.37	90% Chebyshev (MVUE) UCL	22.58
368	95% Chebyshev (MVUE) UCL	25.44	97.5% Chebyshev (MVUE) UCL	29.41
369	99% Chebyshev (MVUE) UCL	37.19		
370				
371	•		tion Free UCL Statistics	
372	Data appear to follow a D	Discernible	Distribution at 5% Significance Level	
373				
374	Nonpara	ametric Dis	tribution Free UCLs	
375	95% CLT UCL	19.71	95% Jackknife UCL	19.92
376	95% Standard Bootstrap UCL	19.63	95% Bootstrap-t UCL	20.84
377	95% Hall's Bootstrap UCL	19.81	95% Percentile Bootstrap UCL	19.88
378	95% BCA Bootstrap UCL	20.06		
379	90% Chebyshev(Mean, Sd) UCL	22.53	95% Chebyshev(Mean, Sd) UCL	25.36
380	97.5% Chebyshev(Mean, Sd) UCL	29.28	99% Chebyshev(Mean, Sd) UCL	36.98
381				
382		Suggested	UCL to Use	
383	95% Student's-t UCL	19.92		
384				
385	• •	, •	normal) distribution passing one of the GOF test	
386	When applicable, it is suggested to use a UCL ba	sed upon a	distribution (e.g., gamma) passing both GOF tests in ProUCL	
387				
388			ovided to help the user to select the most appropriate 95% UCL.	
389		•	a size, data distribution, and skewness.	
390			nulation studies summarized in Singh, Maichle, and Lee (2006).	
391	However, simulations results will not cover all Real Wo	orld data se	ts; for additional insight the user may want to consult a statisticia	in.
392				
393				
394	Copper			
395		<u> </u>	Obsellation	
396			Statistics	4-
397	Total Number of Observations	17	Number of Distinct Observations	15
398		10	Number of Missing Observations	0
399	Minimum	13	Mean	44.71
400	Maximum	87	Median	40
401	SD SD	26.51	Std. Error of Mean	6.429
402	Coefficient of Variation	0.593	Skewness	0.156
403				

	Α	В	С	T	D	_	E I	F	G	Т	Н	-					г -	K	т	
404	Α	ь	C			_		Normal (st	- 11		- 1		J			K		
405				Shap	iro Wilk	k Test	Statistic	0.881				S	hapir	o Wil	k GOF	Test	t		-	
406			5%	Shapi	ro Wilk	Critic	al Value	0.892			Data N				% Sign			evel		
407				L	illiefors	s Test	Statistic	0.183					Lillie	fors (GOF T	est				
408				5% L	illiefors	Critic	al Value	0.207			Data ap	pea	r Norn	nal at	5% Sig	gnific	ance	Level		
409					Dat	ta app	ear Appr	oximate No	rmal at 5	5% S	ignificand	ce L	evel							
410																				
411							Ass	suming Nori	mal Distr	ributi	on									
412			95%	Norma	al UCL						95	% U	CLs (Adjus	sted for	r Ske	wne	ss)		
413					95% St	tudent	's-t UCL	55.93				95	% Ad	juste	d-CLT I	UCL	(Che	n-1995)	55.54
414												9	5% M	odifie	d-t UCI	L (Jo	hnso	n-1978)	55.97
415																				
416								Gamma	GOF Tes	st										
417					A-D) Test	Statistic	0.821			And	lerso	n-Da	rling	Gamm	a GC	OF Te	est		
418				5	5% A-D	Critic	al Value	0.747		Da	ta Not Ga	amm	a Dist	ribute	ed at 59	% Sig	gnific	ance Le	evel	
419					K-S	3 Test	Statistic	0.197			Kolmo	ogor	ov-Sr	nirno	v Gam	ma G	OF	Test		
420				5	5% K-S	Critic	al Value	0.211	Dete	ected	data app	ear	Gamn	na Dis	stribute	d at	5% S	ignifica	ince	Level
421				Det	ected o	data f	ollow App	r. Gamma	Distribut	ion a	at 5% Sig	nific	ance	Level						
422																				
423								Gamma	Statistic	s										
424						k ha	at (MLE)	2.598						k s	tar (bia	s cor	rrecte	ed MLE)	2.179
425					Th	neta ha	at (MLE)	17.21					Th	eta s	tar (bia	s cor	recte	d MLE)	20.52
426						nu ha	at (MLE)	88.33							nu sta	ır (bia	as co	rrected)	74.08
427				MLE N	/lean (b	oias co	orrected)	44.71							MLE S	d (bia	as co	rrected)	30.29
428												Αp	proxii	mate	Chi Sq	uare	Valu	e (0.05)	55.26
429			Adj	justed	Level o	of Sigr	nificance	0.0346						Ad	justed (Chi S	Squar	e Value)	53.55
430																				
431								uming Gam	ıma Dist	ribut										
432	9	5% Approxin	nate Gamr	ma UC	L (use	when	n>=50))	59.93			95% <i>A</i>	Adju	sted G	amm	na UCL	(use	whe	n n<50)	61.84
433																				
434								Lognorma	I GOF To	est										
435							Statistic	0.88							normal					
436			5%				al Value	0.892			Data No							Level		
437							Statistic	0.197							rmal G					
438				5% L			al Value	0.207			Data app				at 5% S	Signit	tican	ce Leve	<u> </u>	
439					Data	appe	ar Approx	kimate Logr	normal a	τ 5%	Significa	nce	Level	l						
440								Lean	l Cacaler											
441				NA:-:	mum a	floor	ed Data	Lognorma 2.565	ıı ətatisti	CS					Ma	an at	locc	od Dot		3.595
442							jed Data jed Data	4.466										ed Data		0.694
443				waxi	mum O	Logg	Jen Darg	4.400							- 5	וט טנ	iogg	eu Data	1	0.094
444							Λοοι	ming Logno	rmel Di	etrib.	ıtion									
445						050	ASSU 6 H-UCL	68.52	AIIIAI DIS	suibl	AUOH		•	20% C	hahva	hov ((N/N/)	JE) UCI	_	69.96
446			OE C	% Cha	hychou		JE) UCL	81.01									•	JE) UCI		96.34
447						•	JE) UCL	126.5					9/	.5% (LIEDYS	iiev ((IVI V C	ie) UCI	+	50.34
448			99	⁄₀ Crie	bysnev	/ (IVIV	JE) UCL	120.5											\perp	
449						Nic	nnarama	tric Distribu	tion Eros	יוי	l Statisti	ce								
450				Det	a anno		•	iric Distribu Discernible					ance	l ave						
451				שט	а арре	יםו נט	ioliow a L	JISCEI IIIDIE	ייסמו וטענ	1011 8	ii u /o oigi	iiiiC	ance	-eve	1					
452																				

	Α		В	С	D	Е	F	G	Н			J		K	L
453						•		stribution Fre	e UCLs			250			
454				050/		95% CLT UC								nife UCL	55.93
455						ootstrap UC				050				ap-t UCL	56.48
456	-					ootstrap UC				957	% Pen	centile	BOOKS	trap UCL	55.06
457						ean, Sd) UC				059/	Choh	rahav/N	Maan	Sd) UCL	72.73
458						ean, Sd) UC						,		Sd) UCL	108.7
459				97.3 % CI	ilenysilev(ivi	ean, Su) OC	L 04.00			33 /0	Crieby	ysnev(n	vieari,	3u) UCL	100.7
460							Suggester	UCL to Use	1						
461					95% St	udent's-t UC		1 002 10 000							
462															
463 464				When a	data set follo	ws an appro	ximate (e.g.,	normal) distr	ibution passi	ng one of	the G	OF tes	t		
465			When app	olicable, it is	suggested to	use a UCL	based upon a	distribution	e.g., gamma	a) passing	both	GOF te	ests in	ProUCL	
466															
467		N	lote: Sugge	estions regard	ding the sele	ction of a 95	% UCL are p	rovided to he	lp the user to	select the	e mos	t appro	priate	95% UC	L.
468				I	Recommend	ations are b	ased upon da	ita size, data	distribution,	and skewr	ness.				
469			These reco	mmendation	s are based	upon the res	ults of the si	nulation stud	ies summariz	zed in Sing	gh, Ma	aichle, a	and Le	ee (2006)	
470		Hov	vever, simu	ulations resul	ts will not co	ver all Real	World data s	ets; for addition	onal insight th	ne user ma	ay wa	nt to co	onsult	a statistic	ian.
471															
472															
473	Iron														
474															
475							_	Statistics							
476				Tota	l Number of	Observation	s 17							ervations	16
477							2010			Numb	ber of	Missing	g Obs	ervations	0
478						Minimur									23859
479						Maximur SI						C+d	Error	Median r of Mean	23600 2381
480					Coefficier	nt of Variatio						Siu.		Skewness	0.424
481					Oocilicici	- Variatio	0.411							Rewricos	0.424
482							Normal	GOF Test							
483 484					Shapiro Wilk	Test Statisti		1		Shapiro '	Wilk (GOF Te	est		
485						Critical Valu			Data appe					e Level	
486					Lilliefors	Test Statisti	c 0.119			Lilliefo	ors GC	F Test	t		
487				5	5% Lilliefors	Critical Valu	e 0.207		Data appe	ear Norma	al at 59	% Signi	ificanc	e Level	
488						Data app	ear Normal a	at 5% Signific	cance Level						
489															
490						A	ssuming No	rmal Distribu	tion						
491				95% N	lormal UCL				95%	UCLs (A	djuste	d for S	kewn	ess)	
492					95% St	udent's-t UC	L 28017			95% Adju	sted-C	CLT UC	L (Ch	en-1995)	28038
493										95% Mod	dified-t	UCL (Johns	on-1978)	28058
494															
495								GOF Test							
496						Test Statisti		<u> </u>		son-Darli					
497						Critical Valu		Detecte	d data appea						ice Level
498	ļ					Test Statisti				orov-Smi					
499						Critical Valu			d data appea			buted a	at 5%	Significan	ice Level
500	ļ				Detecte	data appe	ar Gamma D	istributed at	5% Significa	ince Leve	el				
501															

	Α	В	С	D	-	E	F	G	Н	i		J	Т	К	1
502		В	C	D			-	Statistics				J		K	L
					k h	at (MLE)	5.903				k sta	ır (bias co	orrecte	ed MLE)	4.901
503 504				Т		at (MLE)				Tł		ır (bias c			4868
505						at (MLE)	200.7					nu star (b			166.6
			М	LE Mean (, ,						LE Sd (b		,	10778
506				•						Approxi		hi Squar			137.8
507			Adius	sted Level	of Sia	nificance	0.0346					sted Chi		, ,	135
508 509			.,		- 3						-,-		- 1		
510						As	suming Gan	ma Distribu	ıtion						
511	95	5% Approxin	nate Gamma	UCL (use	when	n>=50))	28855		95% Adj	usted (amma	UCL (us	se whe	en n<50)	29442
512				•								•		<u> </u>	
513							Lognorma	GOF Test							
514			S	hapiro Wil	k Test	t Statistic	0.968		Shap	iro Will	c Logno	ormal GC	OF Te	st	
515			5% S	hapiro Will	k Critic	cal Value	0.892		Data appea	r Logno	rmal at	5% Sigr	nifican	ce Level	
516				Lilliefor	s Test	t Statistic	0.11		Lill	iefors L	.ognorr	nal GOF	Test		
517			5	% Lilliefors	s Critic	cal Value	0.207		Data appea	r Logno	rmal at	5% Sigr	nifican	ce Level	
518					Dat	ta appea	Lognormal	at 5% Signi	ficance Leve	I					
519															
520							Lognorma	l Statistics							
521				Minimum o	of Log	ged Data	9.025					Mean	of logg	ed Data	9.993
522			N	Maximum o	of Log	ged Data	10.68					SD	of logg	ed Data	0.446
523															
524						Assı	uming Logno	rmal Distrib	oution						
525					959	% H-UCL	30127			(90% Ch	nebyshev	/ (MVL	JE) UCL	31993
526			95%	Chebyshe	v (MV	UE) UCL	35613			97	.5% Cr	nebyshev	/ (MVL	JE) UCL	40638
527			99%	Chebyshe	v (MV	UE) UCL	50508								
528							•								
529					No	onparame	etric Distribu	tion Free U	CL Statistics						
530				Data app	ear to	follow a	Discernible	Distribution	at 5% Signif	icance	Level				
531															
532						•	rametric Dis	tribution Fre	e UCLs						
533					95% (CLT UCL	27776					95% .	Jackkr	nife UCL	28017
534				Standard		<u> </u>								p-t UCL	28323
535				5% Hall's		<u> </u>				g	5% Pe	rcentile E	Bootsti	rap UCL	27759
536				95% BCA		<u> </u>									
537				ebyshev(N	,	,						yshev(M			34239
538			97.5% Ch	ebyshev(N	Mean,	Sd) UCL	38730			999	% Cheb	yshev(M	lean, S	Sd) UCL	47553
539															
540								UCL to Use)						
541				95% S	Studen	it's-t UCL	28017								
542														050/	
543	N	lote: Sugges							lp the user to				priate 9	95% UCI	L.
544		- .							distribution, a					(0000)	
545									ies summariz					. ,	
546	Hov	wever, simul	ations result	s will not c	over a	all Real W	orld data se	ts; tor addition	onal insight th	ne user	may wa	ant to co	nsult a	statistic	ıan.
547															
548															

	A B C D E	F	G H I J K	L
549	Lead			
550				
551		General	Statistics	
552	Total Number of Observations	17	Number of Distinct Observations	16
553			Number of Missing Observations	0
554	Minimum	7.6	Mean	29.15
555	Maximum	96.7	Median	16.1
556	SD	26.81	Std. Error of Mean	6.502
557	Coefficient of Variation	0.92	Skewness	1.681
558			-	
559		Normal C	GOF Test	
560	Shapiro Wilk Test Statistic	0.73	Shapiro Wilk GOF Test	
561	5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level	
562	Lilliefors Test Statistic	0.285	Lilliefors GOF Test	
563	5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level	
564	Data Not	Normal at 5	% Significance Level	
565				
566	Ass	suming Norr	nal Distribution	
567	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
568	95% Student's-t UCL	40.5	95% Adjusted-CLT UCL (Chen-1995)	42.67
569			95% Modified-t UCL (Johnson-1978)	40.94
570				
571		Gamma (GOF Test	
572	A-D Test Statistic	1.048	Anderson-Darling Gamma GOF Test	
573	5% A-D Critical Value	0.752	Data Not Gamma Distributed at 5% Significance Leve	el
574	K-S Test Statistic	0.209	Kolmogorov-Smirnov Gamma GOF Test	
575	5% K-S Critical Value	0.212	Detected data appear Gamma Distributed at 5% Significance	e Level
576	Detected data follow App	or. Gamma l	Distribution at 5% Significance Level	
577				
578		Gamma	Statistics	
579	k hat (MLE)	1.792	k star (bias corrected MLE)	1.515
580	Theta hat (MLE)	16.27	Theta star (bias corrected MLE)	19.24
581	nu hat (MLE)	60.92	nu star (bias corrected)	51.5
582	MLE Mean (bias corrected)	29.15	MLE Sd (bias corrected)	23.68
583			Approximate Chi Square Value (0.05)	36.02
584	Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	34.67
585				
586	Ass	uming Gam	ma Distribution	
587	95% Approximate Gamma UCL (use when n>=50)	41.67	95% Adjusted Gamma UCL (use when n<50)	43.3
588	1			
589		Lognormal	GOF Test	
590	Shapiro Wilk Test Statistic	0.914	Shapiro Wilk Lognormal GOF Test	
591	5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
592	Lilliefors Test Statistic	0.178	Lilliefors Lognormal GOF Test	
593	5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level	
			at 5% Significance Level	
594		•	-	
595		Lognorma	I Statistics	
596	Minimum of Logged Data	2.028	Mean of logged Data	3.068
597	Maximum of Logged Data	4.572	SD of logged Data	0.756
598	s.iniaiii oi Loggod Data		55 51 10gg504 Data	
599				

	Α	В	С	D	Е	F	G	Н		J F	K	L
600							rmal Distrib	ution				
601					% H-UCL	44.34			90%	Chebyshev (MVUE)) UCL	44.51
602				Chebyshev (MV		51.98			97.5%	Chebyshev (MVUE)) UCL	62.34
603			99%	Chebyshev (MV	UE) UCL	82.69						
604												
605				No	onparame	tric Distribu	tion Free UC	L Statistics	}			
606				Data appear to	follow a l	Discernible	Distribution a	at 5% Signif	ficance Leve	ol		
607												
608					Nonpar	ametric Dis	tribution Fre	UCLs				
609				95%	CLT UCL	39.84				95% Jackknife		40.5
610			95%	Standard Boots	trap UCL	39.57				95% Bootstrap-	t UCL	46.17
611				95% Hall's Boots	•	40.14			95% F	Percentile Bootstrap	p UCL	39.66
612				95% BCA Boots		42.44						
613				nebyshev(Mean,	,	48.65				ebyshev(Mean, Sd)	•	57.49
614			97.5% Ch	nebyshev(Mean,	Sd) UCL	69.75			99% Ch	ebyshev(Mean, Sd)	I) UCL	93.84
615												
616							UCL to Use				1	
617			95	% Adjusted Gan	nma UCL	43.3						
618												
619				data set follows a								
620		When appl	licable, it is s	suggested to use	e a UCL ba	ased upon a	distribution (e.g., gamma	a) passing bo	oth GOF tests in Pro	oUCL	
621			- * :	Constant of the sales	f - OF0/	1101	and death and see				.0/ 1101	
622	ſ	Note: Sugges						'		nost appropriate 95	% UCL.	
623		Th		Recommendation				· · · · · · · · · · · · · · · · · · ·			(2006)	
624										Maichle, and Lee (•	
625	110	wever, Simul		is will flot cover a	ali Neai vv	ond data se	is, ioi additio	nai insigni ii	ne user may	want to consuit a si	iausucia	111.
626												
627	Lithium											
020												
629												
630						General	Statistics					
631 632			Total	Number of Obs	ervations	General	Statistics		Number	r of Distinct Observa	ations	9
633			Total	Number of Obs	ervations		Statistics			r of Distinct Observa		9
634			Total		ervations Minimum		Statistics			of Missing Observa		
			Total			17	Statistics			of Missing Observa	ations	0
			Total		Minimum	17	Statistics			of Missing Observa	ations Mean Median	0 10.94
635			Total		Minimum Maximum SD	17 6 15	Statistics			of Missing Observa	ations Mean Median	0 10.94 11
635 636			Total	Ŋ	Minimum Maximum SD	17 6 15 2.331	Statistics			of Missing Observa	Mean Median Mean	0 10.94 11 0.565
635 636 637			Total	Ŋ	Minimum Maximum SD	17 6 15 2.331 0.213	Statistics GOF Test			of Missing Observa	Mean Median Mean	0 10.94 11 0.565
635 636 637 638				Ŋ	Minimum Maximum SD Variation	17 6 15 2.331 0.213			Number	of Missing Observa	Mean Median Mean	0 10.94 11 0.565
635 636 637 638 639			S	Coefficient of	Minimum Maximum SD Variation	17 6 15 2.331 0.213		Data appe	Number	of Missing Observa M Std. Error of Skev	ations Mean Iedian Mean wness	0 10.94 11 0.565
635 636 637 638 639 640			S	Coefficient of Shapiro Wilk Tes	Minimum Maximum SD Variation t Statistic cal Value	17 6 15 2.331 0.213 Normal 0		Data appe	Number Shapiro Wi	M Std. Error of Skev	ations Mean Iedian Mean wness	0 10.94 11 0.565
635 636 637 638 639 640 641			S 5% SI	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic	17 6 15 2.331 0.213 Normal 0 0.978 0.892			Number Shapiro Wiear Normal a	M Std. Error of Skev	ations Mean Median Mean wness	0 10.94 11 0.565
635 636 637 638 639 640 641			S 5% SI	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes % Lilliefors Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207		Data appe	Number Shapiro Wiear Normal a	M Std. Error of Skev	ations Mean Median Mean wness	0 10.94 11 0.565
635 636 637 638 639 640 641 642 643			S 5% SI	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes % Lilliefors Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207	GOF Test	Data appe	Number Shapiro Wiear Normal a	M Std. Error of Skev	ations Mean Median Mean wness	0 10.94 11 0.565
635 636 637 638 639 640 641 642 643			S 5% SI	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes % Lilliefors Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207 ar Normal at	GOF Test	Data appeance Level	Number Shapiro Wiear Normal a	M Std. Error of Skev	ations Mean Median Mean wness	0 10.94 11 0.565
635 636 637 638 639 640 641 642 643 644			S 5% Si 5	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes % Lilliefors Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207 ar Normal at	GOF Test	Data appeance Level	Shapiro Wi ear Normal a Lilliefors ear Normal a	M Std. Error of Skev	ations Mean Iedian Mean wness wness Level	0 10.94 11 0.565
635 636 637 638 639 640 641 642 643			S 5% Si 5	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes '% Lilliefors Criti	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value Ass	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207 ar Normal at	GOF Test	Data appeance Level	Shapiro Wi ear Normal a Lilliefors ear Normal a	M Std. Error of Skev Ik GOF Test t 5% Significance L GOF Test t 5% Significance L	ations Mean Iedian Mean wness Level Level	0 10.94 11 0.565
635 636 637 638 639 640 641 642 643 644 645			S 5% Si 5	Coefficient of Shapiro Wilk Tes hapiro Wilk Criti Lilliefors Tes % Lilliefors Criti D	Minimum Maximum SD Variation t Statistic cal Value t Statistic cal Value Ass	17 6 15 2.331 0.213 Normal 0 0.978 0.892 0.106 0.207 ar Normal at	GOF Test	Data appeance Level	Shapiro Wi ear Normal a Lilliefors ear Normal a UCLs (Adju	M Std. Error of Skev Ik GOF Test t 5% Significance L GOF Test t 5% Significance L	Mean Mean Mean wness Level Level Mean Mean Mean Mean Mean Mean Mean Mean	0 10.94 11 0.565 -0.255

	Α		В		С		D	Е		F	G GOF Test	Н	I	J		K		L
650							Δ-D :	Test Stat	istic	0.283	101 1031	Ande	rson-Darling	Gamma G	OF T	oet .		
651							5% A-D (0.738	Detector		ar Gamma Di				nce	l evel
652								Test Stat		0.127	Dotoolog		orov-Smirno			_		
653							5% K-S (0.209	Detected		ar Gamma Di				nce	l evel
654											stributed at				070	Jigiiiiloa		
655							Dottoolog	i data ap	poui	Guillilla Di	ouribatoa at v	o /o Olgillilo	21100 20101					
656										Gamma	Statistics							
657								k hat (M	IF)	21.44			k	star (bias c	orrect	ed MLF	1	17.69
658							The	eta hat (M		0.51				star (bias c				0.618
659								nu hat (M	,	728.9				nu star (b			1	01.6
660						MLE	Mean (bia			10.94				MLE Sd (b			1	2.601
661							(4.1		/				Approximate	•				45.7
662					Adi	iuste	d Level of	Significa	nce	0.0346			• • • • • • • • • • • • • • • • • • • •	djusted Chi		, ,		40.1
663						,		- 3						,				
665									Ass	uming Gam	nma Distribu	tion						
666		95	% Approx	kimat	e Gamr	ma U	CL (use w	/hen n>=		12.06			ljusted Gamr	na UCL (us	se whe	en n<50))	12.19
667							•						-	•				
668										Lognorma	I GOF Test							
669						Sha	piro Wilk	Test Stat	istic	0.945		Sha	oiro Wilk Log	normal G	OF Te	est		
670					5%	Sha	piro Wilk (Critical Va	alue	0.892		Data appea	ar Lognormal	at 5% Sigr	nifican	nce Leve		
671							Lilliefors	Test Stat	istic	0.138		Lil	liefors Logno	ormal GOF	Test			
672						5%	Lilliefors (Critical Va	alue	0.207		Data appea	ar Lognormal	at 5% Sigr	nifican	nce Leve	ı	
673								Data ap	oear	Lognormal	at 5% Signif	icance Leve	əl					
674																		
675										Lognorma	I Statistics							
676						Mi	nimum of	Logged [ata	1.792				Mean	of logo	ged Data	1	2.369
677						Ма	ximum of	Logged D)ata	2.708				SD	of logo	ged Data	,	0.23
678																		
679								-	Assu	ming Logno	ormal Distrib	ution						
680								95% H-l	JCL	12.18			90%	Chebyshev	/ (MVI	UE) UCL	Т	12.8
681					959	% Ch	ebyshev	(MVUE) l	JCL	13.64			97.5%	Chebyshev	/ (MVI	UE) UCL	_	14.8
682					999	% Cr	ebyshev	(MVUE) l	JCL	17.08							\top	
683																		-
684								Nonpar	ame	tric Distribu	tion Free UC	CL Statistics	;					
685						D	ata appea	r to follo	wal	Discernible	Distribution	at 5% Signi	ficance Leve	el				
686																		
687								No	npar	ametric Dis	tribution Fre	e UCLs						
688							9!	5% CLT I	JCL	11.87				95% .	Jackkı	nife UCL		11.93
689					95	% St	andard Bo	ootstrap l	JCL	11.84				95% Bo	ootstra	ap-t UCL		11.88
690						95%	6 Hall's Bo	ootstrap l	JCL	11.87			95% F	Percentile I	Bootst	rap UCL	1	11.82
691						95	% BCA Bo	ootstrap l	JCL	11.76								
692					90% (Cheb	yshev(Me	an, Sd) l	JCL	12.64			95% Ch	ebyshev(M	lean,	Sd) UCL	_	13.41
693					97.5% (Cheb	yshev(Me	an, Sd) l	JCL	14.47			99% Ch	ebyshev(M	lean,	Sd) UCL	_	16.57
694																		
695										Suggested	UCL to Use							
696							95% Stu	ıdent's-t l	JCL	11.93								
697																		
698		N	ote: Sugg	estic	ns rega						ovided to hel	-			priate	95% UC	L.	
699											ta size, data							
700								-			nulation studi						•	
701		How	vever, sim	nulati	ons resi	ults v	vill not cov	er all Re	al W	orld data se	ts; for additio	nal insight t	he user may	want to co	nsult a	a statistic	cian.	
702																		'
703			Note: Fo				•				(e.g., Chen,					y not be		
704					reliable.	. Ch	en's and	Johnson'	s me	thods provi	de adjustme	nts for posi	tvely skewed	d data sets	s			

	A B C D E	F	G H I J K	1
705		•		
706				
707	Manganese			
708				
709		General	Statistics	
710	Total Number of Observations	17	Number of Distinct Observations	16
711			Number of Missing Observations	0
712	Minimum	451	Mean	1331
713	Maximum	2940	Median	1160
714	SD	597.8	Std. Error of Mean	145
715	Coefficient of Variation	0.449	Skewness	1.058
716				
717		Normal (GOF Test	
718	Shapiro Wilk Test Statistic	0.92	Shapiro Wilk GOF Test	
719	5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level	
720	Lilliefors Test Statistic	0.142	Lilliefors GOF Test	
721	5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level	
722	Data appe	ar Normal a	5% Significance Level	
723				
724		suming Nor	nal Distribution	
725	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
726	95% Student's-t UCL	1584	, , , ,	1609
727			95% Modified-t UCL (Johnson-1978)	1590
728				
729			GOF Test	
730	A-D Test Statistic	0.259	Anderson-Darling Gamma GOF Test	
731	5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance	ce Level
732	K-S Test Statistic	0.115	Kolmogorov-Smirnov Gamma GOF Test	
733	5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance	ce Level
734	Detected data appear	Gamma Di	stributed at 5% Significance Level	
735		Gamma	Statistics	
736	k hat (MLE)	5.467	k star (bias corrected MLE)	4.542
737	Theta hat (MLE)	243.4	Theta star (bias corrected MLE)	293
738	nu hat (MLE)	185.9	nu star (bias corrected)	154.4
739	MLE Mean (bias corrected)	1331	MLE Sd (bias corrected)	624.4
740	((Approximate Chi Square Value (0.05)	126.7
741 742	Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	124.1
742	, , , , , , , , , , , , , , , , , , , ,	<u> </u>		
743	Ass	suming Garr	ma Distribution	
745	95% Approximate Gamma UCL (use when n>=50))	1622		1656
746			·	
747		Lognorma	GOF Test	
748	Shapiro Wilk Test Statistic	0.973	Shapiro Wilk Lognormal GOF Test	
749	5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
750	Lilliefors Test Statistic	0.121	Lilliefors Lognormal GOF Test	
751	5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level	
752	Data appear	Lognormal	at 5% Significance Level	
753				
754		Lognorma	I Statistics	
755	Minimum of Logged Data	6.111	Mean of logged Data	7.099
	Maximum of Logged Data	7.986	SD of logged Data	0.456
756				

	Α	В	С	D	Е	F	G	Н	I		J		K	L
758							ormal Distrib	ution						
759					95% H-UCL						nebyshe	,	,	1790
760				Chebyshev (1996			97.	5% Cł	nebyshe	/ (MVU	E) UCL	2282
761			99%	Chebyshev (MVUE) UCL	2844								
762														
763					•		tion Free UC							
764				Data appea	r to follow a	Discernible	Distribution	at 5% Signif	ficance L	.evel				
765														
766				0.5	•		tribution Fre	e UCLS			050/			4504
767			050/		% CLT UCL	1569							ife UCL	1584
768				Standard Bo 5% Hall's Bo	·	1560 1685			05	0/ Do	95% B			1634 1565
769				95% BCA Bo	<u> </u>	1605			90) 70 PE	rcenne	DOUISII	ар ОСС	1303
770				ebyshev(Me	•	1766			95%	Cheh	yshev(N	Mean S	SA) LICI	1963
771				ebyshev(Me		2236					yshev(N		,	2773
772			37.370 011	icby3ncv(ivic	un, ou) ool	2200			3370	Once)y3ncv(n	icari, c	u) ool	2775
773						Suggested	UCL to Use							
774 775				95% Stu	dent's-t UCL	1584								
776														L
777		Note: Sugges	stions regard	ing the selec	tion of a 95%	6 UCL are pr	ovided to hel	p the user to	select th	he mo	st appro	priate 9	5% UCI	L.
778			F	Recommenda	itions are ba	sed upon da	ta size, data	distribution,	and skew	vness.				
779		These recor	nmendations	are based u	pon the resu	Its of the sin	nulation studi	es summari:	zed in Sir	ngh, N	laichle, a	and Lee	(2006)	
780	Н	owever, simu	lations result	s will not cov	er all Real W	orld data se	ts; for additio	nal insight t	he user n	nay wa	ant to co	nsult a	statistic	ian.
781														
782	Molybdeni	ım												
783														
784						General	Statistics							
785			Total	Number of C	Observations	17			Nun	nber o	f Distinc	t Obser	vations	2
786					er of Detects	1					lumber o			16
787			Nu	umber of Dis	tinct Detects	1			Nur	mber o	of Distino	ct Non-	Detects	1
788							,							
789		Warning: Onlessed to use	•				• •	•						
790	it is suggi	esteu to use	aiterriative s	ite specific v	alues deteri	illilea by the	e Project rea	iii to estiilia	ate envir	onne	ıtaı para	meters	, (e.g., c	:PC, БТV).
791				The	data set for	variable Mo	lybdenum wa	s not proce	esedi					
792				1110	data oot ioi	variable ivio	iybaonam we	io not proce						
793 794														
795 796	Nickel													
797														
798						General	Statistics							
799			Total	Number of C	Observations	17			Num	nber o	f Distinc	t Obser	vations	13
800									Num	ber o	f Missing	Obser	vations	0
801					Minimum	6							Mean	24.53
802					Maximum	69							Median	23
803					SD	17.28					Std.	Error o	of Mean	4.19
804				Coefficient	of Variation	0.704						Sk	ewness	1.555
805														
806							GOF Test							
807				hapiro Wilk					Shapiro					
808			5% SI	hapiro Wilk C		0.892		Data No	t Normal				evel	
809			-		Test Statistic			D-4- *1			OF Test		01/61	
810			5	% Lilliefors C		0.207	EO/ Clamific -		t Normal	at 5%	Signific	ance L	evel	
811					Data Not	Normal at t	5% Significa	ice Level						
812														

	A B C D E	F numing Nor	G H I J K mal Distribution	L
813	95% Normal UCL	sulling Non	95% UCLs (Adjusted for Skewness)	
814	95% Student's-t UCL	31.85	95% Adjusted-CLT UCL (Chen-1995)	33.11
815 816			95% Modified-t UCL (Johnson-1978)	32.11
817			\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	
818		Gamma	GOF Test	
819	A-D Test Statistic	0.428	Anderson-Darling Gamma GOF Test	
820	5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance	e Level
821	K-S Test Statistic	0.141	Kolmogorov-Smirnov Gamma GOF Test	
822	5% K-S Critical Value	0.211	Detected data appear Gamma Distributed at 5% Significance	e Level
823	Detected data appear	Gamma Di	stributed at 5% Significance Level	
824				
825			Statistics	0.470
826	k hat (MLE)	2.598	k star (bias corrected MLE)	2.179
827	Theta hat (MLE)	9.441 88.34	Theta star (bias corrected MLE)	11.26 74.09
828	nu hat (MLE) MLE Mean (bias corrected)	24.53	nu star (bias corrected) MLE Sd (bias corrected)	16.62
829	WLL Wear (bias corrected)	24.55	Approximate Chi Square Value (0.05)	55.26
830	Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	53.56
831 832	,			
833	Ass	suming Gan	nma Distribution	
834	95% Approximate Gamma UCL (use when n>=50)	32.88	95% Adjusted Gamma UCL (use when n<50)	33.93
835				
836		Lognorma	I GOF Test	
837	Shapiro Wilk Test Statistic	0.97	Shapiro Wilk Lognormal GOF Test	
838	5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
839	Lilliefors Test Statistic	0.146	Lilliefors Lognormal GOF Test	
840	5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level	
841	Data appear	Lognormal	at 5% Significance Level	
842			I Chabinting	
843	Minimum of Logged Data	1.792	Il Statistics Mean of logged Data	2.995
844	Maximum of Logged Data	4.234	SD of logged Data	0.655
845	Maximum of Edggod Buta	1.201	OD of logged Data	
846 847	Assu	ımina Loand	ormal Distribution	
848	95% H-UCL	35.56	90% Chebyshev (MVUE) UCL	36.68
849	95% Chebyshev (MVUE) UCL	42.24	97.5% Chebyshev (MVUE) UCL	49.95
850	99% Chebyshev (MVUE) UCL	65.1		
851				
852	Nonparame	tric Distribu	tion Free UCL Statistics	
853	Data appear to follow a l	Discernible	Distribution at 5% Significance Level	
854			Adhesian Francisco	
855	· .		tribution Free UCLs	21.05
856	95% CLT UCL	31.42	95% Jackknife UCL	31.85
857	95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL	44.26	95% Bootstrap-t UCL 95% Percentile Bootstrap UCL	31.47
858	95% BCA Bootstrap UCL	32.12	33 % Fercentile bootstrap OCL	J1. 1 /
859	90% Chebyshev(Mean, Sd) UCL	37.1	95% Chebyshev(Mean, Sd) UCL	42.8
860 861	97.5% Chebyshev(Mean, Sd) UCL	50.7	99% Chebyshev(Mean, Sd) UCL	66.22
862	, , , , , , , , , , , , , , , , , , , ,		, , , , , , , , , , , , , , , , , , , ,	
863		Suggested	UCL to Use	
864	95% Adjusted Gamma UCL	33.93		
865				
866	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
867	Recommendations are bas	sed upon da	a size, data distribution, and skewness.	
868			nulation studies summarized in Singh, Maichle, and Lee (2006).	
869	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statistician	ก.

	A B C D E	F	G	Н	ı	J	K	L
870								
871								
872	Strontium							
873								
874		General	Statistics					
875	Total Number of Observations	17			Number	r of Distinct Ob	servations	14
876					Number	of Missing Ob	servations	0
877	Minimum	9					Mean	29.18
878	Maximum	78					Median	21
879	SD	19.99				Std. Err	or of Mean	4.849
880	Coefficient of Variation	0.685					Skewness	1.635
881								
882		Normal C	OF Test					
883	Shapiro Wilk Test Statistic	0.752			•	ilk GOF Test		
884	5% Shapiro Wilk Critical Value	0.892		Data No		5% Significand	e Level	
885	Lilliefors Test Statistic	0.327				GOF Test		
886	5% Lilliefors Critical Value	0.207			Normal at	5% Significand	e Level	
887	Data Not	Normal at 5	% Significa	nce Level				
888								
889		suming Norr	nal Distribut					
890	95% Normal UCL					sted for Skew	•	
891	95% Student's-t UCL	37.64			•	ed-CLT UCL (C		39.21
892					95% Modifie	ed-t UCL (Johr	nson-1978)	37.96
893								
894			GOF Test					
895	A-D Test Statistic	1.046				Gamma GOF		
896	5% A-D Critical Value	0.745	D			ted at 5% Signi		/el
897	K-S Test Statistic	0.252				ov Gamma GC		
898	5% K-S Critical Value	0.211				ted at 5% Signi	ificance Lev	/el
899	Data Not Gami	ma Distribute	ed at 5% Sig	nificance Le	vel			
900								
901		Gamma	Statistics					
902	k hat (MLE)	3.063				star (bias corre		2.562
903	Theta hat (MLE)	9.525			Theta	star (bias corre		11.39
904	nu hat (MLE)	104.1				nu star (bias		87.1
905	MLE Mean (bias corrected)	29.18				MLE Sd (bias		18.23
906	A.F	0.0040		<i>,</i>		Chi Square V	, ,	66.59
907	Adjusted Level of Significance	0.0346			AC	djusted Chi Sq	uare value	64.71
908	A	mina Com	ma Diatribu	tion				
909		suming Gam 38.17	ma Distribu		ata d Cama	LICL /	.h	39.27
910	95% Approximate Gamma UCL (use when n>=50))	38.17		95% Auj	usted Gami	na UCL (use w	vnen n<50)	39.27
911		Lognormal	COE Toot					
912	Shapiro Wilk Test Statistic	0.917	GOF 1681	Chan	iro Wilk I oc	normal GOF	Toot	
913	·			•		-		
914	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.892 0.21				at 5% Signific		
915	5% Lilliefors Critical Value	0.21				t 5% Significar		
916	Data appear Appro		ormal at 5%			. 0 /o Olgi IIIICal	IOC FEAGI	
917	раца арреаі Арріо	ato Logi	.c.mar at 0 //	. JigiiiiiGailG				
918		Lognorma	Statistics					
919	Minimum of Logged Data	2.197				Mean of lo	aged Data	3.201
920	Maximum of Logged Data	4.357					gged Data	0.575
921							55.2.24.4	
922	Assi	ıming Logno	rmal Distrib	ution				
923	95% H-UCL	39.27		-	90%	Chebyshev (M	IVUE) UCL	41.17
924 925	95% Chebyshev (MVUE) UCL	46.83				Chebyshev (M		54.69
925	99% Chebyshev (MVUE) UCL	70.13			<u> </u>	, - (,	
927	, , , , , , , , , , , , , , , , , , , ,	<u> </u>						
927	Nonparame	etric Distribu	tion Free UC	CL Statistics				
929	Data appear to follow a				icance Leve	əl		
930								
931	Nonpa	rametric Dist	ribution Fre	e UCLs				
932	95% CLT UCL	37.15				95% Jack	kknife UCL	37.64
933	95% Standard Bootstrap UCL	36.92				95% Boots		42.34
934	95% Hall's Bootstrap UCL	36.97			95% I	Percentile Boo		37.88
334		l						

	A B C D E	F	G H I J K	L
935	95% BCA Bootstrap UCL	39.71		
936	90% Chebyshev(Mean, Sd) UCL	43.72	95% Chebyshev(Mean, Sd) UCL	50.31
937	97.5% Chebyshev(Mean, Sd) UCL	59.46	99% Chebyshev(Mean, Sd) UCL	77.42
938	,		•	
939		Suggested	JCL to Use	
940	95% H-UCL	39.27		
941				
942	Note: Suggestions regarding the selection of a 95%	UCL are pro	vided to help the user to select the most appropriate 95% UCL.	
943	Recommendations are bas	ed upon data	a size, data distribution, and skewness.	
944	•		ulation studies summarized in Singh, Maichle, and Lee (2006).	
945	However, simulations results will not cover all Real W	orld data set	s; for additional insight the user may want to consult a statisticia	in.
946				
947			based UCLs for historical reasons only.	
948	· · · · · · · · · · · · · · · · · · ·		es of UCL95 as shown in examples in the Technical Guide.	
949			ne use of H-statistic based 95% UCLs.	
950	Use of nonparametric methods are preferred to com	pute UCL95	for skewed data sets which do not follow a gamma distribution	on.
951				
952				
953	Vanadium			
954			N. H. d.	
955	Tatal Name to a Change time	General S		10
956	Total Number of Observations	17	Number of Distinct Observations	16
957	Minimum	00	Number of Missing Observations	0
958	Minimum	26 100	Mean	56.65 51
959	Maximum SD	21.94	Median Std. Error of Mean	5.321
960	Coefficient of Variation	0.387	Skewness	0.445
961	Coefficient of Variation	0.367	Skewiiess	0.443
962		Normal G	OF Test	
963	Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test	
964	5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level	
965	Lilliefors Test Statistic	0.172	Lilliefors GOF Test	
966 967	5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level	
968	Data appea	r Normal at	5% Significance Level	
969	<u> </u>		·	
970	Ass	suming Norn	nal Distribution	
971	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
972	95% Student's-t UCL	65.94	95% Adjusted-CLT UCL (Chen-1995)	66.01
973			95% Modified-t UCL (Johnson-1978)	66.03
974				
975		Gamma C	GOF Test	
976	A-D Test Statistic	0.232	Anderson-Darling Gamma GOF Test	
977	5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance	e Level
978	K-S Test Statistic	0.126	Kolmogorov-Smirnov Gamma GOF Test	
979	5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance	e Level
980	Detected data appear	Gamma Dis	tributed at 5% Significance Level	
981				

	A B C D E I	F	G	Н			J		K		L
982			Statistics								
983	k hat (MLE)	6.928				k sta	ır (bias	correct	ted MLE)	5.	745
984	Theta hat (MLE)	8.177			The	eta sta	r (bias	correct	ted MLE)	9.	.861
985	nu hat (MLE)	235.6				r	nu star	(bias c	orrected)	195	5.3
986	MLE Mean (bias corrected)	56.65				M	ILE Sd	(bias c	orrected)	23	3.63
987				,	Approxin	nate C	hi Squa	are Val	ue (0.05)	164	
988	Adjusted Level of Significance	0.0346				Adju	sted Ch	ni Squa	are Value	161	
989										1	
990	Ass	uming Gan	nma Distribu	tion							
991	95% Approximate Gamma UCL (use when n>=50))	67.47		95% Ad	justed G	amma	UCL (ı	use wh	en n<50)	68	3.73
992											
993		Lognorma	I GOF Test								
994	Shapiro Wilk Test Statistic	0.961		Shap	iro Wilk	Logno	ormal G	OF Te	est		
995	5% Shapiro Wilk Critical Value	0.892		Data appea	r Lognor	mal at	t 5% Siç	gnificar	nce Leve	I	
996	Lilliefors Test Statistic	0.0998		Lill	iefors Lo	ognori	mal GO	F Test	t		
997	5% Lilliefors Critical Value	0.207		Data appea	r Lognor	mal at	t 5% Siç	gnificar	nce Leve	I	
998	Data appear	Lognormal	at 5% Signi	icance Leve	l						
999											
1000		Lognorma	al Statistics								
1001	Minimum of Logged Data	3.258							ged Data		.963
1002	Maximum of Logged Data	4.605					SD	of log	ged Data	0.	404
1003											
1004	Assu	ming Logno	ormal Distrib	ution							
1005	95% H-UCL	69.47			9	0% Cł	nebyshe	ev (MV	UE) UCL	. 73	1.85
1006	95% Chebyshev (MVUE) UCL	81.58			97.	5% Cł	nebyshe	ev (MV	UE) UCL	. 92	2.31
1007	99% Chebyshev (MVUE) UCL	113.4									
1008											
1009	<u> </u>		ition Free UC								
1010	Data appear to follow a [Discernible	Distribution	at 5% Signif	icance L	_evel					
1011			=								
1012	<u> </u>		tribution Fre	e UCLs							
1013	95% CLT UCL	65.4							nife UCL		5.94
1014	95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL	65.26			0.0	-0/ D-			ap-t UCL trap UCL		5.91
1015	95% BCA Bootstrap UCL	65.64 65.53			90	5% Pe	rcentile	BOOKS	пар ОСЕ	. 00	5.18
1016	90% Chebyshev(Mean, Sd) UCL	72.61									0.0
1017					0E0/	Chak	wobow/	Maan	64) I ICI	70	.04
	• • • •						, ,		Sd) UCL	. 79	6
1018	97.5% Chebyshev(Mean, Sd) UCL	89.88					, ,		Sd) UCL	. 79	0.6
1018 1019	97.5% Chebyshev(Mean, Sd) UCL	89.88	LICI to lise				, ,				0.6
1018 1019 1020	97.5% Chebyshev(Mean, Sd) UCL	89.88	UCL to Use				, ,				0.6
1018 1019 1020 1021	97.5% Chebyshev(Mean, Sd) UCL	89.88 Suggested	UCL to Use				, ,				0.6
1018 1019 1020 1021 1022	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL	89.88 Suggested 65.94		p the user to	99%	6 Chek	pyshev(Mean,	Sd) UCL	. 109	0.6
1018 1019 1020 1021 1022 1023	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95%	89.88 Suggested 65.94 UCL are pr	ovided to he	•	99%	6 Cheb	pyshev(Mean,	Sd) UCL	. 109	0.6
1018 1019 1020 1021 1022 1023 1024	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are bas	Suggested 65.94 UCL are preded upon date	ovided to he	distribution,	99% select to	he mo	pyshev(Mean,	Sd) UCL	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	Suggested 65.94 UCL are priced upon datasets of the sim	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are bas	Suggested 65.94 UCL are priced upon datasets of the sim	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	Suggested 65.94 UCL are priced upon datasets of the sim	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	Suggested 65.94 UCL are priced upon datasets of the sim	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	Suggested 65.94 UCL are priced upon datasets of the sim	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	89.88 Suggested 65.94 UCL are project upon data set orld data set	rovided to he ta size, data nulation studi	distribution, a	99% select to and skew zed in Si	he mo	st appro	Mean,	95% UC	109	0.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul	89.88 Suggested 65.94 UCL are project upon data set orld data set	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev zed in Si ne user r	6 Cheb	est appro-	Mean, opriate and Le	95% UC	109 EL.	
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real We	89.88 Suggested 65.94 UCL are predupon datased upon dat	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	Mean, opriate and Le onsult	95% UCL	109 EL.	
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032 1033	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real We	89.88 Suggested 65.94 UCL are predupon datased upon dat	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	Mean, opriate and Le onsult	95% UCL 95% UCCee (2006 a statistic	109 LL.). cian.	
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032 1033 1034	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real William (State of Control of Contro	89.88 Suggested 65.94 UCL are prized upon datased upon	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	Mean, opriate and Le onsult	95% UCL 95% UCCee (2006 a statistic	109 L). Cician.	6.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032 1033 1034 1035	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real W. Total Number of Observations Minimum	89.88 Suggested 65.94 UCL are prized upon datats of the simorld data see General 17	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	mean, popriate and Le consult	95% UCL 95% UCCee (2006 a statistic	109 109 101 101	6.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032 1033 1034 1035 1036	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real W. Total Number of Observations Minimum Maximum	89.88 Suggested 65.94 UCL are project upon datats of the simoral data see General 17 39 329	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	Mean, ppriate and Le and Le ct Obse	95% UCL 95% UCCee (2006 a statistic	109 109 101 101 101 118	3.6
1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 Zinc 1030 1031 1032 1033 1034 1035	97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resul However, simulations results will not cover all Real Western Students of Chebrology Total Number of Observations Minimum Maximum SD	89.88 Suggested 65.94 UCL are project upon datasts of the simoorld data see General 17 39 329 76.38	rovided to he ta size, data nulation studi tts; for additio	distribution, a	99% select t and skev red in Si ne user r	6 Cheb	est appro-	Mean, ppriate and Le and Le ct Obse	95% UCL 95% UCCee (2006 a statistic	109 109 101 101 101 118	3.6

	A B C D E	F	G	Н	I	J K	L
1039	· · · · · · · · · · · · · · · · · · ·	Normal (GOF Test				
1040	Shapiro Wilk Test Statistic	0.827			Shapiro Wi	lk GOF Test	
1041	5% Shapiro Wilk Critical Value	0.892		Data No	Normal at	5% Significance Level	
1042	Lilliefors Test Statistic	0.219			Lilliefors	GOF Test	
1043	5% Lilliefors Critical Value	0.207			Normal at	5% Significance Level	
1044	Data Not	Normal at 5	5% Significar	nce Level			
1045							
1046		suming Nor	mal Distribut				
1047	95% Normal UCL	455.0				isted for Skewness)	1010
1048	95% Student's-t UCL	155.9			•	ed-CLT UCL (Chen-1995) ed-t UCL (Johnson-1978)	
1049					95%	ed-t OCL (Johnson-1978)	157.1
1050		Gamma	GOF Test				
1051	A-D Test Statistic		1001 1001	Ander	son-Darling	Gamma GOF Test	
1052 1053	5% A-D Critical Value	0.744	Detected			istributed at 5% Significa	nce Level
1053	K-S Test Statistic	0.161		Kolmogo	orov-Smirno	ov Gamma GOF Test	
1055	5% K-S Critical Value	0.21	Detected	data appea	r Gamma Di	istributed at 5% Significa	nce Level
1056	Detected data appear	r Gamma Di	istributed at !	5% Significa	nce Level		
1057							
1058		Gamma	Statistics				
1059	k hat (MLE)					star (bias corrected MLE)	
1060	Theta hat (MLE)	35.22			Theta	star (bias corrected MLE)	
1061	nu hat (MLE)					nu star (bias corrected)	
1062	MLE Mean (bias corrected)	123.6				MLE Sd (bias corrected)	
1063	Adjusted Level of Significance	0.0346		<i>,</i>	• •	Chi Square Value (0.05)	
1064	Adjusted Level of Significance	0.0340			AC	njusteu Cili Square Value	75.55
1065	Ass	sumina Gam	nma Distribut	tion			
1066 1067	95% Approximate Gamma UCL (use when n>=50)				usted Gamr	na UCL (use when n<50)	163
1067	.,						
1069		Lognorma	I GOF Test				
1070	Shapiro Wilk Test Statistic	0.962		Shap	iro Wilk Log	normal GOF Test	-
1071	5% Shapiro Wilk Critical Value	0.892			•	at 5% Significance Leve	ī
1072	Lilliefors Test Statistic	0.127				ormal GOF Test	
1073	5% Lilliefors Critical Value	0.207			•	at 5% Significance Leve	1
1074	Data appear	Lognormal	at 5% Signif	icance Leve	l		
1075							
1076	Minimum of Logged Data	3.664	al Statistics			Mean of logged Data	4.668
1077	Maximum of Logged Data	5.796				SD of logged Data	
1078 1079	Maximum of Logged Bata	0.700				OD 01 logged Date	0.017
1079	Assı	uming Logno	ormal Distrib	ution			
1081	95% H-UCL	164.3			90%	Chebyshev (MVUE) UCL	. 173
1082	95% Chebyshev (MVUE) UCL	195.9			97.5%	Chebyshev (MVUE) UCL	. 227.7
1083	99% Chebyshev (MVUE) UCL	290.1					
1084							
1085	<u>-</u>		Ition Free UC				
1086	Data appear to follow a	uscernible	Distribution	at 5% Signif	cance Leve	el .	
1087	Nonna	romotrio Die	tribution Fre	o LICL o			
1088	95% CLT UCL	154.1		e octs		95% Jackknife UCL	155.9
1089	95% Standard Bootstrap UCL	153				95% Bootstrap-t UCL	
1090	95% Hall's Bootstrap UCL	164.3			95% I	Percentile Bootstrap UCL	
1091	95% BCA Bootstrap UCL	161.2					1
1093	90% Chebyshev(Mean, Sd) UCL	179.2			95% Ch	nebyshev(Mean, Sd) UCL	204.3
1094	97.5% Chebyshev(Mean, Sd) UCL	239.3			99% Ch	nebyshev(Mean, Sd) UCL	. 307.9
1095							
1096			UCL to Use				
1097	95% Adjusted Gamma UCL	163					
1098	Notes Occasion in the control of the	/ LIO!		- 41	1		<u> </u>
1099	Note: Suggestions regarding the selection of a 95%						L.
1100	Recommendations are based upon the resu)
1101	However, simulations results will not cover all Real W					*	
1102		36	, addid	orgrit ti	acoi may		
1103							

			_	_								1		
_	Α	В		С	D	E UCL Statis	F tics for Data	G Sets with N	H Ion-Detects	ı	J	K		L
1						OOL Oldie		0000 11101 11	10.11 20.00.00					
2		User Sel	lected	Ontions										
3	Date	/Time of (•	ProLICL 5.1	11/15/2018 8	:38:55 AM							
4	Date	7111110 01 0		m File	WorkSheet.		7.00.00 AW							
5		F	ull Pre		OFF	A10								
6		Confidence			95%									
7	Number of				2000									
8	Number of	Вооізпар	p Open	alions	2000									
9														
10	Al													
11	AI .													
12							Conoral	Statistics						
13				Total	Number of C	hearyations	15	otationics		Numbo	r of Dictinat	Observations	12)
14				Total	Number of C	Diservations	15					Observations		-
15						Minimum	7190			Number	OI WIISSING			75
16						Maximum	14300					Mean Median		
17		Ma					1828				C+-1			
18		Coefficient of Va									Sta.	Error of Mean		
19					Coemicient	or variation	0.17					Skewness	-0.	269
20							Name at 6	00F T4						
21					h : \ \ \ /: .	C+-+:-+:-		GOF Test		Ohanina Wi	U- 005 T-			
22					hapiro Wilk T		0.97		Data	Shapiro Wi				
23				5% Sr	napiro Wilk C		0.881		Data appe			cance Level		
24						est Statistic	0.136		D.I.		GOF Test			
25				5	% Lilliefors C		0.22	F0/ O!!#-		ar Normai a	t 5% Signifi	cance Level		
26						Data appe	ar Normal at	5% Signific	ance Level					
27							aumalma Nam	nal Distribut	Nam.					
28				OEO/ No	rmal UCL	AS	suming Non	nai Distribui			atad fan Cle	·		
29				90% NO		dent's-t UCL	11607			UCLs (Adju		. (Chen-1995)	115	17
30					95% 510	ueni s-i ocl	11007		;			ohnson-1978)		
31										95% MOUIII	ea-i OCL (Ji	01115011-1976)	1100)
32							Gommo	GOF Test						
33					A D T	Fest Statistic	0.365	GOF TEST	Andor	son-Darling	Commo C	OF Toot		
34						critical Value	0.735	Dataata				5% Significa		ı al
35						Test Statistic	0.735	Detecte		orov-Smirno		-	ice Le	v CI
36						ritical Value	0.15	Datasta				5% Significa	nce I a	vol
37									u uata appea 5% Significa		on buttu at	o /o oigiiiicai	ICE LE	v C1
38					Detected	uata appea	Gamma Di	aumurea at :	o /o olyllilical	ICE LEVEI				
39							Commo	Statistics						
40						k hat (MLE)	35.01	Ciausucs		le.	etar (biac a	orrected MLE	20	3.05
41					The	ta hat (MLE)	307.8				•	orrected MLE)	384	
42						nu hat (MLE)	1050			ineta	•	ias corrected)	841	
43				R A I	E Mean (bia	. ,	1050				`	ias corrected)	203	
44				IVIL	-r mean (nia	is corrected)	10773			Annrovimete	•	e Value (0.05)	775	
45				۸ ما:، ۰ -	ted Level of	Cianificans -	0.0324					Square Value		
46				Aajus	teu Level of	orgrinicance	0.0324			A	ajustea CNI	oquare value	/6/	r.5
47						A -	aumina Osaa	ma Distrik	tion					
48	25	0/ 4		0	HOL / 1		suming Gam	ına Distribu			1101 /	b : :50\	140	17
49	95	% Approx	xımate	Gamma	UCL (use w	nen n>=50))	11697		95% Ad	justed Gami	ma UCL (us	e when n<50)	118	1/
50														

	Α	В	С	D	E	F	G	Н	I	J K	L
51						Lognorma	GOF Test				
52			Sł	hapiro Wilk To	est Statistic	0.947		Shap	oiro Wilk Log	normal GOF Test	
53			5% Sh	napiro Wilk Cr	ritical Value	0.881		Data appea	r Lognormal	at 5% Significance Level	
54				Lilliefors To	est Statistic	0.157		Lil	liefors Logno	ormal GOF Test	
			5°	% Lilliefors Cr	ritical Value	0.22				at 5% Significance Level	
55							at 5% Signif				
56					Jata appear	Logiloilliai	at 5 % Olgilli	icance Leve	,1		
57											
58							l Statistics				
59			N	Minimum of Lo	ogged Data	8.88				Mean of logged Data	9.271
60			M	Maximum of Lo	ogged Data	9.568				SD of logged Data	0.179
61											
62					Assu	ıming Logno	rmal Distrib	ution			
63				9	95% H-UCL	11759			90%	Chebyshev (MVUE) UCL	12280
64			95% (Chebyshev (N	NVUE) UCL	12959			97.5%	Chebyshev (MVUE) UCL	13901
				Chebyshev (N	,	15753				, , ,	
65					, , , , ,						
66					Namaanana	ania Diaanikaa	Van Fran III	N Otatiatiaa			
67					-		tion Free UC				
68				Data appear	to follow a	Discernible	Distribution	at 5% Signif	icance Leve	l	
69											
70					•		tribution Fre	e UCLs			
71				959	% CLT UCL	11552			-	95% Jackknife UCL	11607
72			95%	Standard Boo	otstrap UCL	11540				95% Bootstrap-t UCL	11554
73				5% Hall's Boo	otstrap UCL	11533			95% F	Percentile Bootstrap UCL	11497
74			ć	95% BCA Boo	otstrap UCL	11480				•	
75				ebyshev(Mea	'	12192			95% Ch	nebyshev(Mean, Sd) UCL	12833
				ebyshev(Mea	, ,	13724				nebyshev(Mean, Sd) UCL	15473
76				CDy3HCV(IVICA	iii, ou) ool	10724			3370 011	icbysnev(weari, ou) ool	10470
77						0					
78							UCL to Use				
79				95% Stud	lent's-t UCL	11607					
80											
81		Note: Sugge	stions regardi	ing the select	tion of a 95%	UCL are pro	ovided to hel	p the user to	select the m	ost appropriate 95% UC	
UΙ											
82			R	Recommendat	tions are bas		a size, data (distribution, a	and skewnes	S.	
		These recor				sed upon dat				s. Maichle, and Lee (2006)	
82 83	Н		mmendations	are based up	pon the resu	sed upon dat	ulation studi	es summariz	ed in Singh,		
82 83 84	Н		mmendations	are based up	pon the resu	sed upon dat	ulation studi	es summariz	ed in Singh,	Maichle, and Lee (2006)	
82 83 84 85	Н	owever, simu	mmendations ılations results	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim orld data set	ulation studi	es summariz	zed in Singh, ne user may	Maichle, and Lee (2006)	
82 83 84 85 86	Н	owever, simu	mmendations ulations results highly negati	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim Yorld data set	ulation studits; for addition	es summariz nal insight th	ed in Singh, ne user may v	Maichle, and Lee (2006) want to consult a statistic nd Gamma) may not be	
82 83 84 85 86 87	Н	owever, simu	mmendations ulations results highly negati	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim Yorld data set	ulation studits; for addition	es summariz nal insight th	ed in Singh, ne user may v	Maichle, and Lee (2006) want to consult a statistic nd Gamma) may not be	
82 83 84 85 86 87 88		owever, simu	mmendations ulations results highly negati	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim Yorld data set	ulation studits; for addition	es summariz nal insight th	ed in Singh, ne user may v	Maichle, and Lee (2006) want to consult a statistic nd Gamma) may not be	
82 83 84 85 86 87 88	H	owever, simu	mmendations ulations results highly negati	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim Yorld data set	ulation studits; for addition	es summariz nal insight th	ed in Singh, ne user may v	Maichle, and Lee (2006) want to consult a statistic nd Gamma) may not be	
82 83 84 85 86 87 88 89		owever, simu	mmendations ulations results highly negati	s are based up s will not cove	pon the resu er all Real W	sed upon dat Its of the sim orld data set dence limits ethods provi	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	ed in Singh, ne user may v	Maichle, and Lee (2006) want to consult a statistic nd Gamma) may not be	
82 83 84 85 86 87 88 89 90		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Jo	oon the resu er all Real W data, confid ohnson's me	sed upon dat Its of the sim forld data set dence limits ethods provi	ulation studits; for addition	es summariz nal insight th	red in Singh, ne user may v ognormal, ar vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be data sets.	ian.
82 83 84 85 86 87 88 89 90 91		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je	pon the resurer all Real Wilder all Aconfidence ohnson's me	sed upon dat Its of the sim forld data set dence limits ethods provi	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, ar vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be data sets.	ian.
82 83 84 85 86 87 88 89 90		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Number	pon the resurer all Real Wilder all Real Wilder and data, confident ohnson's me	sed upon dat Its of the sim forld data set dence limits ethods provi General 15 8	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be data sets. r of Distinct Observations Number of Non-Detects	ian. 4
82 83 84 85 86 87 88 89 90 91		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Number of Disti	data, confidence of the confid	sed upon dat lits of the sim forld data set dence limits ethods provi General 15 8 4	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Triangle of Distinct Observations Number of Non-Detects ar of Distinct Non-Detects	4 7
82 83 84 85 86 87 88 89 90 91 92		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Numbe umber of Disti	data, confidence of the confid	sed upon dat lts of the sim forld data set dence limits ethods provi General 15 8 4 1	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Triple of Distinct Observations Number of Non-Detects are of Distinct Non-Detects Minimum Non-Detects	4 7 1
82 83 84 85 86 87 88 89 90 91 92 93		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Numbe umber of Disti Minir Maxir	bservations r of Detects mum Detect mum Detect mum Detect	sed upon dat lits of the sim forld data set dence limits ethods provi General 15 8 4	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Triple of Distinct Observations Number of Non-Detects or of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect	4 7 1
82 83 84 85 86 87 88 89 90 91 92 93 94		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Numbe umber of Disti Minir Maxir	data, confidence of the confid	sed upon dat lts of the sim forld data set dence limits ethods provi General 15 8 4 1	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Triple of Distinct Observations Number of Non-Detects are of Distinct Non-Detects Minimum Non-Detects	4 7 1
82 83 84 85 86 87 88 89 90 91 92 93 94 95		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Numbe umber of Disti Minir Maxir Variar	bservations r of Detects mum Detect mum Detect mum Detect	General 15 8 4 1 28	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Triple of Distinct Observations Number of Non-Detects or of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect	4 7 1 1 1 46.67%
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Numbe umber of Disti Minir Maxir Variar	bservations r of Detects mum Detect nce Detects pont the result of the r	General 15 8 4 1 28 86.86	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects Percent Non-Detects	4 7 1 1 1 46.67% 9.32
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Number umber of Disti Minir Maxir Variar Med	bservations or of Detects inct Detects num Detect num D	General 15 8 4 1 28 86.86 5	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. r of Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects Percent Non-Detects SD Detects	4 7 1 1 1 46.67% 9.32 1.864
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Je Number of Ol Number umber of Disti Minir Maxir Variar Med	bservations of Detects inct Detects mum Detect mum Detect pan Detects an Detects an Detects an Detects as Detects	General 15 8 4 1 28 86.86 5 2	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. r of Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects SD Detects CV Detects	4 7 1 1 1 46.67% 9.32 1.864 7.865
82 83 84 85 86 87 90 91 92 93 94 95 96 97 98 99 100		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and John Number of Ol Number of Disti Minir Maxir Variar Med Skewned Skewne	bservations of Detects inct Detects mum Detect mum Detect pan Detects an Detects an Detects an Detects as Detects	General 15 8 4 1 28 86.86 5 2 2.797	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz nal insight th	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Tof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects Percent Non-Detects SD Detects CV Detects Kurtosis Detects	4 7 1 1 1 46.67% 9.32 1.864 7.865
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and John Number of Ol Number of Disti Minir Maxir Variar Med Skewned Skewne	bservations of Detects fund Det	General 15 8 4 1 28 86.86 5 2 2.797 0.814	ulation studi	es summariz	red in Singh, ne user may v ognormal, al vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Tof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects Percent Non-Detects SD Detects CV Detects Kurtosis Detects	4 7 1 1 1 46.67% 9.32 1.864 7.865
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102		owever, simu	mmendations ulations results highly negati reliable. C	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewned Mean of Logg	bservations or of Detects inct Detects an Detects and Detects	General 15 8 4 1 28 86.86 5 2 2.797 0.814	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz	ne user may vognormal, at vely skewed	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects or of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects	4 7 1 1 1 46.67% 9.32 1.864 7.865
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104		owever, simu	mmendations results highly negative reliable. Control of the contr	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewner Mean of Logg	bservations or of Detects incum Detect mum Detect mum Detect sean Detects ean Detects ged Detects Worm est Statistic	General 15 8 4 1 28 86.86 5 2 2.797 0.814	ulation studi ts; for addition (e.g., Chen, de adjustment Statistics	es summariz	ne user may vognormal, at vely skewed Number	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. Trof Distinct Observations Number of Non-Detects or of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102		owever, simu	mmendations results highly negative reliable. Control of the contr	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewne Mean of Logg hapiro Wilk Trapiro Wilk Cr	bservations r of Detects mum Detect mum Detects an Detects an Detects ged Detects Worm est Statistic ritical Value	General 15 8 4 1 28 86.86 5 2 2.797 0.814 mal GOF Tes 0.484 0.818	ulation studi ts; for addition (e.g., Chen, de adjustment Statistics	es summariz	Number Number Number Number	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects lk GOF Test al at 5% Significance Lev	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Numbe umber of Disti Minir Wariar Med Skewne Mean of Logg hapiro Wilk To Lilliefors To the swill red to the same of	bservations or of Detects on Dete	General 15 8 4 1 28 86.86 5 2 2.797 0.814 and GOF Tes 0.484 0.818 0.46	ulation studi ts; for additio (e.g., Chen, de adjustme	es summariz unal insight th Johnson, L ints for posit Only Detected Da	Number Shapiro Wita Not Norma Lilliefors	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up a will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewne Mean of Logg Chen properties of Chen apiro Wilk Tonapiro Wilk Tonapiro Wilk Tonapiro Wilk Chen Chen Chen Chen Chen Chen Chen Chen	bservations r of Detects inct Detects mum Detect mum Detects lian Detects lian Detects ged Detects ged Detects get Statistic ritical Value est Statistic ritical Value	General 15 8 4 1 28 86.86 5 2 2.797 0.814 aal GOF Tes 0.484 0.818 0.46 0.283	ulation studi ts; for additio (e.g., Chen, de adjustme	es summarizinal insight the Johnson, Lints for position of the Johnson of the Joh	Number Shapiro Witta Not Normata Not Norm	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects lk GOF Test al at 5% Significance Lev	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up a will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewne Mean of Logg Chen properties of Chen apiro Wilk Tonapiro Wilk Tonapiro Wilk Tonapiro Wilk Chen Chen Chen Chen Chen Chen Chen Chen	bservations r of Detects inct Detects mum Detect mum Detects lian Detects lian Detects ged Detects ged Detects get Statistic ritical Value est Statistic ritical Value	General 15 8 4 1 28 86.86 5 2 2.797 0.814 aal GOF Tes 0.484 0.818 0.46 0.283	ulation studi ts; for additio (e.g., Chen, de adjustme	es summarizinal insight the Johnson, Lints for position of the Johnson of the Joh	Number Shapiro Witta Not Normata Not Norm	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up a will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewne Mean of Logg Chen properties of Chen apiro Wilk Tonapiro Wilk Tonapiro Wilk Tonapiro Wilk Chen Chen Chen Chen Chen Chen Chen Chen	bservations r of Detects inct Detects mum Detect mum Detects lian Detects lian Detects ged Detects ged Detects get Statistic ritical Value est Statistic ritical Value	General 15 8 4 1 28 86.86 5 2 2.797 0.814 aal GOF Tes 0.484 0.818 0.46 0.283	ulation studi ts; for additio (e.g., Chen, de adjustme	es summarizinal insight the Johnson, Lints for position of the Johnson of the Joh	Number Shapiro Witta Not Normata Not Norm	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up a will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewne Mean of Logg Chen properties of Chen apiro Wilk Tonapiro Wilk Tonapiro Wilk Tonapiro Wilk Chen Chen Chen Chen Chen Chen Chen Chen	bservations of Detects inct Detects inct Detects inct Detects inct Detects inct Detects inct Detects ince Detects ince Detects ged Detects ged Detects ritical Value est Statistic ritical Value estected Data	General 15 8 4 1 28 86.86 5 2 2.797 0.814 all GOF Tes 0.484 0.283 a Not Norma	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Number Shapiro Witta Not Norma Lilliefors ta Not Norma	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects al at 5% Significance Lev GOF Test al at 5% Significance Lev	4 7 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up s will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewno Mean of Logo Chenpiro Wilk Tonapiro Wilk Chenpiro Wilk	bservations of Detects inct Detects inct Detects inct Detects inct Detects inct Detects inct Detects ince Detects ince Detects ged Detects ged Detects ritical Value est Statistic ritical Value estected Data	General 15 8 4 1 28 86.86 5 2 2.797 0.814 all GOF Tes 0.484 0.283 a Not Norma	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Number Shapiro Witta Not Norma Lilliefors ta Not Norma Vel Nonparame	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects er of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects al at 5% Significance Lev GOF Test al at 5% Significance Lev	4 7 1 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 110 110 110 110 110 110 110 110		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up s will not cove ively-skewed Chen's and Ju Chen's Alexandria Med Skewno Mean of Logo Chenpiro Wilk Tonapiro Wilk Chenpiro Wilk	bservations of Detects inct Detects ince Detects ince Detects ged Detects ged Detects itical Value est Statistic ritical Value stected Data	General 15 8 4 1 28 86.86 5 2 2.797 0.814 all GOF Tes 0.484 0.818 0.46 0.283 a Not Normal	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Number Shapiro Witta Not Norma Lilliefors ta Not Norma Vel Nonparame	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be I data sets. Trof Distinct Observations Number of Non-Detects of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test al at 5% Significance Lev Itric UCLs	4 7 1 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 110 1110 1111		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Maxim Varian Med Skewne Mean of Logg hapiro Wilk Trapiro Wilk Cl Lilliefors To K Lilliefors Cr De Meier (KM) S	bservations r of Detects incu Detects mum Detect mum Detects an Detects an Detects an Detects ged Detects ged Detects ritical Value est Statistic ritical Value etected Data KM Mean KM SD	General 15 8 4 1 28 86.86 5 2 2.797 0.814 Mal GOF Tes 0.484 0.283 A Not Normal O.283 A Not Normal O.3.133 6.672	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Number Shapiro Wita Not Norma Lilliefors ta Not Norma KNumparamete	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects or of Distinct Non-Detects Minimum Non-Detects Maximum Non-Detects CV Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test al at 5% Significance Lev tric UCLs M Standard Error of Mean 95% KM (BCA) UCL	4 7 1 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 111 111 112 113		owever, simu	mmendations results highly negative reliable. Contact of the second reliable of the second	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewner Mean of Logs Mapiro Wilk Trapiro Wilk Cr Lilliefors Tr % Lilliefors Cr Weier (KM) S	bservations of Detects	General 15 8 4 1 28 86.86 5 2 2.797 0.814 Mal GOF Tes 0.484 0.818 0.46 0.283 A Not Normal Mal GOF Tes 0.484 0.818 0.46 0.283 A Not Normal Mal GOF Tes 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Shapiro Wi ta Not Norma Lilliefors ta Not Norma Vel Nonparame KN 95% KM (P	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects A statistic To of Distinct Observations Number of Non-Detects Minimum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test al at 5% Significance Lev GOF Test A standard Error of Mean 95% KM (BCA) UCL Percentile Bootstrap) UCL	4 7 1 1 1 46.67% 9.32 1.864 7.865 1.099
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 111 111 111 111		owever, simu	mmendations results highly negative reliable. Control of the contr	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewne Mean of Logs hapiro Wilk Trapiro Wilk Cr Lilliefors Tr % Lilliefors Cr Weier (KM) S	bservations of Detects	General 15 8 4 1 28 86.86 5 2 2.797 0.814 D.484 0.283 8 Not Normal 0.283 8 Not Normal 0.3.133 6.672 6.377 6.163	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Shapiro Wi ta Not Norma Lilliefors ta Not Norma Vel Nonparame KN	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be and Gamma) may	4 7 7 1 1 46.67% 9.32 1.864 7.865 1.099 el el el 1.842 N/A N/A N/A
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 111 111 112 113		owever, simu	mmendations results highly negative reliable. Contact of the second seco	s are based up s will not cove ively-skewed Chen's and Ju Number of Ol Number of Disti Minir Maxir Variar Med Skewner Mean of Logs Mapiro Wilk Trapiro Wilk Cr Lilliefors Tr % Lilliefors Cr Weier (KM) S	bservations of Detects	General 15 8 4 1 28 86.86 5 2 2.797 0.814 Mal GOF Tes 0.484 0.818 0.46 0.283 A Not Normal Mal GOF Tes 0.484 0.818 0.46 0.283 A Not Normal Mal GOF Tes 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487 0.487	ulation studi ts; for addition (e.g., Chen, de adjustment) Statistics t on Detects	es summarizinal insight the Johnson, Lants for position of the Johnson of the Joh	Number Shapiro Wita Not Norma Lilliefors ta Not Norma Vel Nonparamet KN 95% KM (P	Maichle, and Lee (2006) want to consult a statistic and Gamma) may not be a data sets. To of Distinct Observations Number of Non-Detects A statistic To of Distinct Observations Number of Non-Detects Minimum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects Ik GOF Test al at 5% Significance Lev GOF Test al at 5% Significance Lev GOF Test A standard Error of Mean 95% KM (BCA) UCL Percentile Bootstrap) UCL	4 7 7 1 1 46.67% 9.32 1.864 7.865 1.099 el el el 1.842 N/A N/A N/A

	A B C D E	F	G	Н	I	J K	L
117	Gamma GOF	Tests on De	etected Ohse	rvations On	lv		
118	A-D Test Statistic	1.445			•	rling GOF Test	
120	5% A-D Critical Value	0.745	Detecte			tributed at 5% Significand	e Level
121	K-S Test Statistic	0.378		K	Colmogorov-	Smirnov GOF	
122	5% K-S Critical Value	0.304	Detecte	d Data Not	Gamma Dis	tributed at 5% Significand	e Level
123	Detected Data Not 0	Gamma Dist	ributed at 5%	Significand	e Level		
124	0	04-41-41	. D.44. 4 D.	O b .			
125	k hat (MLE)	0.752	n Detected Da	ata Only	k	star (bias corrected MLE)	0.553
126	Theta hat (MLE)	6.648				star (bias corrected MLE)	
127 128	nu hat (MLE)	12.03				nu star (bias corrected)	8.854
129	Mean (detects)	5					
130							
131	Gamma ROS						
132	GROS may not be used when data s			•		*	
133	GROS may not be used when kstar of detects is s			-			
134	For such situations, GROS of This is especi		-			IVS	
135	For gamma distributed detected data, BTVs a		<u>'</u>			tion on KM estimates	
136 137	Minimum	0.01	, ,	33		Mean	2.671
138	Maximum	28				Median	1
139	SD	7.076				CV	2.649
140	k hat (MLE)	0.261			k	star (bias corrected MLE)	0.254
141	Theta hat (MLE)	10.22			Theta	star (bias corrected MLE)	10.53
142	nu hat (MLE)	7.842				nu star (bias corrected)	7.607
143	Adjusted Level of Significance (β) Approximate Chi Square Value (7.61, α)	0.0324 2.51			Adjusted C	hi Square Value (7.61, β)	2.164
144	95% Gamma Approximate UCL (use when n>=50)	8.097		95% Ga		ted UCL (use when n<50)	9.391
145 146							
147	Estimates of G	amma Para	meters using	KM Estima	tes		
148	Mean (KM)	3.133				SD (KM)	6.672
149	Variance (KM)	44.52				SE of Mean (KM)	
150	k hat (KM)	0.221				k star (KM)	
151	nu hat (KM)	6.616 14.21				nu star (KM)	
152	theta hat (KM) 80% gamma percentile (KM)	4.332			909	theta star (KM) gamma percentile (KM)	
153 154	95% gamma percentile (KM)	15.72				% gamma percentile (KM)	32.67
155							
156	Gamm	a Kaplan-M	eier (KM) Sta	tistics			
157	Approximate Chi Square Value (6.63, α)	1.968				hi Square Value (6.63, β)	
158	95% Gamma Approximate KM-UCL (use when n>=50)	10.55	,	95% Gamma	a Adjusted k	(M-UCL (use when n<50)	12.42
159	Lognormal GC	E Toot on D	atastad Obas	nations O	alaz.		
160	Shapiro Wilk Test Statistic	0.73	elected Obse	n valions Oi		ilk GOF Test	
161 162	5% Shapiro Wilk Critical Value	0.818	De	tected Data	•	mal at 5% Significance Le	vel
163	Lilliefors Test Statistic	0.294				GOF Test	
164	5% Lilliefors Critical Value	0.283	De	tected Data	Not Lognorr	mal at 5% Significance Le	vel
165	Detected Data	Not Lognorn	nal at 5% Sig	nificance Le	evel		
166				·			
167	Lognormal RO		Using Impute	a Non-Dete	cts	Moon in Las Casta	0.524
168	Mean in Original Scale SD in Original Scale	2.746 7.047				Mean in Log Scale SD in Log Scale	
169	95% t UCL (assumes normality of ROS data)	5.95			95%	Percentile Bootstrap UCL	6.16
170 171	95% BCA Bootstrap UCL	8.197			20.01	95% Bootstrap t UCL	21.6
172	95% H-UCL (Log ROS)	20.79				-	
173			ı				1
174	Statistics using KM estimates		Data and Ass	uming Logn	ormal Distr		1
175	KM Mean (logged)	0.434				KM Geo Mean	
176	KM SD (logged)	0.853			95% (Critical H Value (KM-Log)	
177	KM Standard Error of Mean (logged)	0.236			0E0/ /	95% H-UCL (KM -Log)	
178	KM SD (logged) KM Standard Error of Mean (logged)	0.853			95% (Critical H Value (KM-Log)	2.52
179	Kivi Standard Effor Of Weart (1099ed)	0.230					
180		DL/2 S	tatistics				
181	DL/2 Normal				DL/2 Log-1	Transformed	
102			I				

	Α	В	С	D	E	F	G	Н		J	K	L				
183				Mean in O	riginal Scale	2.9				Mean	in Log Scale	0.111				
184				SD in O	riginal Scale	6.988				SD	in Log Scale	1.1				
185			95% t l	JCL (Assume	es normality)	6.078				95%	H-Stat UCL	4.803				
186			DL/2 i	s not a reco	mmended m	ethod, provi	ded for comp	parisons and	l historical r	easons						
187		Noncompatio Distribution Front IOI Challetion														
188		Nonparametric Distribution Free UCL Statistics														
189		Data do not follow a Discernible Distribution at 5% Significance Level														
190																
191						Suggested	UCL to Use									
192			95	5% KM (Chel	yshev) UCL	11.16										
193																
194		Note: Sugge:	stions regard	ling the selec	tion of a 95%	6 UCL are pr	ovided to hel	p the user to	select the m	nost appropria	ate 95% UCL					
195			F	Recommenda	ations are bas	sed upon dat	a size, data d	distribution, a	and skewnes	SS.						
196		These recor	mmendations	s are based ι	ipon the resu	Its of the sim	ulation studi	es summariz	ed in Singh,	Maichle, and	d Lee (2006).					
197	Ho	wever, simu	lations result	s will not cov	er all Real W	orld data se	ts; for additio	nal insight th	ne user may	want to cons	ult a statistici	an.				
198																
199																

	۸ .	D	0		7		_	I -		1 11								-	
200	As	В	С		D	_	E	F	G	Н	l	- 1		J			K		L
201																			
202								Genera	Statistics										
203			To	otal Nu	ımber of	Obse	rvations	15				Nu	mber	of Dist	inct (Obse	ervation	s	12
203												Nu	mber	of Miss	sing (Obse	ervation	s	0
205						N	/linimum	17									Mea	n	31.13
206						M	laximum	78									Media	n	24
207							SD	17.76							Std. E	rror	of Mea	n	4.586
208				(Coefficie	nt of \	/ariation	0.57								S	kewnes	s	1.943
209																			
210								Normal	GOF Test										
211				Sha	piro Wilk	Test	Statistic	0.726				Shapir	o Wil	k GOF	Test	t			
212			5%	6 Shap	oiro Wilk	Critic	al Value	0.881		Da	ta Not	Norma	al at 5	% Sigr	nificar	nce	_evel		
213					Lilliefors	Test	Statistic	0.237				Lillie	fors (GOF T	est				
214				5% I	Lilliefors	Critic	al Value	0.22		Da	ta Not	Norma	al at 5	% Sigr	nificar	nce	_evel		
215						I	Data No	t Normal at	5% Signific	ance Lev	/el								
216	1																		
217							A:	ssuming No	mal Distrib	ition									
218			95%	Norm	nal UCL						95%	UCLs (Adjus	sted fo	r Ske	wne	ess)		
219					95% St	udent	's-t UCL	. 39.21			ç	5% Ad	ljuste	d-CLT	UCL	(Che	en-1995	6)	41.13
220												95% M	odifie	d-t UC	L (Jo	hns	n-1978	5)	39.59
221																			
222								Gamma	GOF Test										
223					A-D	Test	Statistic	1.125		A	Anders	on-Da	rling	Gamm	a GC)F T	est		
224					5% A-D	Critic	al Value	0.739		Data Not	Gamr	na Dist	tribute	d at 59	% Sig	nific	ance Le	evel	
225					K-S	Test	Statistic	0.219		Ko	lmogo	rov-Sr	nirno	v Gam	ma G	OF	Test		
ZZ 3	1							0.213							ına c				
					5% K-S				Detect	ed data a	appear	Gamn	na Dis					ince	Level
225 226 227						Critic	al Value											ince	Level
226						Critic	al Value	0.222										ince	Level
226 227						Critic	al Value	opr. Gamma										ince	Level
226 227 228						Critic	al Value	0.222 opr. Gamma	Distribution				Level	stribute	ed at 5	5% \$			Level 3.811
226 227 228 229					etected c	Critic data for k ha	al Value	O.222 Opr. Gamma Gamma 4.708	Distribution			cance I	Level k s	stribute	ed at 5	5% s	Significa	<u>:</u>)	
226 227 228 229 230					etected c	Critic	al Value ollow Ap	0.222 opr. Gamma Gamma 4.708 6.612	Distribution			cance I	Level k s	tar (bia	ed at 5	5% s	Significa	i)	3.811
226 227 228 229 230 231				De	etected c	Critic	al Value ollow Ap at (MLE) at (MLE) at (MLE)	Gamma 4.708 6.612 141.2	Distribution			cance I	k s	tar (bia nu sta	ed at 5	rrect	ed MLE	(i)	3.811 8.169
226 227 228 229 230 231 232				De	Th	Critic	al Value ollow Ap at (MLE) at (MLE) at (MLE)	Gamma 4.708 6.612 141.2	Distribution		Signific	Th	k s	tar (bia tar (bia nu sta MLE S	as con as con ar (bia	rrect rrect as co	ed MLE	(i) (i) (i)	3.811 8.169 114.3
226 227 228 229 230 231 232 233			Ac	MLE	Th	Critic data for k ha eta ha nu ha ias co	al Value ollow Ap at (MLE) at (MLE) at (MLE)	0.222 ppr. Gamma Gamma 4.708 6.612 141.2 31.13	Distribution		Signific	Th	k s neta s	tar (bia tar (bia nu sta MLE S Chi Sq	ed at 5 as cor as cor ar (bia d (bia	rrect rrect as co	ed MLE ed MLE orrected	(i)	3.811 8.169 114.3 15.95
226 227 228 229 230 231 232 233 234			Ac	MLE	Th	Critic data for k ha eta ha nu ha ias co	at (MLE) at (MLE) at (MLE) orrected)	Gamma 4.708 6.612 141.2 31.13	Distribution	at 5% S	Signific	Th	k s neta s	tar (bia tar (bia nu sta MLE S Chi Sq	ed at 5 as cor as cor ar (bia d (bia	rrect rrect as co	ed MLE ed MLE orrected prrected ue (0.05	(i)	3.811 8.169 114.3 15.95 90.65
226 227 228 229 230 231 232 233 234 235				MLE djusted	Th Mean (b	Critic k ha eta ha nu ha ias co	al Value ollow Ap at (MLE) at (MLE) orrected) As	Gamma 4.708 6.612 141.2 31.13 0.0324	Distribution	at 5% S	Signifid	Th	k s neta s mate	tar (bia tar (bia nu sta MLE S Chi Sq justed	as cor as cor (bia d (bia uare	5% §	ed MLE ed MLE orrected orrected ue (0.05 re Value	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236	,	95% Approxi		MLE djusted	Th Mean (b	Critic k ha eta ha nu ha ias co	al Value ollow Ap at (MLE) at (MLE) orrected) As	Gamma 4.708 6.612 141.2 31.13 0.0324	Distribution	at 5% S	Signifid	Th	k s neta s mate	tar (bia tar (bia nu sta MLE S Chi Sq justed	as cor as cor (bia d (bia uare	5% §	ed MLE ed MLE orrected prrected ue (0.05	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65
226 227 228 229 230 231 232 233 234 235 236	,	95% Approxi		MLE djusted	Th Mean (b	Critic k ha eta ha nu ha ias co	al Value ollow Ap at (MLE) at (MLE) orrected) As	Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai	Distribution Statistics	at 5% S	Signifid	Th	k s neta s mate	tar (bia tar (bia nu sta MLE S Chi Sq justed	as cor as cor (bia d (bia uare	5% §	ed MLE ed MLE orrected orrected ue (0.05 re Value	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237	(95% Approxi		MLE dijustec	Th Mean (b d Level o	k ha eta ha nu ha ias cc	al Value al Value at (MLE) at (MLE) at (MLE) brrected) As a n>=50)	Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai	Distribution	at 5% \$	A Adj	Th	k s neta s mate Ad	ttar (bia nu sta MLE S Chi Sq justed	as corress corresponding correspondi	rrect rrectas cras consiste values of values o	ed MLE ed MLE ed MLE orrected orrected ue (0.05 re Value	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 239	(95% Approxi	mate Gan	MLE djustec	Th Mean (b JCL (use	k hheta ha nu ha ias co	at Value ollow Ap at (MLE) at (MLE) orrected) at ificance As n n>=50)	Gamma Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai 39.27 Lognorma 0.857	Distribution Statistics	at 5% \$	A Adj	The Approxi	k s neta s mate Ad	ttar (bia nu sta MLE S Chi Sc justed	as cor as cor ar (bia d (bia uare Chi S	5% \$ free the state of the stat	ed MLE ed MLE priected priected priected ue (0.05 re Value	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240		95% Approxi	mate Gan	MLE MLE Shal	Th Mean (b JCL (use	k haeta hi nu haias co	at Value at (MLE) at (MLE) at (MLE) at (MLE) arcted arcted As n n>=50) Statistic al Value	Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai 39.27 Lognorma 0.857 0.881	Distribution Statistics	at 5% \$	A Adj	The Approxi	k s sneta s smate Ad	ttar (bia ttar (bia nu sta MLE S Chi Sc Chi Sc Chi Sc Si Justed	as cor as cor as cor (bia d (bia puare Chi S	5% streets as consistent with the second value of the second value	ed MLE ed MLE orrected prected ue (0.05 re Value	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240		95% Approxi	mate Gan	MLE MLE dijusted	Th Mean (b d Level o JCL (use piro Wilk Lilliefors	Critice Critice k his eta his nu his sco	al Value pollow Ap at (MLE) at (MLE) at (MLE) principle finiticance As n n>=50) Statistic al Value Statistic	Gamma Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai 39.27 Lognorma 0.857 0.881 0.196	Distribution Statistics	ution 95	A Adj Shapi I Not L Lilli	The Approxi	k s sneta s smate Add	tar (bia tar (bia nu star (bia	as corras	5% \$ rrect rrect as co Vali S F Te eance	ed MLE ed MLE princted princted ue (0.05 re Value en n<50 st e Level	(i) (ii) (iii) (ii	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241		95% Approxi	mate Gan	MLE MLE dijusted	Th Mean (b d Level o JCL (use piro Wilk biro Wilk Lilliefors Lilliefors	Critical Cri	at Value ollow Ap at (MLE) at (MLE) at (MLE) orrected) ifficance As n n>=50) Statistic al Value Statistic al Value	Gamma Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai 39.27 Lognorma 0.857 0.881 0.196 0.22	Statistics Statistics mma Distrib	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	tar (bia tar (bia nu star (bia	as corras	5% \$ rrect rrect as co Vali S F Te eance	ed MLE ed MLE orrected prected ue (0.05 re Value	(i) (ii) (iii) (ii	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243		95% Approxi	mate Gan	MLE MLE dijusted	Th Mean (b d Level o JCL (use piro Wilk biro Wilk Lilliefors Lilliefors	Critical Cri	at Value ollow Ap at (MLE) at (MLE) at (MLE) orrected) ifficance As n n>=50) Statistic al Value Statistic al Value	Gamma Gamma 4.708 6.612 141.2 31.13 0.0324 ssuming Gai 39.27 Lognorma 0.857 0.881 0.196	Statistics Statistics mma Distrib	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	tar (bia tar (bia nu star (bia	as corras	5% \$ rrect rrect as co Vali S F Te eance	ed MLE ed MLE princted princted ue (0.05 re Value en n<50 st e Level	(i) (ii) (iii) (ii	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 240 241 242 243 244		95% Approxi	mate Gan	MLE MLE dijusted	Th Mean (b d Level o JCL (use piro Wilk biro Wilk Lilliefors Lilliefors	Critical Cri	at Value ollow Ap at (MLE) at (MLE) at (MLE) orrected) ifficance As n n>=50) Statistic al Value Statistic al Value	0.222	Statistics Statistics mma Distrib al GOF Test	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	tar (bia tar (bia nu star (bia	as corras	5% \$ rrect rrect as co Vali S F Te eance	ed MLE ed MLE princted princted ue (0.05 re Value en n<50 st e Level	(i) (ii) (iii) (ii	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 240 241 242 243 244 245		95% Approxi	mate Gan	MLE MLE Shal	Th Mean (b JCL (use Diro Wilk Diro Wilk Lilliefors Data	k had eta had nu had ias cool of Sigral where a Test Critical Test Critical appears and the cool of th	al Value collow Ap at (MLE) at (MLE) at (MLE) at (MLE) at (MLE) brrected) alificance As a n>=50) Statistic al Value Statistic al Value ar Appro	0.222	Statistics Statistics mma Distrib	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	ttar (bia nu statar (ad at § ad at § as cor as cor ar (bias ad (bias auare Chi S auare I GOF	5% (frect f	ed MLE ed MLE prected prected ue (0.05 re Value en n<50 st e Level	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05
226 227 228 229 230 231 232 233 234 235 236 237 238 240 241 242 243 244 245 246		95% Approxi	mate Gan	MLE MLE MIF Shap 5% I	Th Mean (b d Level o JCL (use piro Wilk biro Wilk Lilliefors Data	k his eta his nu his ias cc of Sigr wher Test Critic Test Critic appe	al Value ollow Ap at (MLE) at (MLE) orrected) orrected) orrected As an n>=50) Statistic al Value statistic al Value ar Appre	0.222 0.222	Statistics Statistics mma Distrib al GOF Test	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	ttar (bia tar (bia tar (bia nu star (bia nu	ad at § and at	5% (filogo	ed MLE ed MLE prected prected ue (0.05 re Value en n<50 st e Level ce Level	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05 40.43
226 227 228 229 230 231 232 233 234 235 236 237 238 240 241 242 243 244 245 246		95% Approxi	mate Gan	MLE MLE MIF Shap 5% I	Th Mean (b JCL (use Diro Wilk Diro Wilk Lilliefors Data	k his eta his nu his ias cc of Sigr wher Test Critic Test Critic appe	al Value ollow Ap at (MLE) at (MLE) orrected) orrected) orrected As an n>=50) Statistic al Value statistic al Value ar Appre	0.222 0.222	Statistics Statistics mma Distrib al GOF Test	ution 95 Data	A Adj Shapi Not L Lilli Lilli	The Approxi	k s someta somet	ttar (bia tar (bia tar (bia nu star (bia nu	ad at § and at	5% (filogo	ed MLE ed MLE prected prected ue (0.05 re Value en n<50 st e Level	(i) (i) (ii) (iii)	3.811 8.169 114.3 15.95 90.65 88.05

П	A	В	С	D	E	F	G	Н	l i	J	К	П	L
251					_		ormal Distribu						-
252					95% H-UCL	39.3			90%	6 Chebyshev	(MVUE)	JCL	41.55
253			95%	Chebyshev (MVUE) UCL	46.5			97.5%	6 Chebyshev	(MVUE)	JCL	53.37
254			99%	Chebyshev (MVUE) UCL	66.86							
255													
256					Nonparame	tric Distribu	ition Free UC	L Statistics					
257				Data appea	r to follow a	Discernible	Distribution a	t 5% Signifi	icance Lev	el el			
258													
259					Nonpa	rametric Dis	tribution Free	UCLs					
260				95	5% CLT UCL	38.68				95%	Jackknife I	JCL	39.21
261				Standard Bo	•	38.5				95% B	ootstrap-t	JCL	50.75
262			9	5% Hall's Bo	otstrap UCL	74.95			95%	Percentile I	Bootstrap I	JCL	38.47
263				95% BCA Bo	•	41.4							
264				ebyshev(Me		44.89				Chebyshev(N			51.12
265			97.5% Ch	ebyshev(Me	an, Sd) UCL	59.77			99% (Chebyshev(N	lean, Sd) l	JCL	76.76
266													
267							UCL to Use						
268			95	% Adjusted C	Gamma UCL	40.43							
269			144			,	N. II 'I			205.			
270		14/1			- ''		normal) distrib	•	•			01	
271		When app	licable, it is s	suggested to	use a UCL b	ased upon a	distribution (e	e.g., gamma) passing b	ooth GOF tes	its in ProU	CL	
272		Noto: Cuasa	ationa ragard	ing the color	tion of a OE0	LICI ara ne	ravidad ta bala	the weer to	anlant the	most spars	rioto 0E%	LICI	
273		Note: Sugge					rovided to help ta size, data d				riate 95%	UCL.	
274		These recor					nulation studie				nd I ee (20	106)	
275	H				•		ets; for addition				•		ın
276		, omita			TOT UIT TOUT TO	ona data se	no, for addition	iai iiioigiit tii	10 4001 1114	y want to con	louit a otat	iotioic	
277 278													
-	Ва												
280													
281						General	Statistics						
282			Total	Number of C	Observations	15			Numb	er of Distinc	t Observat	ions	15
283									Numb	er of Missing	Observat	ions	0
284					Minimum	48					M	lean	124.5
285					Maximum	250					Me	dian	120
286					SD	55.47				Std.	Error of M	lean	14.32
287				Coefficient	t of Variation	0.445					Skewr	ness	0.882
288													
289						Normal	GOF Test						
290			S	hapiro Wilk 1	Test Statistic	0.943			Shapiro V	Vilk GOF Te	st		
291			5% SI	napiro Wilk C	Critical Value	0.881		Data appe		at 5% Signif		/el	
292				Lilliefors 7	Test Statistic	0.13				s GOF Test			
293			5	% Lilliefors C	Critical Value	0.22			ear Normal	at 5% Signif	icance Lev	/el	
294					Data appe	ar Normal a	t 5% Significa	nce Level					
295													
296					As	suming Nor	mal Distributi						
297			95% No	rmal UCL						justed for SI			
				95% Stu	dent's-t UCL	149.8			95% Adius	ted-CLT UC	Chen-19	995)	151.6
298				0070 010							•		
298 299										fied-t UCL (J	•		150.3

	Α	В	С	D	E	F	G	Н	I	J	K		L
301				A-D	Test Statistic	0.127	GOF Test	Ander	son-Darling	Gamma GC	OF Test		
302					Critical Value	0.738	Detecte	ed data appea				nce Lev	vel
304				K-S	Test Statistic	0.0823		Kolmog	orov-Smirno	ov Gamma C	GOF Test		
305				5% K-S	Critical Value	0.222	Detecte	ed data appea	ır Gamma Di	stributed at	5% Significar	nce Lev	vel
306				Detecte	d data appea	Gamma Di	stributed at	5% Significa	nce Level				
307													
308					k hat (MLE)	Gamma 5.575	Statistics		le.	atar (bian an	rrected MLE)	J 41	505
309				The	eta hat (MLE)	22.34				•	rrected MLE)		
310					nu hat (MLE)	167.3				,	as corrected)	1	
312			ML	E Mean (bi	as corrected)	124.5				MLE Sd (bi	as corrected)	58.	.68
313									Approximate	Chi Square	Value (0.05)		
314			Adjus	ted Level of	Significance	0.0324			Ad	djusted Chi S	Square Value	106.	.4
315					Λα.	numina Com	ma Diatribu	tlan					
316	ç	95% Approxim	nate Gamma	UCL (use v	vhen n>=50))	suming Gam	ima Distribl		liusted Gami	na UCL (use	e when n<50)	158.	1
317		.с. / г.		002 (000)				0070710	jaotoa aa	002 (000		1.00.	
319						Lognorma	GOF Test						
320			S	hapiro Wilk	Test Statistic	0.987		Shap	oiro Wilk Log	normal GO	F Test		
321			5% Sh	<u> </u>	Critical Value	0.881		- ''			ficance Level	1	
322			-		Test Statistic	0.0821			liefors Logn				
323			5	% Lilletors	Critical Value		at 5% Signi	ficance Leve	•	at 5% Signii	ficance Level		
324 325					Jana appear	_ognomidi	0 /0 Olylli		•				
326						Lognorma	l Statistics						
327			N	Minimum of	Logged Data	3.871				Mean of	f logged Data	4.7	732
328			N	laximum of	Logged Data	5.521				SD of	f logged Data	0.4	451
329							151.1						
330					Assu 95% H-UCL	iming Logno 160.4	ormal Distrib	oution	00%	Chahyahay	(MVUE) UCL	169.	5
331			95% (Chebyshev	(MVUE) UCL	189.8				•	(MVUE) UCL		
332					(MVUE) UCL	273.1						+	
334												1	
335					•			CL Statistics					
336				Data appea	ar to follow a	Discernible	Distribution	at 5% Signifi	icance Leve	l			
337					Nonna	rametric Dis	tribution Era	a IICI e					
338				9	5% CLT UCL	148.1		JC O'OLS		95% Ja	ackknife UCL	149.	.8
339			95%		ootstrap UCL	148					otstrap-t UCL		
341			9	5% Hall's B	ootstrap UCL	162.1			95%	Percentile Bo	ootstrap UCL	. 147.	.1
342					ootstrap UCL	149.8							
343				• •	ean, Sd) UCL	167.5				• •	ean, Sd) UCL		
344			97.5% Ch	ebyshev(M	ean, Sd) UCL	214			99% Ch	ebyshev(Me	ean, Sd) UCL	267	
345						Suggested	UCL to Use)					
346				95% St	udent's-t UCL	149.8							
348												1	
349		Note: Sugge		•	ction of a 95%			•			ate 95% UCI	L.	
350		There			ations are bas						d L oc (2000)		
351	П				upon the resuver all Real W				•		, ,		
352	170	ATTOVGI, SIIIIU	ianorio result	5 WIII HULCU	voi un inedi Vi	Jina data Se	.o, ioi auuilli	onai maigiit lii	io usei illay	a to COIIS	-un a statistic	iai I.	
353 354	Be												
355													
356							Statistics						
357			Total		Observations	15			Numbe		Observations		
358			ķi.		er of Detects	0			Numbe		Non-Detects Non-Detects		
359			INU	anno c i Ui Di	Junior Defects	J			INUITIDE	וטוווופוע וט וג	- VOII-DELECTS	1 '	
360 361		Warr	ning: All obse	rvations ar	e Non-Detect	s (NDs), the	refore all st	atistics and e	estimates sh	ould also be	e NDsl		
362		Specific	cally, sample	mean, UC	Ls, UPLs, an	d other stati	stics are als	o NDs lying l	below the la	rgest detect	ion limit!		
363	Т	he Project T	eam may de	cide to use	alternative s	ite specific v	alues to es	timate enviro	nmental pai	ameters (e.	g., EPC, BT	v).	
364				·									
365					The data se	t for variable	e Be was no	t processed!					
366													

	Α	В	C	;	D	E	F	G	Н		J	K	L
367													
368													
369	В												
370							0	0					
371				Tatal	Normala and C	Observations	15	Statistics		Niversia	f Di-tit (Observations	14
372				rotai	Number of C	observations	15				r of Missing (
373						Minimum	26			Nullibe	i oi iviissiriy o	Mean	
374						Maximum	152					Median	
375						SD	35.21				Std F	rror of Mean	
376 377					Coefficient	of Variation	0.58				0.0	Skewness	
378													
379							Normal (GOF Test					
380				S	hapiro Wilk 1	est Statistic	0.835			Shapiro W	ilk GOF Test		
381			į	5% Sł	napiro Wilk C	critical Value	0.881		Data No		5% Significar	nce Level	
382						est Statistic	0.253				GOF Test		
383				5	% Lilliefors C	Critical Value	0.22			t Normal at	5% Significar	nce Level	
384						Data Not	Normal at 5	5% Significa	nce Level				
385						۸	ounded Nor	nal Distribut	·				
386			05	0/ No	rmal UCL	AS	suming Non	mal Distribut		LICL o (Adio	sted for Ske	·wpoco)	
387			90	70 NC		dent's-t UCL	76.68				ed-CLT UCL		79.35
388					3070 010		. 0.00				ed-t UCL (Jo	·	77.26
390													
391							Gamma	GOF Test					
392					A-D 1	est Statistic	0.544		Ander	son-Darling	Gamma GC	F Test	
393					5% A-D C	critical Value	0.74	Detecte	d data appea	ar Gamma D	istributed at 5	5% Significar	ice Level
394					K-S 1	est Statistic	0.204		-		ov Gamma G		
395						Critical Value	0.223				istributed at 5	5% Significar	ice Level
396					Detected	data appea	r Gamma Di	stributed at !	5% Significa	nce Level			
397													
398						1 1 - 1 (8 41 5)		Statistics					2.010
399					Tho	k hat (MLE) ta hat (MLE)	3.968 15.29				star (bias cor	rrected MLE)	
400						nu hat (MLE)	119			Tileta	· ·	as corrected)	
401				MI	E Mean (bia		60.67				,	as corrected)	33.81
402										Approximate	e Chi Square	,	74.91
404				Adjus	ted Level of	Significance	0.0324			A	djusted Chi S	Square Value	72.56
405													
406						As	suming Gam	nma Distribu	tion				
407		95% Appr	oximate G	amma	a UCL (use v	vhen n>=50)	78.22		95% Ac	ljusted Gamı	ma UCL (use	when n<50)	80.75
408													
409								I GOF Test					
410					•	est Statistic	0.946				gnormal GOF		
411				o% Sr	<u>'</u>	Critical Value	0.881				ormal GOF 1	icance Level	
412				59		ritical Value	0.17					icance Level	
413								at 5% Signif			at 0 70 Oigini		
414													
416							Lognorma	l Statistics					
417				-	Minimum of L	ogged Data	3.258				Mean of	logged Data	3.974
418				N	laximum of L	ogged Data	5.024				SD of	logged Data	0.511
419													
420								rmal Distrib	ution				
421						95% H-UCL	80.58				•	(MVUE) UCL	
422					• •	MVUE) UCL	95.7			97.5%	Chebyshev (MVUE) UCL	111.1
423				99% (Chebyshev (MVUE) UCL	141.4						
424						Nonnarama	atric Dietrib	tion Free UC	1 Statistics				
425					Data annes	•		Distribution			<u> </u>		
426					Sara ahhea	. W IOIIOW d	- 1906HIIDIG	Diocribution i	a. o /o olyilli	.ca.ice Leve	··		
427						Nonpa	rametric Dis	tribution Fre	e UCLs				
428 429					95	% CLT UCL	75.62				95% Ja	ackknife UCL	76.68
429				95%	Standard Bo		75.66					otstrap-t UCL	84.18
431						otstrap UCL	81.8			95%	Percentile Bo		
432				(95% BCA Bo	otstrap UCL	79.47						
.52								1					

	Α	В	С	D	Е	F	G	Н	I	J	K	L			
433			90% Ch	ebyshev(Me	an, Sd) UCL	87.94			95% Ch	ebyshev(Me	an, Sd) UCL	100.3			
434			97.5% Ch	ebyshev(Me	an, Sd) UCL	117.4			99% Ch	ebyshev(Me	an, Sd) UCL	151.1			
435															
436						Suggested	UCL to Use								
437			95	% Adjusted C	amma UCL	80.75									
438															
439		Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness.													
440		<u> </u>													
441		These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). However, simulations results will not cover all Real World data sets: for additional insight the user may want to consult a statistic.													
442	Ho	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statisticia													
443															
444	Cd														
445															
446							Statistics								
447			Total	Number of C	bservations	-			Number	of Distinct (Observations	5			
448				Numbe	er of Detects	12				Number of	Non-Detects	3			
449			Nı	umber of Dist	tinct Detects	5			Numbe	r of Distinct	Non-Detects	1			
450				Mini	mum Detect	0.3				Minimum	n Non-Detect	0.3			
451				Maxi	mum Detect	1				Maximum	n Non-Detect	0.3			
452				Varia	nce Detects	0.039				Percent	Non-Detects	20%			
453				М	ean Detects	0.458					SD Detects	0.198			
454				Med	dian Detects	0.4					CV Detects	0.431			
455				Skewn	ess Detects	2.06				Kurl	tosis Detects	5.185			
456				Mean of Log	ged Detects	-0.846				SD of Log	gged Detects	0.36			

	A B C D E	F	G H I J K	L
457				
458	Norm		t on Detects Only	
459	Shapiro Wilk Test Statistic	0.759	Shapiro Wilk GOF Test	
460	5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Leve	l
461	Lilliefors Test Statistic	0.25	Lilliefors GOF Test	
462	5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Leve	I
463	Detected Date	Not Norma	ll at 5% Significance Level	
464				
465			critical Values and other Nonparametric UCLs	
466	KM Mean	0.427	KM Standard Error of Mean	0.0487
467	KM SD	0.181	95% KM (BCA) UCL	0.507
468	95% KM (t) UCL	0.512	95% KM (Percentile Bootstrap) UCL	0.507
469	95% KM (z) UCL	0.507	95% KM Bootstrap t UCL	0.578
470	90% KM Chebyshev UCL	0.573	95% KM Chebyshev UCL	0.639
471	97.5% KM Chebyshev UCL	0.731	99% KM Chebyshev UCL	0.911
472				
473			etected Observations Only	
474	A-D Test Statistic	0.698	Anderson-Darling GOF Test	
475	5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significan	ce Level
476	K-S Test Statistic	0.191	Kolmogorov-Smirnov GOF	
477	5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significan	ce Level
478	Detected data appear	r Gamma Di	stributed at 5% Significance Level	
479				
480			n Detected Data Only	
481	k hat (MLE)	7.728	k star (bias corrected MLE)	5.851
482	Theta hat (MLE)	0.0593	Theta star (bias corrected MLE)	0.0783
483	nu hat (MLE)	185.5	nu star (bias corrected)	140.4
484	Mean (detects)	0.458		
485				
486			sing Imputed Non-Detects	
487	<u> </u>		NDs with many tied observations at multiple DLs	
488			s <1.0, especially when the sample size is small (e.g., <15-20)	
489			yield incorrect values of UCLs and BTVs	
490	· · · · · · · · · · · · · · · · · · ·		en the sample size is small.	
491			y be computed using gamma distribution on KM estimates	
492	Minimum	0.0412	Mean	0.386
493	Maximum	1	Median	0.4
494	SD	0.232	CV	0.6
495	k hat (MLE)	2.433	k star (bias corrected MLE)	1.991
496	Theta hat (MLE)	0.159	Theta star (bias corrected MLE)	0.194
497	nu hat (MLE)	72.98	nu star (bias corrected)	59.72
498	Adjusted Level of Significance (β)	0.0324	A II	44.5
499	Approximate Chi Square Value (59.72, α)	42.95	Adjusted Chi Square Value (59.72, β)	41.2
500	95% Gamma Approximate UCL (use when n>=50)	0.536	95% Gamma Adjusted UCL (use when n<50)	0.559
501	_			
502			meters using KM Estimates	0 ::::
503	Mean (KM)	0.427	SD (KM)	0.181
504	Variance (KM)	0.0326	SE of Mean (KM)	0.0487
505	k hat (KM)	5.58	k star (KM)	4.509
506	nu hat (KM)	167.4	nu star (KM)	135.3
507	theta hat (KM)	0.0765	theta star (KM)	0.0946
508	80% gamma percentile (KM)	0.58	90% gamma percentile (KM)	0.696
509	95% gamma percentile (KM)	0.802	99% gamma percentile (KM)	1.026

	Α	В	С		D		E	F	G	Н		I		J			K		L
510																			
511								•	eier (KM) St	atistics									
512			oximate Ch					109.4						Square \					6.5
513	95%	Gamma App	oroximate k	KM-U	CL (use v	when n	>=50)	0.528		95% Gan	nma	Adjus	sted K	M-UCL	use	when	n<50)	().542
514																			
515						•			etected Obs	ervations		•							
516					iro Wilk			0.866	_			•		lk GOF					
517			5%		iro Wilk (0.859	Det	ected Data	a app					ignitic	ance L	.evel	
518					_illiefors			0.173						GOF Te					
519				5% L	illiefors (0.243		ected Data			.ogno	rmal at 5	% S	ignitio	ance L	.evel	
520					Dete	ected D	ata ap	pear Logno	rmal at 5% \$	Significand	ce L	evel							
521							100	0.00											
522						•			Using Imput	ea Non-De	etec	ts					0		011
523				IV	lean in O			0.404									Scale		.014
524		050/ 11	101 /		SD in O			0.208					250/ 5				Scale		0.475
525		95% t C	JCL (assun				,	0.499					95% F	Percentil			•		0.494
526					6 BCA Bo		'	0.52						95%	B00	tstrap	t UCL	(0.536
527				95	5% H-UC	L (Log	ROS)	0.526											
528					.114								.						
529			Stat	tistics					Data and As	suming Lo	ogno	rmai	DISTRI	Dution	1/1	10			2 200
530						ean (lo		-0.918					250/ 6	N 202 - 1 1 1			Mean		0.399
531			I/M Ot and			SD (lo	00 /	0.34					J5% C	Critical H		•			1.915
532			KM Stand	lard E		•		0.0917					250/ 6	95% F		•			0.504
533			I/M Ot and			SD (lo	,	0.34					J5% C	Critical H	vait	ie (Ki	vi-Log)		1.915
534			KM Stand	iard E	rror of IVI	ean (Io	iggea)	0.0917											
535								DI /0 C	tatistics										
536			DI /	2 Nor	mal			DL/2 3	tausucs			ו מי ומ	T	ransforr	204				
537			DUZ		mai lean in O	riginal	Coolo	0.397			- '	ו צעוע	Log- i			n l nn	Scale	1	.056
538				IV	SD in O			0.397									Scale		0.54
539			05%	+ 1.101	(Assume			0.495									at UCL		0.545
540					•		• •		ded for com	narieone a	and k	nietori	ical re		90 /0	11-30	at UCL	,	7.545
541			<i>DU2</i>	- 10 11	J. a 1000		404 III	calou, piovi	ada idi ddili	Juliaulia d	anu I	notUl l	oal It	Jug () 18					
542						Nonn	arame	atric Dietribu	tion Free U	Cl Statieti	ics								
543					Detected				stributed at			ce Le	vel						
544					_ 5.56.60	au	_ppoa	. Janima Di		- /o Olgilli	.carr		. 01						
545								Suggested	UCL to Use										
546			95%	KM A	djusted (Gamma	a UCI	0.542				95%	GRO	S Adjust	ed G	amm	a UCI	(0.559
547					,			0.0.2					J	- / 10,00			- 002	`	
548	1	Note: Sugge	stions rega	ırdina	the selec	ction of	f a 95%	UCL are nr	ovided to he	p the user	r to s	elect	the m	ost annr	opria	te 95	% UCI		
549		caggo	5.1.0 . ogu						ta size, data	-					-			-	
550		These recor	mmendatio						nulation studi						and	Lee	(2006)		
551	Ho								ts; for addition									an.	
552	. 10	, 							.,				, •						
553																			

			В	-	С	-	D	_	E	F	G	Т ⊔	1		J.	_		V	_	
554	A		В		C		D		E	<u> </u>	G	Н		<u> </u>	J			K		L
555	Cr																			
556																				
557										General	Statistics									
558					Tot	tal Nu	ımber of	Obser	vations	15			N	umbe	r of Distin	ct O	bser	vations	;	13
559													N	umbei	of Missin	ng O	bser	vations	;	0
560								М	inimum	11								Mean		34.4
561								Ma	aximum	98								Median		31
562									SD	22.64					Sto	d. Er	rror c	f Mean	1	5.846
563						(Coefficier	nt of Va	ariation	0.658							Ske	ewness	;	1.933
564											-									
565										Normal	GOF Test									
566						Sha	piro Wilk	Test S	Statistic	0.78			Shap	iro Wi	Ik GOF T	est				
567					5%		oiro Wilk			0.881		Data No			5% Signifi		ce L	evel		
568							Lilliefors	Test S	Statistic	0.286			Lilli	efors	GOF Tes	st				
569						5% I	Lilliefors						ot Norm	al at !	5% Signifi	ican	ce L	evel		
570								D	ata No	t Normal at	5% Significa	ance Level								
571																				
572									As	suming Nor	mal Distribu									
573					95%	Norm	nal UCL					95%			sted for S					
574							95% Stu	udent's	s-t UCL	44.7					ed-CLT UC					47.13
575	L												95% N	Modifi	ed-t UCL	(Joh	nsor	1-1978)		45.18
576	L																			
577	<u> </u>							T			GOF Test									
578									Statistic		D.1				Gamma					
579							5% A-D		Il Value Statistic	0.744 0.206	Detect	ed data appe							nce I	_evel
580	-						5% K-S				Detect				ov Gamma					Lovel
581	-											ed data appea t 5% Signific a			Simbuleu	al 5	70 SI	griilicai	ice i	_evei
582							Detected	u uata	appea	i Gaillilla D	istributed at	3 / Significa	iiice Le	7461						
583	-									Gamma	Statistics									
584								k ha	t (MLE)					k	star (bias	corr	recte	d MLE)	т	2.617
585 586							The		t (MLE)	10.7			1		star (bias					13.14
587	<u> </u>								t (MLE)	96.47					nu star					78.51
588						MLE	Mean (bi	as cor	rected)	34.4					MLE Sd	(bia	s cor	rected)		21.26
589							•						Approx	kimate	Chi Squa	are \	Value	e (0.05)		59.1
590					Adj	justed	d Level of	Signi	ficance	0.0324			· · · · · · · · · · · · · · · · · · ·		djusted Ch					57.03
591										<u>I</u>	I									
592									As	suming Gar	nma Distrib	ution								
593		ç	95% Appro	xima	ite Gam	ıma U	JCL (use	when	n>=50)	45.7		95% A	djusted	Gamı	na UCL (ເ	use	wher	n <50)		47.36
594										1	1									
595										Lognorma	I GOF Test									
596						Sha	piro Wilk	Test S	Statistic	0.938		Sha	piro Wi	lk Log	normal G	OF	Tes	t		
597					5%	Shap	oiro Wilk	Critica	l Value	0.881		Data appea	ar Logn	ormal	at 5% Sig	gnific	canc	e Level		
598							Lilliefors					Lii	liefors	Logn	ormal GO	FT	est			
599						5% I	Lilliefors					Data appea		ormal	at 5% Sig	gnific	canc	e Level		
600								Data	appea	r Lognormal	at 5% Sign	ificance Leve	el							
601																				
602											al Statistics									
603							nimum of											ed Data		3.375
604						Max	kimum of	Logge	ed Data	4.585					SD	of I	logge	ed Data	I	0.58
605																				

	Α	В	С	D	Е	F	G H	I	J	K	L
606					Assu	ıming Logno	rmal Distribution				
607					95% H-UCL	48.31		90%	Chebyshev	(MVUE) UCL	50.08
608			95%	Chebyshev (I	MVUE) UCL	57.3		97.5%	Chebyshev	(MVUE) UCL	67.33
609			99%	Chebyshev (I	MVUE) UCL	87.02					
610											
611					Nonparame	tric Distribu	tion Free UCL Statistics)			
612				Data appear	r to follow a l	Discernible I	Distribution at 5% Signi	ficance Leve	l		
613											
614					Nonpar	rametric Dis	ribution Free UCLs				
615				95	% CLT UCL	44.02			95% J	ackknife UCL	44.7
616			95%	Standard Bo	otstrap UCL	43.68			95% Bo	otstrap-t UCL	55.06
617			9	5% Hall's Bo	otstrap UCL	105.1		95%	ercentile B	ootstrap UCL	44.27
618			!	95% BCA Bo	otstrap UCL	46.4					
619			90% Ch	ebyshev(Mea	an, Sd) UCL	51.94		95% Ch	ebyshev(M	ean, Sd) UCL	59.88
620			97.5% Ch	ebyshev(Mea	an, Sd) UCL	70.91		99% Ch	ebyshev(M	ean, Sd) UCL	92.57
621											
622						Suggested	UCL to Use				
623			95	% Adjusted G	amma UCL	47.36					
624											
625		Note: Sugge	stions regard	ling the selec	tion of a 95%	UCL are pro	ovided to help the user to	select the m	ost appropr	iate 95% UCL	
626			F	Recommenda	itions are bas	sed upon dat	a size, data distribution,	and skewnes	S.		
627		These reco	mmendations	s are based u	pon the resul	Its of the sim	ulation studies summari	zed in Singh,	Maichle, an	d Lee (2006).	
628	Н	lowever, simu	ılations result	ts will not cov	er all Real W	orld data set	s; for additional insight t	he user may	want to cons	sult a statisticia	an.
629											
630											
631	Со										
632											
633						General	Statistics				
634			Total	Number of C	bservations	15		Numbe	r of Distinct	Observations	10
635								Number	of Missing	Observations	0
636					Minimum	8				Mean	13.53
637					Maximum	22				Median	13
638					SD	3.739			Std. I	Error of Mean	0.965
639				Coefficient	of Variation	0.276				Skewness	0.859
640											
641				de este MACH. T			GOF Test	Oh ! \4/!	U- 00F T		
642				hapiro Wilk T		0.922	Data and	Shapiro Wi			
643			5% 51	hapiro Wilk C	est Statistic	0.881	рата арр	ear Normal a	GOF Test	cance Level	
644			E-	% Lilliefors C		0.223	Data N	ot Normal at		noo Lovol	
645							rmal at 5% Significance		- Significa	lice Level	
646				Data	арроаі Аррі	Oximate 140	illiai at 0 % Olgriillicance	LOVOI			
647					Δε	suming Norr	nal Distribution				
648			95% No	ormal UCL		ounning recir		6 UCLs (Adju	sted for Sk	ewness)	
649			0070110		dent's-t UCL	15.23				(Chen-1995)	15.35
650								•		ohnson-1978)	15.27
651 652										/	
653						Gamma (GOF Test				
654				A-D T	est Statistic	0.436		rson-Darling	Gamma G	OF Test	
655				5% A-D C	Critical Value	0.736	Detected data appe				ce Level
656				K-S T	est Statistic	0.193		gorov-Smirno			
657				5% K-S C	critical Value	0.221	Detected data appe	ar Gamma Di	stributed at	5% Significan	ce Level
658				Detected	data appear	Gamma Di	stributed at 5% Significa	ance Level			
659											
660						Gamma	Statistics				
661					k hat (MLE)	14.85		k	star (bias co	orrected MLE)	11.93
662				Thet	ta hat (MLE)	0.911		Theta	star (bias co	orrected MLE)	1.135
663				n	nu hat (MLE)	445.6			nu star (bi	ias corrected)	357.8
664			MI	LE Mean (bia	s corrected)	13.53			•	ias corrected)	3.919
665										e Value (0.05)	315
666			Adjus	sted Level of	Significance	0.0324		Ad	ljusted Chi	Square Value	310
667											
668							ma Distribution				
669		95% Approxir	mate Gamma	UCL (use w	hen n>=50))	15.37	95% A	djusted Gamr	na UCL (use	e when n<50)	15.62
670	I										
-	1						GOF Test				

	A B C D E	F	G H I J K	L
672	Shapiro Wilk Test Statistic	0.959	Shapiro Wilk Lognormal GOF Test	
673	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
674	Lilliefors Test Statistic	0.176	Lilliefors Lognormal GOF Test	
675	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
676	Data appear	Lognormal	at 5% Significance Level	
677				
678			al Statistics	
679	Minimum of Logged Data	2.079	Mean of logged Data	2.571
680	Maximum of Logged Data	3.091	SD of logged Data	0.269
681				
682	Assu	ıming Logno	ormal Distribution	
683	95% H-UCL	15.5	90% Chebyshev (MVUE) UCL	16.37
684	95% Chebyshev (MVUE) UCL	17.66	97.5% Chebyshev (MVUE) UCL	19.44
685	99% Chebyshev (MVUE) UCL	22.95		
686				
687	•		tion Free UCL Statistics	
688	Data appear to follow a	Discernible	Distribution at 5% Significance Level	
689				
690	Nonpar	rametric Dis	tribution Free UCLs	
691	95% CLT UCL	15.12	95% Jackknife UCL	15.23
692	95% Standard Bootstrap UCL	15.06	95% Bootstrap-t UCL	15.61
693	95% Hall's Bootstrap UCL	15.69	95% Percentile Bootstrap UCL	15
694	95% BCA Bootstrap UCL	15.2		
695	90% Chebyshev(Mean, Sd) UCL	16.43	95% Chebyshev(Mean, Sd) UCL	17.74
696	97.5% Chebyshev(Mean, Sd) UCL	19.56	99% Chebyshev(Mean, Sd) UCL	23.14
697				
698		Suggested	UCL to Use	
699	95% Student's-t UCL	15.23		
700				
701		, •	normal) distribution passing one of the GOF test	
702	When applicable, it is suggested to use a UCL ba	ased upon a	distribution (e.g., gamma) passing both GOF tests in ProUCL	
703				
704			ovided to help the user to select the most appropriate 95% UCL.	
705	Recommendations are bas	sed upon da	ta size, data distribution, and skewness.	
706			nulation studies summarized in Singh, Maichle, and Lee (2006).	
707	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statistician	n.
708				

	A B C D E	F	G H I J K	L							
709											
710	Cu										
711											
712			Statistics								
713	Total Number of Observations	15	Number of Distinct Observations	14							
714			Number of Missing Observations	0							
715	Minimum	63	Mean	145.3							
716	Maximum	260	Median	147							
717	SD	50.21	Std. Error of Mean	12.96							
718	Coefficient of Variation	0.345	Skewness	0.443							
719											
720			GOF Test								
721	Shapiro Wilk Test Statistic	0.952	Shapiro Wilk GOF Test								
722	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level								
723	Lilliefors Test Statistic	0.171	Lilliefors GOF Test								
724	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level								
725	Data appea	ar Normal a	: 5% Significance Level								
726	An	ouming Non	mal Distribution								
727	95% Normal UCL	suming Non	95% UCLs (Adjusted for Skewness)								
728	95% Student's-t UCL	168.2	95% Adjusted Of Skewness) 95% Adjusted-CLT UCL (Chen-1995)	168.2							
729	95 % Students-t OCL	100.2	95% Modified-t UCL (Johnson-1978)	168.4							
730			33% Wodined-t OCE (Johnson-1378)	100.4							
731		Gamma	GOF Test								
732	A-D Test Statistic	0.412	Anderson-Darling Gamma GOF Test								
733	5% A-D Critical Value	0.738									
734	K-S Test Statistic	0.202	Kolmogorov-Smirnov Gamma GOF Test	20 20 10.							
735 736	5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance	ce Level							
737	Detected data appear	Gamma Di	stributed at 5% Significance Level								
738											
739		Gamma	Statistics								
740	k hat (MLE)	8.461	k star (bias corrected MLE)	6.814							
741	Theta hat (MLE)	17.18	Theta star (bias corrected MLE)	21.33							
742	nu hat (MLE)	253.8	nu star (bias corrected)	204.4							
743	MLE Mean (bias corrected)	145.3	MLE Sd (bias corrected)	55.68							
744			Approximate Chi Square Value (0.05)	172.3							
745	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	168.7							
746											
747			ma Distribution								
748	95% Approximate Gamma UCL (use when n>=50))	172.4	95% Adjusted Gamma UCL (use when n<50)	176.1							
749											
750			I GOF Test								
751	Shapiro Wilk Test Statistic	0.944	Shapiro Wilk Lognormal GOF Test								
752	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level								
753	Lilliefors Test Statistic	0.221	Lilliefors Lognormal GOF Test								
754	5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level								
755	Data appear Approx	ximate Logi	normal at 5% Significance Level								
756			I Chatintina								
757	Minimum of Land 18 or		I Statistics	4.010							
758	Minimum of Logged Data	4.143 5.561	Mean of logged Data	4.919 0.371							
759	Maximum of Logged Data	0.001	SD of logged Data	0.3/1							
760											

	Α	В	С	D	E	F	G H	I	J K	L
761					Assu	ıming Logno	rmal Distribution			
762					95% H-UCL	177.7		90%	Chebyshev (MVUE) UC	L 188.6
763			95% (Chebyshev (I	MVUE) UCL	207.9		97.5%	Chebyshev (MVUE) UC	L 234.7
764			99% (Chebyshev (I	MVUE) UCL	287.4				
765										
766					Nonparame	tric Distribu	tion Free UCL Statistic	s		
767				Data appear	r to follow a	Discernible	Distribution at 5% Sign	ificance Leve	<u> </u>	
768										
					Nonpai	rametric Dis	tribution Free UCLs			
769				95	% CLT UCL	166.7			95% Jackknife UC	L 168.2
770			95%	Standard Bo		166.4			95% Bootstrap-t UC	
771				5% Hall's Bo	•	171.7		95% F	Percentile Bootstrap UC	
772				95% BCA Bo	•	166.9				1000
773				ebyshev(Mea	•	184.2		95% Ch	ebyshev(Mean, Sd) UC	L 201.8
774				ebyshev(Mea		226.3			ebyshev(Mean, Sd) UC	
775			37.370 011	CDySHCV(IVIC	un, ou) ool	220.0		33 70 011	icbysnev(wican, ou) oo	274.0
776						Suggested	UCL to Use			
777				050/ 04	dent's-t UCL	168.2	OCL to Ose			1
778				95% 5100	uents-t occ	100.2				
779		Note O					. Calculate to the theory			
780		Note: Sugge							ost appropriate 95% UC	L.
781		There					a size, data distribution			
782									Maichle, and Lee (2006	
783	Н	owever, simu	lations result	s will not cov	er all Real W	orld data se	ts; for additional insight	the user may	want to consult a statistic	ian.
784										
785										
786	Fe									
787										
788							Statistics			
789			Total	Number of C	bservations	15		Number	r of Distinct Observation	
790								Number	of Missing Observation	s 0
791					Minimum	19400			Mea	n 33507
792					Maximum	50000			Media	n 31300
793					SD	9302			Std. Error of Mea	n 2402
794				Coefficient	of Variation	0.278			Skewnes	s 0.381
795										
796						Normal (GOF Test			
797			S	hapiro Wilk T	est Statistic	0.961		Shapiro Wi	lk GOF Test	
798			5% Sh	napiro Wilk C	ritical Value	0.881	Data ap	oear Normal a	t 5% Significance Level	
799				Lilliefors T	est Statistic	0.127		Lilliefors	GOF Test	
800			59	% Lilliefors C	ritical Value	0.22	Data ap	oear Normal a	t 5% Significance Level	
801					Data appea	ar Normal at	5% Significance Leve			
802										
803					As	suming Non	nal Distribution			
804			95% No	rmal UCL			959	% UCLs (Adju	sted for Skewness)	
805				95% Stud	dent's-t UCL	37737		95% Adjuste	d-CLT UCL (Chen-1995	37710
806								95% Modifie	ed-t UCL (Johnson-1978	37777
807										_1
808						Gamma	GOF Test			
809				A-D T	est Statistic	0.169	And	erson-Darling	Gamma GOF Test	
810				5% A-D C	ritical Value	0.736	Detected data appe	ear Gamma Di	stributed at 5% Significa	nce Level
811				K-S T	est Statistic	0.108	Kolmo	gorov-Smirno	v Gamma GOF Test	
812				5% K-S C	ritical Value	0.221	Detected data appe	ear Gamma Di	stributed at 5% Significa	nce Level
813				Detected	data appear	Gamma Di	stributed at 5% Signific	ance Level		
814										
815						Gamma	Statistics			
816					k hat (MLE)	13.9		k	star (bias corrected MLE	11.16
817				Thet	ta hat (MLE)	2411		Theta	star (bias corrected MLE	3002
818				n	u hat (MLE)	416.9			nu star (bias corrected) 334.9
819			ML	E Mean (bia	s corrected)	33507			MLE Sd (bias corrected	10029
820				•	,			Approximate	Chi Square Value (0.05	·
821			Adjus	ted Level of	Significance	0.0324			ljusted Chi Square Value	*
822					- 1	<u> </u>				
					Ass	suming Gam	ma Distribution			
823		95% Approxir	nate Gamma	UCL (use w				djusted Gamr	na UCL (use when n<50) 38865
824				3 = 2 (400 W)	30//		3370 F	.,		,
825						Loanorma	GOF Test			
826										

	Α	В	С	D	E	F	G	Н	ı	J	К	L
827			-	Shapiro Wilk	Test Statistic	0.976		Shap	iro Wilk Lo	gnormal GO	F Test	-
828			5% 5	Shapiro Wilk (Critical Value	0.881		Data appea	r Lognorma	l at 5% Signi	ificance Level	
829				Lilliefors	Test Statistic	0.0902		Lill	iefors Logr	ormal GOF	Test	
830				5% Lilliefors (Critical Value	0.22		Data appea	r Lognorma	l at 5% Signi	ificance Level	
831					Data appear	Lognormal	at 5% Signif	icance Leve	I			
832												
833						Lognorma	l Statistics					
834				Minimum of	Logged Data	9.873				Mean o	f logged Data	10.38
835				Maximum of	Logged Data	10.82				SD o	f logged Data	0.281
836												
837							ormal Distrib	ution				
838					95% H-UCL	38673					(MVUE) UCL	40893
839				Chebyshev (44233			97.5%	Chebyshev	(MVUE) UCL	48868
840			99%	Chebyshev (MVUE) UCL	57973						
841												
842							tion Free UC					
843				Data appea	r to follow a	Discernible	Distribution a	at 5% Signifi	cance Leve	əl		
844												
845					•		tribution Fre	e UCLs				
846					5% CLT UCL						ackknife UCL	
847				6 Standard Bo		37270					otstrap-t UCL	
848				95% Hall's Bo	<u> </u>	37931			95%	Percentile B	ootstrap UCL	37327
849				95% BCA Bo		37333						
850				hebyshev(Me		40712				, ,	ean, Sd) UCL	
851			97.5% C	hebyshev(Me	an, Sd) UCL	48506			99% C	hebyshev(M	ean, Sd) UCL	57405
852												
853							UCL to Use					
854				95% Stu	dent's-t UCL	37737						
855												
856		Note: Sugge									riate 95% UCI	
857				Recommend							(22	
858					<u>'</u>					· · ·	nd Lee (2006)	
859	Но	wever, simu	lations resu	Its will not co	ver all Real W	/orld data se	ts; for additio	nal insight th	e user may	want to cons	sult a statistic	ian.
860												
861												

		۸	n	_		_	т —	_	-				_	T		Т	1/	一																		
962	Pb	A	В	С		D		E	F	G	Н		-		J	_	K																			
862																																				
863 864									General	Statistics																										
865				Т	otal N	umber of	Obse	rvations	15				Numbe	er of	Distinc	t Ob	servation	าร	13																	
866													Numbe	r of I	Missing) Ob	servation	าร	0																	
867							M	linimum	54.4								Mea	an	286.9																	
868							Ma	aximum	728								Media	an	252																	
869								SD	165.1						Std.	Erro	or of Mea	an	42.62																	
870					-	Coefficier	nt of V	'ariation	0.575								Skewne	ss	1.26																	
871									•																											
872									Normal	GOF Test																										
873					Sha	piro Wilk	Test :	Statistic	0.91			Sha	piro W	ilk G	OF Te	st																				
874				59	% Sha	piro Wilk	Critica	al Value	0.881		Data ap	pear N	ormal a	at 5%	6 Signif	ican	ce Level																			
875						Lilliefors	Test :	Statistic	0.151			L	illiefors	GO	F Test																					
876					5%	Lilliefors	Critica	al Value	0.22		Data ap	pear N	ormal a	at 5%	6 Signif	ican	ce Level	Ī																		
877							Da	ita appe	ar Normal a	t 5% Signifi	cance Leve	l																								
878																																				
879								As	suming No	mal Distribu																										
880				959	6 Norn	nal UCL					95		.s (Adjı																							
881						95% Stu	udent'	's-t UCL	362							•	hen-199		371.8																	
882												95%	Modifi	ied-t	UCL (J	John	son-197	8)	364.3																	
883																																				
884										a GOF Test																										
885								Statistic					Darling																							
886						5% A-D			-	Detecte	ed data app							ance	e Level																	
887								Statistic					-Smirn																							
888						5% K-S					ed data app			istrit	outed a	t 5%	Signific	ance	Level																	
889						Detected	d data	a appea	r Gamma D	istributed at 5% Significance Level																										
890																																				
891								. (841.5)		Statistics					0.1				0.500																	
892						The		at (MLE)							•		cted MLI		2.593 110.6																	
893								at (MLE)	95.57				rneta		`		cted MLI	-	77.79																	
894					MIE	Mean (bi		at (MLE)									correcte		178.2																	
895					IVILE	weari (bi	as co	necteu)	200.9			A n.n.	avimat.		,		alue (0.0	′	58.47																	
896				٨	diueta	d Level of	f Sian	ificanco	0.0324			Appr					aiue (0.0 Jare Valu		56.41																	
897					.ujust e	u LCVCI ()	. Jigil	carice	0.0324					ujus	.cu Oill	oqu	aure vall		00.41																	
898								Δο	suming Ger	nma Distribu	ıtion																									
899		9	5% Approxir	nate Gar	nma U	CL (use v	when i					\diuste	d Gam	ma I	JCL (114	se w	hen n<5	0)	395.6																	
900						(2007		55//				-,	. 50111		(30			- /																		
901																										Lognorma	I GOF Test									
902					Sha	piro Wilk	Test	Statistic			Sh	apiro \	Vilk Lo	gnor	mal G	OF T	Test		-																	
903				59		piro Wilk				· · · · · · · · · · · · · · · · · · ·																										
904						Lilliefors							s Logn																							
905					5%	Lilliefors					Data appe							el																		
907										at 5% Signi																										
908									-																											
909									Lognorma	al Statistics																										
910					Mi	nimum of	Logg	ed Data	3.996						Mean	of lo	gged Da	ta	5.494																	
911					Ма	ximum of	Logg	ed Data	6.59						SD	of lo	gged Da	ta	0.633																	
912									1	1																										
J 1																																				

	Α	В	С	D	Е	F	G	Н		J	K	L		
913							rmal Distribu	ution						
914					95% H-UCL	432.6				Chebyshev (M		442.5		
915				•	MVUE) UCL	510.4			97.5%	Chebyshev (M	√IVUE) UCL	604.7		
916			99%	Chebyshev (MVUE) UCL	789.8								
917					M	ad - Disadh	u F 110							
918				Data annaa			tion Free UC		ioonoo I oyo					
919				Data appea	r to follow a	Discernible	DISTRIBUTION 8	it 5% Signii	icance Leve	1				
920					Nonna	rametric Dis	ribution Free	IICI e						
921				95	5% CLT UCL	357	and diameter (95% Jac	ckknife UCL	362		
922			95%	Standard Bo	otstrap UCL	355				95% Boot	strap-t UCL	382.2		
924			9	5% Hall's Bo	ootstrap UCL	446.1			95%	Percentile Boo	otstrap UCL	360.1		
925			,	95% BCA Bo	ootstrap UCL	363.3						·		
926					an, Sd) UCL	414.7				nebyshev(Mea	-	472.7		
927			97.5% Ch	ebyshev(Me	an, Sd) UCL	553			99% CI	nebyshev(Mea	an, Sd) UCL	710.9		
928														
929				050/ 04	d	Suggested 362	UCL to Use							
930				95% Stu	dent's-t UCL	302								
931		Note: Sugges	stions regard	ling the selec	ction of a 95%	UCL are pro	ovided to help	the user to	select the m	nost appropria	te 95% UCL			
932		33			ations are bas									
934		These recor								Maichle, and	Lee (2006).			
935	Но	owever, simul	lations result	s will not cov	ver all Real W	orld data set	s; for addition	nal insight th	ne user may	want to consu	ılt a statisticia	an.		
936														
937														
938	Li													
939						0	Otatiatica							
940			Total	Number of (Observations	15	Statistics		Numbe	r of Distinct O	heervations	8		
941			Total	ivalliber of C	Dosei valions	13						0		
942		Number of Missing Observations Minimum 13 Mean												
943					Maximum	22					Median	17		
945					SD	2.774				Std. Er	rror of Mean	0.716		
946				Coefficien	t of Variation	0.158					Skewness	0.00522		
947														
948							GOF Test							
949					Test Statistic	0.956			•	Ik GOF Test				
950			5% Si	•	Critical Value Test Statistic	0.881		Data appe	ear Normal a	t 5% Significa	nce Level			
951			5'		Critical Value	0.11		Data anne		t 5% Significa	nce Level			
952				70 Elillololo C			5% Significa		our recimier e	t 0 70 Olgriillou				
953 954					•••									
955					As	suming Norr	nal Distributi	on						
956			95% No	rmal UCL				95%	UCLs (Adju	sted for Skev	vness)	,		
957				95% Stu	dent's-t UCL	18.79				ed-CLT UCL (,	18.71		
958									95% Modifi	ed-t UCL (Joh	nson-1978)	18.8		
959						Comme	OF Test							
960				V D -	Test Statistic	0.265	GOF Test	Δndo	renn-Darlina	Gamma GOI	F Toet			
961					Critical Value	0.205	Detected			istributed at 5		ce Level		
962 963					Test Statistic	0.108				ov Gamma G				
964				5% K-S C	Critical Value	0.221	Detected			istributed at 5		ce Level		
965				Detected	l data appea	Gamma Di	stributed at 5	% Significa	nce Level					
966														
967							Statistics							
968					k hat (MLE)	41.82				star (bias corr	· · · · · ·	33.5		
969					ta hat (MLE)	0.419			Theta	star (bias corr	ŕ	0.523		
970			N/II		nu hat (MLE) as corrected)	1255 17.53				MLE Sd (bias	s corrected)	1005 3.029		
971			IVII	LE INICALI (DIS	ao conected)	17.00			Approximate	Chi Square \		932.4		
972 973			Adjus	sted Level of	Significance	0.0324			• •	djusted Chi So	, ,	923.8		
973			• • • • • • • • • • • • • • • • • • • •	·	- '	<u> </u>								
975					Ass	suming Gam	ma Distributi	ion						
976	g	95% Approxin	nate Gamma	UCL (use w	rhen n>=50))	18.9		95% Ac	ljusted Gami	ma UCL (use	when n<50)	19.07		
977														
978						Lognorma	GOF Test							

	Α	В	С	D	Е	F	G	Н		l		J			K		L
979			S	hapiro Wilk	Test Statistic	0.948		Shap	iro Wi	lk Log	nori	nal GC	OF T	est	t		
980			5% S	hapiro Wilk (Critical Value	0.881		Data appea	Ü			Ü			e Level	ĺ	-
981				Lilliefors	Test Statistic	0.12		Lil	liefors	Logno	orma	I GOF	Tes	st			
982			5	% Lilliefors (Critical Value	0.22		Data appea	r Logn	ormal	at 5	% Sign	ifica	ance	e Level	ĺ	
983					Data appear	Lognormal	at 5% Signif	icance Leve	ı								
984																	
985						Lognorma	l Statistics										
986					Logged Data	2.565						Mean c	of log	gge	d Data	1	2.852
987			ı	Maximum of	Logged Data	3.091						SD	of log	gge	d Data	ì	0.162
988																	
989							ormal Distrib	ution									
990					95% H-UCL	18.96				90%	Che	byshev	′ (M\	VUE	E) UCL	-	19.74
991					(MVUE) UCL	20.74			9	7.5%	Che	byshev	′ (M\	VUE	E) UCL	. 2	22.13
992			99%	Chebyshev	(MVUE) UCL	24.85											
993																	
994							tion Free UC										
995				Data appea	ar to follow a	Discernible	Distribution a	at 5% Signif	icance	Leve	ı						
996																	
997					•		tribution Fre	e UCLs									
998					5% CLT UCL	18.71									fe UCL		18.79
999					ootstrap UCL	18.67						95% Bo					18.9
1000					ootstrap UCL	18.75				95% I	Perc	entile E	3oot:	stra	ip UCL		18.73
1001					ootstrap UCL	18.53											
1002				• •	ean, Sd) UCL	19.68						shev(M			,		20.66
1003			97.5% Ch	nebyshev(Me	ean, Sd) UCL	22.01			99	9% Ch	eby	shev(M	lean	ı, So	d) UCL	- 2	24.66
1004																	
1005							UCL to Use										
1006				95% Stu	udent's-t UCL	18.79										\bot	
1007																	
1008		Note: Sugge		•	ction of a 95%	<u>'</u>		<u>'</u>				approp	riate	∍ 95	% UCI	L.	
1009					ations are ba	•											
1010					upon the resu					,					, ,		
1011	Но	wever, simu	llations resul	ts will not co	ver all Real V	Vorld data se	ts; for additio	nal insight th	ne user	may	want	to con	sult	as	tatistic	ian.	
1012																	

	A B C D E	F	G H I J K	L
1014	Mn			
1015				
1016		General	Statistics	
1017	Total Number of Observations	15	Number of Distinct Observations	15
1018			Number of Missing Observations	0
1019	Minimum	115	Mean	319.6
1020	Maximum	559	Median	326
1021	SD	107.8	Std. Error of Mean	27.82
1022	Coefficient of Variation	0.337	Skewness	-0.152
1023				
1024		Normal (GOF Test	
1025	Shapiro Wilk Test Statistic	0.898	Shapiro Wilk GOF Test	
1026	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
1027	Lilliefors Test Statistic	0.203	Lilliefors GOF Test	
1028	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	
1029	Data appea	ar Normal at	5% Significance Level	
1030				
1031	Ass	suming Nor	mal Distribution	
1032	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1033	95% Student's-t UCL	368.6	95% Adjusted-CLT UCL (Chen-1995)	364.2
1034			95% Modified-t UCL (Johnson-1978)	368.4
1035			1	
1036		Gamma	GOF Test	
1037	A-D Test Statistic	1.139	Anderson-Darling Gamma GOF Test	
1038	5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Leve	el
1039	K-S Test Statistic	0.256	Kolmogorov-Smirnov Gamma GOF Test	
1040	5% K-S Critical Value	0.222	Data Not Gamma Distributed at 5% Significance Leve	el
1041	Data Not Gamr	na Distribute	ed at 5% Significance Level	
1042				
1043		Gamma	Statistics	
1044	k hat (MLE)	7.32	k star (bias corrected MLE)	5.901
1045	Theta hat (MLE)	43.66	Theta star (bias corrected MLE)	54.16
1046	nu hat (MLE)	219.6	nu star (bias corrected)	177
1047	MLE Mean (bias corrected)	319.6	MLE Sd (bias corrected)	131.6
1048			Approximate Chi Square Value (0.05)	147.2
1049	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	143.9
1050				
1051	Ass	suming Gam	ma Distribution	
1052	95% Approximate Gamma UCL (use when n>=50))	384.2	95% Adjusted Gamma UCL (use when n<50)	393.1
1053				
1054		Lognorma	GOF Test	
1055	Shapiro Wilk Test Statistic	0.79	Shapiro Wilk Lognormal GOF Test	
1056	5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level	
1057	Lilliefors Test Statistic	0.288	Lilliefors Lognormal GOF Test	
1058	5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level	
1059	Data Not L	ognormal at	5% Significance Level	
1060				
1061		Lognorma	l Statistics	
1062	Minimum of Logged Data	4.745	Mean of logged Data	5.697
1063	Maximum of Logged Data	6.326	SD of logged Data	0.423
1064				

	Α	В	С	D	E	F	G	Н	I	J	K	L
1065							ormal Distrib	ution				
1066					95% H-UCL	408.1				Chebyshev (N	· ·	432.2
1067					(MVUE) UCL	481.3			97.5%	Chebyshev (M	MVUE) UCL	549.5
1068			99%	Chebyshev	(MVUE) UCL	683.4						
1069												
1070					•		ition Free UC					
1071				Data appea	ar to follow a	Discernible	Distribution	at 5% Signif	icance Leve	l		
1072												
1073					•		tribution Fre	e UCLs		050/ 1		202.2
1074					5% CLT UCL	365.4					ckknife UCL	368.6
1075					ootstrap UCL	363			050/ 5		strap-t UCL	365.5
1076				95% Hall's B		372			95% F	Percentile Boo	otstrap UCL	362.8
1077					ootstrap UCL	363.3			050/ 05		C4/ 1101	440.9
1078				• •	ean, Sd) UCL ean, Sd) UCL	403.1 493.4				nebyshev(Mea nebyshev(Mea		596.5
1079			97.5% CI	nebysnev(ivie	an, su) occ	493.4			99% CI	iebysnev(iviea	an, Su) UCL	596.5
1080						Suggested	UCL to Use					
1081				95% Sti	ıdent's-t UCL	368.6	001 10 030				1	
1082				3370 010	dCITS-1 OOL	300.0						
1083		Note: Sugge	stions regard	ding the sele	ction of a 95%	UCL are p	rovided to hel	In the user to	select the m	ost appropria	te 95% UCL.	
1084					ations are bas			•				
1085 1086		These reco			upon the resu	· ·					Lee (2006).	
1087	Н				ver all Real W				•		, ,	ın.
1088									•			
1089		Note: For	highly nega	tively-skewe	d data, confi	dence limits	(e.g., Chen,	, Johnson, L	ognormal, a	nd Gamma) r	nay not be	
1090			reliable.	Chen's and	Johnson's me	ethods prov	ide adjustme	ents for posit	vely skewed	data sets.		
1091												
1092												
1093	Hg											
1094												
1095						General	Statistics					
1096			Tota	I Number of	Observations	15				r of Distinct O		9
1097									Number	of Missing O		0
1098					Minimum	0.05						
1099					Maximum	0.64					Mean	0.118
1100											Median	0.118
1101				0	SD	0.148				Std. Er	Median rror of Mean	0.118 0.07 0.0381
				Coefficien	SD at of Variation	1.251				Std. Er	Median	0.118
1102				Coefficien		1.251	00F T4			Std. Er	Median rror of Mean	0.118 0.07 0.0381
1103					t of Variation	1.251 Normal	GOF Test		Shanira Mari		Median rror of Mean	0.118 0.07 0.0381
1103 1104				Shapiro Wilk	t of Variation	1.251 Normal 0.461	GOF Test	Data Na		lk GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105				Shapiro Wilk Shapiro Wilk (t of Variation Test Statistic Critical Value	1.251 Normal 0.461 0.881	GOF Test	Data No	t Normal at 5	Ik GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105 1106			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors	Test Statistic Critical Value Test Statistic	1.251 Normal 0.461 0.881 0.374	GOF Test		t Normal at 5	Ik GOF Test 5% Significand GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105 1106 1107			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors	Test Statistic Critical Value Critical Value	1.251 Normal 0.461 0.881 0.374 0.22		Data No	t Normal at 5	Ik GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105 1106 1107 1108			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors	Test Statistic Critical Value Critical Value	1.251 Normal 0.461 0.881 0.374 0.22	GOF Test	Data No	t Normal at 5	Ik GOF Test 5% Significand GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105 1106 1107 1108 1109			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors	Test Statistic Critical Value Test Statistic Critical Value Data Not	1.251 Normal 0.461 0.881 0.374 0.22 Normal at	5% Significa	Data No	t Normal at 5	Ik GOF Test 5% Significand GOF Test	Median Fror of Mean Skewness	0.118 0.07 0.0381
1103 1104 1105 1106 1107 1108 1109			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors 5% Lilliefors (Test Statistic Critical Value Test Statistic Critical Value Data Not	1.251 Normal 0.461 0.881 0.374 0.22 Normal at		Data Nonce Level	t Normal at 5 Lilliefors t Normal at 5	Ik GOF Test 5% Significand GOF Test 5% Significand	Median rror of Mean Skewness ce Level	0.118 0.07 0.0381
1103 1104 1105 1106 1107 1108 1109 1110			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors 5% Lilliefors (ormal UCL	Test Statistic Critical Value Test Statistic Critical Value Test Statistic Critical Value Data Not	1.251 Normal 0.461 0.881 0.374 0.22 Normal at 1	5% Significa	Data Nonce Level	t Normal at 5 Lilliefors t Normal at 5	Ik GOF Test 5% Significand GOF Test 5% Significand	Median rror of Mean Skewness ce Level ce Level	0.118 0.07 0.0381 3.601
1103 1104 1105 1106 1107 1108 1109 1110 1111			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors 5% Lilliefors (ormal UCL	Test Statistic Critical Value Test Statistic Critical Value Data Not	1.251 Normal 0.461 0.881 0.374 0.22 Normal at	5% Significa	Data Nonce Level	t Normal at 5 Lilliefors at Normal at 5 UCLs (Adju 95% Adjuste	Ik GOF Test 5% Significant GOF Test 5% Significant sted for Skeved-CLT UCL (4)	Median rror of Mean Skewness ce Level ce Level wness) Chen-1995)	0.118 0.07 0.0381 3.601
1103 1104 1105 1106 1107 1108 1109 1110			5% S	Shapiro Wilk Shapiro Wilk (Lilliefors 5% Lilliefors (ormal UCL	Test Statistic Critical Value Test Statistic Critical Value Test Statistic Critical Value Data Not	1.251 Normal 0.461 0.881 0.374 0.22 Normal at 1	5% Significa	Data Nonce Level	t Normal at 5 Lilliefors at Normal at 5 UCLs (Adju 95% Adjuste	Ik GOF Test 5% Significand GOF Test 5% Significand	Median rror of Mean Skewness ce Level ce Level wness) Chen-1995)	0.118 0.07 0.0381 3.601

	Α		В	С	D	Е	F	G	Н	I	J	K	L		
1115								GOF Test							
1116						Test Statistic	1.766				Gamma GOF				
1117						Critical Value	0.75				ed at 5% Signif		el		
1118						Test Statistic	0.248				ov Gamma GO				
1119						Critical Value	0.225				ed at 5% Signif	ficance Lev	el 		
1120					Da	ata Not Gamr	na Distribut	ed at 5% Sig	gnificance L	evel					
1121							0	04-41-41							
1122						I. bat (MI E)		Statistics			-t /b:	-4- d MI (T)	1 405		
1123					The	k hat (MLE)	1.801 0.0655				star (bias corre star (bias corre		1.485 0.0795		
1124						nu hat (MLE)	54.02			Tileta	nu star (bias	,	44.55		
1125				ML		as corrected)	0.118				MLE Sd (bias		0.0968		
1126						,				Approximate	Chi Square Va	,	30.24		
1127 1128				Adjus	ted Level of	Significance	0.0324				djusted Chi Squ	` '	28.79		
1129				<u> </u>							· ·				
1130						Ass	suming Gam	ma Distribu	ition						
1131		9	5% Approxim	nate Gamma	UCL (use w	/hen n>=50))	0.174		95% A	djusted Gam	ma UCL (use w	hen n<50)	0.183		
1132								l							
1133							Lognorma	GOF Test							
1134				SI	hapiro Wilk	Test Statistic	0.771		Sha	piro Wilk Log	normal GOF T	Test			
1135				5% Sh	napiro Wilk (Critical Value	0.881				t 5% Significan				
1136						Test Statistic	0.198		Li	lliefors Logn	ormal GOF Tes	st			
1137				59		Critical Value	0.22				at 5% Significa	ance Level			
1138					Data a	ppear Appro	ximate Logr	ormal at 59	6 Significan	ce Level					
1139															
1140								l Statistics							
1141				Minimum of Logged Data -2.996 Mean of logged Data Maximum of Logged Data -0.446 SD of logged Da									-2.44		
1142				IV	laximum of	Logged Data	-0.446				2D 01 10	gged Data	0.656		
1143						Acci	ıming Logno	rmal Dietrik	ution						
1144						95% H-UCL	0.16	Alliai Distrit	duon	90%	Chebyshev (M)	VIIE) LICI	0.163		
1145				95% (Chehyshey ((MVUE) UCL	0.189				Chebyshev (M)	,	0.103		
1146						(MVUE) UCL	0.294					. 02, 002			
1147 1148															
1149						Nonparame	tric Distribu	tion Free U	CL Statistics	3					
1150					Data appea	r to follow a	Discernible	Distribution	at 5% Signi	ficance Leve	l				
1151															
1152						Nonpai	rametric Dis	tribution Fre	e UCLs						
1153					95	5% CLT UCL	0.181				95% Jack	knife UCL	0.185		
1154				95%	Standard Bo	ootstrap UCL	0.181				95% Boots	trap-t UCL	0.386		
1155						ootstrap UCL	0.408			95%	Percentile Boot	strap UCL	0.191		
1156						ootstrap UCL	0.233								
1157						ean, Sd) UCL	0.232				nebyshev(Mean	. ,	0.284		
1158				97.5% Ch	ebyshev(Me	ean, Sd) UCL	0.356			99% CI	nebyshev(Mean	ı, Sd) UCL	0.497		
1159							Suggests 1	UCL to Use							
1160						95% H-UCL	0.16	JOL IO USE	•						
1161						00 /0 TI-UCL	0.10								
1162		N	lote: Sugges	stions regard	ing the selec	ction of a 95%	UCL are nr	ovided to he	lp the user to	select the n	nost appropriate	95% UCI			
1163					•	ations are bas			•						
1164 1165			These recor								Maichle, and L	ee (2006).			
1166						•					want to consult	, ,	an.		
1167															
1168				Prol	JCL comput	tes and outpu	ıts H-statisti	c based UC	Ls for histor	ical reasons	only.				
1169			H-statistic	often results	in unstable	(both high a	nd low) valu	es of UCL9	5 as shown	in examples	in the Technic	al Guide.			
1170				lt	is therefore	recommende	ed to avoid t	he use of H	-statistic bas	sed 95% UC	Ls.				
1171		Use	of nonpara	metric meth	ods are pre	ferred to com	pute UCL9	for skewed	l data sets v	hich do not	follow a gamm	a distribution	on.		
1172															
1173	Мо														
1174															
1175				T	Nicos I	Observation 1		Statistics			(D) - () - (C)				
1176				ı otal		Observations or of Detects	15 14			Numbe	r of Distinct Ob		1		
1177				NI.		er of Detects	6			Numb	Number of No er of Distinct No		1		
1178				NU		imum Detect	2			INUMD	Minimum N		2		
1179						imum Detect	9				Maximum N		2		
1180					IVIdX	um Detect	9				waxiiiluiii N	יסוו-הפופרו			

	Α	В	С	D	E	F	G	Н	ı	J K	L
1181				Vari	ance Detects	5.824				Percent Non-Detects	6.667%
1182				N	lean Detects	5.143				SD Detects	2.413
1183				Me	dian Detects	4.5				CV Detects	0.469
1184				Skew	ness Detects	0.61				Kurtosis Detects	-0.637
1185				Mean of Log	ged Detects	1.53				SD of Logged Detects	0.493
1186											
1187					Norm	nal GOF Tes	t on Detects	Only			
1188			SI	hapiro Wilk	Test Statistic	0.884		-	Shapiro Wil	k GOF Test	
1189			5% Sh	napiro Wilk (Critical Value	0.874	D	etected Data	appear Norn	nal at 5% Significance Lev	/el
1190				Lilliefors	Test Statistic	0.182			Lilliefors	GOF Test	
1191			59	% Lilliefors (Critical Value	0.226	D	etected Data	appear Norn	nal at 5% Significance Lev	/el
				De	tected Data	appear Norn					
1192 1193						••					
1193			Kaplan-N	Meier (KM)	Statistics usi	ng Normal C	ritical Value	es and other	Nonparamet	ric UCLs	
1194			•	. ,	KM Mean	4.933				Standard Error of Mean	0.638
					KM SD	2.38				95% KM (BCA) UCL	5.933
1196				95%	6 KM (t) UCL	6.056			95% KM (P	ercentile Bootstrap) UCL	5.933
1197					KM (z) UCL	5.982			,	95% KM Bootstrap t UCL	6.324
1198			g		byshev UCL	6.846				5% KM Chebyshev UCL	7.713
1199					byshev UCL	8.915				19% KM Chebyshev UCL	11.28
1200						0.010				0.00,000,000	20
1201				(Gamma GOF	Tests on De	etected Ohe	ervations Or	nlv		
1202					Test Statistic	0.446			•	ling GOF Test	
1203					Critical Value	0.738	Detecte			stributed at 5% Significan	ce I evel
1204					Test Statistic	0.147				Smirnov GOF	
1205					Critical Value	0.229	Detecte			stributed at 5% Significan	ce Level
1206					l data appear						
1207											
1208					Gamma	Statistics or	Detected D	Data Only			
1209 1210					k hat (MLE)	4.82			k s	star (bias corrected MLE)	3.835
				The	eta hat (MLE)	1.067				star (bias corrected MLE)	1.341
1211					nu hat (MLE)	135				nu star (bias corrected)	107.4
1212 1213					ean (detects)	5.143				,	
1213					, ,						
1215				-	Gamma ROS	Statistics u	sing Impute	d Non-Detec	ts		
1216			GROS may	not be used	l when data s	et has > 50%	6 NDs with m	nany tied obs	ervations at r	nultiple DLs	
1217		GROS may	not be used	when kstar	of detects is	small such a	s <1.0, espe	cially when the	ne sample siz	re is small (e.g., <15-20)	
1218					tions, GROS						
1219					This is especi						
1220		For gan	nma distribut	ed detected	data, BTVs a	ind UCLs ma	y be compu	ted using gar	nma distribut	ion on KM estimates	
1221					Minimum	0.828				Mean	4.855
1222					Maximum	9				Median	4
1223					SD	2.579				CV	0.531
1224					k hat (MLE)	3.199			ks	star (bias corrected MLE)	2.604
1225				The	eta hat (MLE)	1.518			Theta	star (bias corrected MLE)	1.865
1226					nu hat (MLE)	95.98				nu star (bias corrected)	78.12
1227			Adjusted		nificance (β)	0.0324				,	
1228		App	roximate Chi	`	,	58.76			Adjusted Chi	Square Value (78.12, β)	56.69
1229	(95% Gamma	Approximate	e UCL (use	when n>=50)	6.455			-	ed UCL (use when n<50)	6.69
1230				•	,	<u> </u>	I			/	
1231				E	stimates of G	amma Para	meters using	g KM Estima	tes		
1231					Mean (KM)	4.933				SD (KM)	2.38
1233				V	ariance (KM)	5.662				SE of Mean (KM)	0.638
1234					k hat (KM)	4.298				k star (KM)	3.483
1235					nu hat (KM)	128.9				nu star (KM)	104.5
1236				th	eta hat (KM)	1.148				theta star (KM)	1.416
1237			80%	gamma pe	rcentile (KM)	6.913			90%	gamma percentile (KM)	8.478
1238			95%	gamma pe	rcentile (KM)	9.927			99%	gamma percentile (KM)	13.04
1239											
1240					Gamm	a Kaplan-M	eier (KM) St	atistics			
1241		Appro	oximate Chi S	Square Valu	e (104.49, α)	81.9		P	Adjusted Chi	Square Value (104.49, β)	79.44
1242	95%	Gamma App	roximate KM	1-UCL (use	when n>=50)	6.294		95% Gamm	a Adjusted K	M-UCL (use when n<50)	6.489
1243											
1244				L	ognormal GC	F Test on D	etected Obs	servations O	nly		
1245			SI	hapiro Wilk	Test Statistic	0.92			Shapiro Wil	k GOF Test	
1246			5% Sh	napiro Wilk (Critical Value	0.874	Det	ected Data a	ppear Logno	rmal at 5% Significance L	evel

	Α	В	С	D	E	F	G	Н	ı	J	К	L
1247			•	Lilliefors	Test Statistic	0.171			Lilliefors	GOF Test	•	•
1248			5	% Lilliefors (Critical Value	0.226	Det	ected Data a	ppear Logn	ormal at 5% S	Significance L	_evel
1249				Dete	cted Data ap	pear Logno	rmal at 5% S	Significance	Level			
1250												
1251				Lo	gnormal RO	S Statistics (Using Imput	ed Non-Dete	cts			
1252				Mean in O	riginal Scale	4.894				Mean	in Log Scale	1.451
1253				SD in O	riginal Scale	2.517				SD	in Log Scale	0.565
1254		95% t U	JCL (assume	s normality	of ROS data)	6.039			95%	Percentile Bo	ootstrap UCL	6
1255				95% BCA B	ootstrap UCL	6.067				95% Boo	otstrap t UCL	6.206
1256				95% H-UC	L (Log ROS)	6.914						
1257												
1258			Statis	tics using K	M estimates	on Logged [Data and As	suming Logr	normal Dist	ribution		
1259				KM M	ean (logged)	1.474				KI	M Geo Mean	4.369
1260				KM	SD (logged)	0.504			95%	Critical H Val	ue (KM-Log)	2.072
1261			KM Standar	d Error of M	ean (logged)	0.135				95% H-UC	CL (KM -Log)	6.557
1262				KM	SD (logged)	0.504			95%	Critical H Val	ue (KM-Log)	2.072
1263			KM Standar	d Error of M	ean (logged)	0.135						
1264												
1265						DL/2 St	tatistics					
1266			DL/2 I	Normal					DL/2 Log-	Transformed		
1267				Mean in O	riginal Scale	4.867				Mean	in Log Scale	1.428
1268				SD in O	riginal Scale	2.56				SD	in Log Scale	0.618
1269			95% t l	JCL (Assum	es normality)	6.031				95%	H-Stat UCL	7.261
1270			DL/2 i	s not a reco	mmended m	ethod, provid	ded for comp	parisons and	historical I	reasons		
1271												

	A B C D E I	F	G H I I J K I	L
1272		tric Distribu	tion Free UCL Statistics	_
1273	Detected Data appear	Normal Di	stributed at 5% Significance Level	
1274				
1275		Suggested	UCL to Use	
1276	95% KM (t) UCL	6.056		
1277				
1278			ovided to help the user to select the most appropriate 95% UCL	-
1279			ta size, data distribution, and skewness.	
1280			nulation studies summarized in Singh, Maichle, and Lee (2006).	
1281	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticia	an.
1282				
1283	Ali			
1204	Ni			
1285		General	Statistics	
1286	Total Number of Observations	15	Number of Distinct Observations	10
1287	Total Number of Observations		Number of Missing Observations	0
1288	Minimum	9	Mean	21.73
1289 1290	Maximum	45	Median	22
1290	SD	8.102	Std. Error of Mean	2.092
1292	Coefficient of Variation	0.373	Skewness	1.516
1293				
1294		Normal	GOF Test	
1295	Shapiro Wilk Test Statistic	0.853	Shapiro Wilk GOF Test	
1296	5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level	
1297	Lilliefors Test Statistic	0.21	Lilliefors GOF Test	
1298	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	
1299	Data appear Appr	oximate No	rmal at 5% Significance Level	
1300				
1301		suming Non	mal Distribution	
1302	95% Normal UCL 95% Student's-t UCL	25.42	95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995)	26.05
1303	95% Students-t OCL	25.42	95% Modified-t UCL (Johnson-1978)	25.55
1304			93 % Woullied-t OCE (30111S011-1976)	25.55
1305		Gamma	GOF Test	
1306	A-D Test Statistic	0.563	Anderson-Darling Gamma GOF Test	
1307 1308	5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significant	ce Level
1309	K-S Test Statistic	0.164	Kolmogorov-Smirnov Gamma GOF Test	
1310	5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significant	ce Level
1311	Detected data appear	Gamma Di	stributed at 5% Significance Level	
1312				
1313		Gamma	Statistics	
1314	k hat (MLE)	8.487	k star (bias corrected MLE)	6.834
1315	Theta hat (MLE)	2.561	Theta star (bias corrected MLE)	3.18
1316	nu hat (MLE)	254.6	nu star (bias corrected)	205
1317	MLE Mean (bias corrected)	21.73	MLE Sd (bias corrected)	8.314
1318			Approximate Chi Square Value (0.05)	172.9
1319	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	169.2
1320	A	umine Oc	nes Distribution	
1321	95% Approximate Gamma UCL (use when n>=50))	25.77	nma Distribution 95% Adjusted Gamma UCL (use when n<50)	26.33
1322	30 % Approximate damina OCL (use when n>=50))	20.77	33 / Aujusteu Gallilla OCL (use when II<50)	۷۵.۵۵
1323				

	Α	В	С	D	Е	F	G	Н	I		J	K		L
1324							GOF Test							
1325					Test Statistic	0.93					rmal GOF			
1326			5% Sh	•	Critical Value	0.881		Data appea					evel	
1327					Test Statistic	0.179					nal GOF T			
1328			59	% Lilliefors (Critical Value	0.22		Data appea		mal at	5% Signif	icance Le	evel	
1329					Data appear	Lognormal	at 5% Signifi	cance Leve						
1330														
1331							l Statistics							0.010
1332					Logged Data	2.197						logged D		3.019
1333			IV	laximum of	Logged Data	3.807	ata	0.361						
1334					A		al Distrib	41						
1335							rmal Distrib	Juon	0/	00/ 01-		NAV/115\1	ICI	27.01
1336			050/ /	Oh = h= h = /	95% H-UCL	26.31					ebyshev (•		27.91
1337					MVUE) UCL	30.71 42.21			97.	5% Cn	ebyshev (MVUE) C	JCL	34.59
1338			99% (chebysnev (MVUE) UCL	42.21								
1339					Nonnarama	tric Dietribu	tion Free UC	Statistics						
1340				Data annos	r to follow a l					evel				
1341				Data appea	i to ioliow a i	Discernible	DISTIDUTION 6	it 5 /6 Olgilli	icance Le	CVCI				
1342					Nonnar	rametric Dis	tribution Free	llCl s						
1343				95	5% CLT UCL	25.17					95% Ja	ickknife L	ICI	25.42
1344			95%		otstrap UCL	25					95% Boo			26.67
1345					otstrap UCL	32.44			95	5% Pe	centile Bo			25.2
1346					otstrap UCL	26.13								
1347 1348					an, Sd) UCL	28.01			95%	6 Cheb	yshev(Me	an. Sd) L	JCL	30.85
1349				•	an, Sd) UCL	34.8					yshev(Me			42.55
1350				<u> </u>	. ,						• `			
1351						Suggested	UCL to Use							
1352				95% Stu	dent's-t UCL	25.42								
1353														
1354			When a d	ata set follo	ws an approx	imate (e.g., r	normal) distril	oution passii	ng one of	f the G	OF test			
1355		When appl	icable, it is s	uggested to	use a UCL ba	ased upon a	distribution (e.g., gamma) passing	both	GOF tests	in ProU0	CL	
1356														
1357		Note: Sugges	tions regard	ing the selec	ction of a 95%	UCL are pr	ovided to help	the user to	select th	ne mos	t appropria	ate 95% l	JCL.	
1358			R	ecommenda	ations are bas	sed upon dat	a size, data d	listribution, a	and skew	ness.				
1359		These recon	nmendations	are based (upon the resu	Its of the sim	ulation studie	es summariz	ed in Sin	igh, Ma	aichle, and	d Lee (20	06).	
1360	Ho	wever, simul	ations result	s will not cov	ver all Real W	orld data se	ts; for additio	nal insight th	ne user m	nay wa	nt to cons	ult a stati	sticia	n.
1361														
1362	Se													
1363														
1364							Statistics							•
1365			Total		Observations	15			Num		Distinct C			3
1366					er of Detects	12					umber of			3
1367			Nι		tinct Detects	3			Nur	mber o	of Distinct			1
1368					imum Detect	1					Minimum			1
1369					imum Detect	3					Maximum			1
1370					lean Detects	0.447 1.417					rercent	Non-Dete		0.669
1371					dian Detects	1.417						CV Dete		0.669
1372					ness Detects	1.455					I/14	osis Dete		1.388
1373					ged Detects	0.265					SD of Log			0.405
1374				wean or Lot	geu Delecis	0.200					OD OI LOG	geu Dell	.013	0.400
1375														

		-		
1070	A B C D E	F nal GOF Tes	G H I J K St on Detects Only	<u> </u>
1376	Shapiro Wilk Test Statistic		Shapiro Wilk GOF Test	
1377	5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level	
1378	Lilliefors Test Statistic	0.4	Lilliefors GOF Test	
1379	5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Level	
1380			al at 5% Significance Level	
1381	Detected Date	a Not Norme	il at 5 % Olymnication Level	
1382	Kanlan-Majar (KM) Statistics usi	na Normal C	Critical Values and other Nonparametric UCLs	
1383	KM Mean	1.333	KM Standard Error of Mean	0.161
1384	KM SD	0.596	95% KM (BCA) UCL	N/A
1385	95% KM (t) UCL	1.617	95% KM (Percentile Bootstrap) UCL	N/A
1386	95% KM (z) UCL	1.598	95% KM Bootstrap t UCL	N/A
1387	90% KM Chebyshev UCL	1.816	95% KM Chebyshev UCL	2.034
1388	97.5% KM Chebyshev UCL	2.338	99% KM Chebyshev UCL	2.933
1389	37.3% Rivi Chebyshev OCL	2.330	33 % KW Chebyshev OCL	2.955
1390	Gommo GOE	Toote on D	etected Observations Only	
1391	A-D Test Statistic		Anderson-Darling GOF Test	
1392	5% A-D Critical Value	0.732	Detected Data Not Gamma Distributed at 5% Significance I	Lovel
1393	K-S Test Statistic	0.732	Kolmogorov-Smirnov GOF	_evei
1394	5% K-S Critical Value	0.418	Detected Data Not Gamma Distributed at 5% Significance I	Lovel
1395			tributed at 5% Significance Level	
1396	Detected Data Not v	Gaillilla Disi	induted at 5% Significance Level	
1397	Commo	Ctatiation o	n Detected Data Only	
1398	k hat (MLE)	6.152	k star (bias corrected MLE)	4.67
1399	<u> </u>	0.132	Theta star (bias corrected MLE)	0.303
1400	Theta hat (MLE)	147.7	· · ·	112.1
1401	nu hat (MLE) Mean (detects)	1.417	nu star (bias correcteu)	112.1
1402	wearr (detects)	1.417		
1403	Commo POS	Statiation u	sing Imputed Non-Detects	
1404			6 NDs with many tied observations at multiple DLs	
1405	•		s <1.0, especially when the sample size is small (e.g., <15-20)	
1406			yield incorrect values of UCLs and BTVs	
1407		-	en the sample size is small.	
1408		-	by be computed using gamma distribution on KM estimates	
1409	Minimum	0.0812	Mean	1.183
1410	Maximum	3	Median	1.103
1411	SD	0.767	CV	0.649
1412	k hat (MLE)		k star (bias corrected MLE)	1.626
1413	Theta hat (MLE)	0.598	Theta star (bias corrected MLE)	0.728
1414	nu hat (MLE)	59.3	nu star (bias corrected)	48.77
1415	Adjusted Level of Significance (β)	0.0324	na star (bias corrected)	
1416	Approximate Chi Square Value (48.77, α)	33.74	Adjusted Chi Square Value (48.77, β)	32.21
1417	95% Gamma Approximate UCL (use when n>=50)	1.71	95% Gamma Adjusted UCL (use when n<50)	1.791
1418		, .	55% Gamma Adjusted 55E (disc when 11550)	
1419	Fetimates of C	iamma Para	meters using KM Estimates	
1420	Mean (KM)	1.333	SD (KM)	0.596
1421	Variance (KM)	0.356	SE of Mean (KM)	0.390
1422	k hat (KM)	5	k star (KM)	4.044
1423	nu hat (KM)	150	1 1	121.3
1424	theta hat (KM)	0.267	theta star (KM)	0.33
1425	80% gamma percentile (KM)		90% gamma percentile (KM)	2.222
1426		1.836		
1427	95% gamma percentile (KM)	2.577	99% gamma percentile (KM)	3.335
1428				

	A B C D E	F	G H I J K Leier (KM) Statistics	L
1429	Approximate Chi Square Value (121.33, α)		Adjusted Chi Square Value (121.33, β)	94.21
1430	95% Gamma Approximate KM-UCL (use when n>=50)		95% Gamma Adjusted KM-UCL (use when n<50)	1.717
1431 1432			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
1433	Lognormal GC	OF Test on D	etected Observations Only	
1434	Shapiro Wilk Test Statistic	0.675	Shapiro Wilk GOF Test	
1435	5% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 5% Significance Leve	el
1436	Lilliefors Test Statistic	0.41	Lilliefors GOF Test	
1437	5% Lilliefors Critical Value	0.243	Detected Data Not Lognormal at 5% Significance Leve	el
1438	Detected Data	Not Lognorn	nal at 5% Significance Level	
1439				
1440		,	Using Imputed Non-Detects	0.0024
1441	Mean in Original Scale SD in Original Scale		Mean in Log Scale SD in Log Scale	0.0924
1442	95% t UCL (assumes normality of ROS data)		95% Percentile Bootstrap UCL	1.542
1443	95% BCA Bootstrap UCL	1.619	95% Bootstrap t UCL	1.66
1444	95% H-UCL (Log ROS)		50 % Bootshap (5 5 E	1.00
1445 1446				
1447	Statistics using KM estimates	on Logged I	Data and Assuming Lognormal Distribution	
1448	KM Mean (logged)	0.212	KM Geo Mean	1.236
1449	KM SD (logged)	0.363	95% Critical H Value (KM-Log)	1.935
1450	KM Standard Error of Mean (logged)	0.0979	95% H-UCL (KM -Log)	1.593
1451	KM SD (logged)		95% Critical H Value (KM-Log)	1.935
1452	KM Standard Error of Mean (logged)	0.0979		
1453				
1454	DIVON	DL/2 S	tatistics	
1455	DL/2 Normal	1.233	DL/2 Log-Transformed	0.0732
1456	Mean in Original Scale SD in Original Scale		Mean in Log Scale SD in Log Scale	0.0732
1457	95% t UCL (Assumes normality)		95% H-Stat UCL	1.678
1458 1459			ded for comparisons and historical reasons	1.070
1460		•••	·	
1461	Nonparame	etric Distribu	tion Free UCL Statistics	
1462	Data do not follow a D	iscernible D	istribution at 5% Significance Level	
1463				
1464			UCL to Use	
1465	95% KM (t) UCL		KM H-UCL	1.593
1466	95% KM (BCA) UCL	N/A	manded LICL(a) not evellable	
1467	Warning. One or	IIIOI RECOII	imended UCL(s) not available!	
1468	Note: Suggestions regarding the selection of a 959	% UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
1469 1470			a size, data distribution, and skewness.	
1471	These recommendations are based upon the resu	ults of the sim	nulation studies summarized in Singh, Maichle, and Lee (2006).	
1471	However, simulations results will not cover all Real V	Vorld data se	ts; for additional insight the user may want to consult a statisticia	n.
1473				
1474	Ag			
1475				
1476			Statistics	
1477	Total Number of Observations		Number of Distinct Observations	1
1478	Number of Detects	-	Number of Non-Detects	15
1479	Number of Distinct Detects	U	Number of Distinct Non-Detects	1
1480	Warning: All observations are Non-Detec	ts (NDs) the	erefore all statistics and estimates should also be NDs!	
1481			stics are also NDs lying below the largest detection limit!	
1482			values to estimate environmental parameters (e.g., EPC, BTV)	
1483 1484	,,	F - 2003		
1485	The data se	et for variable	e Ag was not processed!	
1400			•	

	Α	В	С	D	Е	F	G	Н	I	J	K	L
1486												
1487												
1488												
1489	Sr											
1490						0	04-41-41					
1491			Total	Number of (Observations	General 15	Statistics		Numbe	or of Diations	Observations	15
1492			Total	Number of C	Observations	15					Observations	0
1493					Minimum	15			Numbe	i or ivilsaling	Mean	84.67
1494					Maximum	345					Median	50
1495 1496					SD	85.5				Std. I	Error of Mean	22.08
1497				Coefficien	t of Variation	1.01					Skewness	2.396
1498												
1499						Normal (GOF Test					
1500			S	hapiro Wilk	Test Statistic	0.706			Shapiro W	ilk GOF Tes	t	
1501			5% S	hapiro Wilk (Critical Value	0.881		Data No	t Normal at	5% Significa	nce Level	
1502					Test Statistic	0.269				GOF Test		
1503			5	% Lilliefors (Critical Value				t Normal at	5% Significa	nce Level	
1504					Data No	t Normal at 5	5% Significa	nce Level				
1505												
1506			050/ 11		As	suming Non	mal Distribu		1101 - (4.4)			
1507			95% N	ormal UCL	ıdent's-t UCL	123.5				usted for Sk	(Chen-1995)	135.6
1508				95% 311	Jueni S-i UCL	123.5			•		hnson-1978)	125.8
1509									95 % WOUII	ieu-i OCL (Ji	71113011-1370)	123.0
1510						Gamma	GOF Test					
1511 1512				A-D	Test Statistic			Andei	rson-Darling	Gamma G	OF Test	
1513				5% A-D (Critical Value	0.752	Detecte			•	5% Significar	ice Level
1514				K-S	Test Statistic	0.176		Kolmog	orov-Smirn	ov Gamma (GOF Test	
1515				5% K-S (Critical Value	0.225	Detecte	d data appea	ar Gamma D	Distributed at	5% Significar	ice Level
1516				Detected	d data appea	r Gamma Di	stributed at	5% Significa	nce Level			
1517												
1518							Statistics					
1519					k hat (MLE)	1.657				•	rrected MLE)	1.37
1520					eta hat (MLE)	51.1			Theta	•	rrected MLE)	61.8
1521					nu hat (MLE)	49.71					as corrected)	41.1
1522			M	LE Mean (bi	as corrected)	84.67			Annravimat	•	as corrected) Value (0.05)	72.33 27.41
1523			Δdius	sted Level of	Significance	0.0324			••		Square Value	26.04
1524			Aujus	sted Level of	Significance	0.0324				iujusteu Cili (Square value	20.04
1525					As	suming Gam	ma Distribu	tion				
1526		5% Approxir	mate Gamm	a UCL (use	when n>=50)	127			liusted Gam	ıma UCL (use	e when n<50)	133.7
1527 1528									,		,	
1529						Lognorma	I GOF Test					
1530			S	hapiro Wilk	Test Statistic	0.975		Shap	oiro Wilk Lo	gnormal GO	F Test	
1531			5% S	hapiro Wilk (Critical Value	0.881		Data appea	r Lognorma	l at 5% Signi	ficance Level	
1532				Lilliefors	Test Statistic	0.13		Lil	liefors Logr	ormal GOF	Test	
1533			5	% Lilliefors (Critical Value					l at 5% Signi	ficance Level	
1534					Data appear	r Lognormal	at 5% Signi	ficance Leve	l			
1535												
1536							l Statistics					T
1537					Logged Data	2.708					f logged Data	4.108
1538				Maximum of	Logged Data	5.844				SD o	f logged Data	0.802
1539					A		al Distelle					
1540					95% H-UCL	uming Logno	amai Distrib	ruu011	000/	Chehychov	(MVUE) UCL	135.8
1541			95%	Chehyshey	(MVUE) UCL	160.3					(MVUE) UCL	194.3
1542					(MVUE) UCL	261.2			37.370	. JilobysiieV	, J D D D D D D D D D D D D D D D D D	134.3
1543			3370		, 32, 002		<u> </u>					
1544 1545					Nonparame	etric Distribu	tion Free U	CL Statistics				
1546				Data appea	r to follow a					əl		
1040	I								==•			

	A B C D E	F	G H I J K	L
1547				
1548	-		tribution Free UCLs	
1549	95% CLT UCL		95% Jackknife UCL	123.5
1550	95% Standard Bootstrap UCL	119.4	95% Bootstrap-t UCL	177.1
1551	95% Hall's Bootstrap UCL	294.5	95% Percentile Bootstrap UCL	124.1
1552	95% BCA Bootstrap UCL 90% Chebyshev(Mean, Sd) UCL	134.2 150.9	95% Chebyshev(Mean, Sd) UCL	180.9
1553	97.5% Chebyshev(Mean, Sd) UCL	222.5	99% Chebyshev(Mean, Sd) UCL	304.3
1554	97.378 Chebyshev (Weari, 3u) OCL	222.5	33 % Chebyshev(Mean, 3d) OCL	304.3
1555 1556		Suggested	UCL to Use	
1557	95% Adjusted Gamma UCL	133.7		
1558	<u> </u>			
1559	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
1560	Recommendations are bas	sed upon da	ta size, data distribution, and skewness.	
1561	These recommendations are based upon the resu	Its of the sim	nulation studies summarized in Singh, Maichle, and Lee (2006).	
1562	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticia	in.
1563				
1564	П			
1565		Conoral	Statistics	
1566	Total Number of Observations	15	Number of Distinct Observations	1
1567	Number of Detects	0	Number of Non-Detects	15
1568	Number of Distinct Detects	0	Number of Distinct Non-Detects	1
1569 1570				
1571	Warning: All observations are Non-Detect	s (NDs), the	erefore all statistics and estimates should also be NDs!	
1572	Specifically, sample mean, UCLs, UPLs, and	d other stati	stics are also NDs lying below the largest detection limit!	
1573	The Project Team may decide to use alternative si	ite specific v	values to estimate environmental parameters (e.g., EPC, BTV)).
1574				
1575	The data se	et for variabl	e TI was not processed!	
1576				
1577				
1578	Sn.			
1579	SII			
1580		General	Statistics	
1581 1582	Total Number of Observations	15	Number of Distinct Observations	11
1583			Number of Missing Observations	0
1584	Minimum	7	Mean	14.73
1585	Maximum	28	Median	13
1586	SD	6.617	Std. Error of Mean	1.708
1587	Coefficient of Variation	0.449	Skewness	0.826
1588		N		
1589	OL. 1 1000 T. 100 11		GOF Test	
1590	Shapiro Wilk Test Statistic	0.906	Shapiro Wilk GOF Test	
1591	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.881	Data appear Normal at 5% Significance Level Lilliefors GOF Test	
1592	5% Lilliefors Critical Value	0.163	Data appear Normal at 5% Significance Level	
1593			t 5% Significance Level	
1594 1595				
1595	As	suming Non	mal Distribution	
1597	95% Normal UCL	· · · · · · · · · · · · · · · · · · ·	95% UCLs (Adjusted for Skewness)	
1598	95% Student's-t UCL	17.74	95% Adjusted-CLT UCL (Chen-1995)	17.93
1599			95% Modified-t UCL (Johnson-1978)	17.8
1600				
1601			GOF Test	
1602	A-D Test Statistic	0.338	Anderson-Darling Gamma GOF Test	
1603	5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance	ce Level
1604	K-S Test Statistic	0.166	Kolmogorov-Smirnov Gamma GOF Test	20 01/01
1605	5% K-S Critical Value		Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level	e revel
1606	регестей дага арреат	Gaillillä Di	Suivated at 0/0 Giginiicalice Level	
1607				

	Α	В	С		D	E	F	G	Н	I	J	K	L		
1608								Statistics							
1609						k hat (MLE)	5.709				star (bias correc		4.612		
1610						ta hat (MLE)	2.581			Theta	star (bias correc		3.195		
1611						nu hat (MLE)	171.3				nu star (bias		138.4		
1612				MLE N	lean (bia	as corrected)	14.73				MLE Sd (bias		6.861		
1613			Λ -1:		ll£	0::6	0.0324				Chi Square Va	` ′	112.2 109.3		
1614			Au	justeu	Level of	Significance	0.0324			AC	djusted Chi Squ	iale value	109.3		
1615						Δe	sumina Gan	nma Distribu	tion						
1616		95% Approxi	mate Gami	ma UC	l (use w		18.17			diusted Gamr	na UCL (use wh	hen n<50)	18.65		
1617		50 70 7 			_ (400 11					ajuotou du	002 (000 111		.0.00		
1618 1619							Lognorma	I GOF Test							
1620				Shapi	ro Wilk	Test Statistic	0.954		Sha	piro Wilk Log	normal GOF T	est			
1621			5%	Shapi	ro Wilk C	Critical Value	0.881		Data appea	ar Lognormal	at 5% Significa	nce Level			
1622				L	illiefors ⁻	Test Statistic	0.152		Lil	liefors Logno	ormal GOF Tes	st			
1623				5% Li	lliefors C	Critical Value	0.22		Data appea	ar Lognormal	at 5% Significa	nce Level			
1624						Data appear	Lognormal	at 5% Signif	icance Leve	əl					
1625															
1626							Lognorma	al Statistics							
1627				Mini	mum of I	Logged Data	1.946				Mean of log	gged Data	2.6		
1628				Maxi	mum of I	Logged Data	3.332				SD of log	gged Data	0.437		
1629															
1630								ormal Distrib	ution						
1631						95% H-UCL	18.72				Chebyshev (M\		19.81		
1632					•	MVUE) UCL	22.11			97.5%	Chebyshev (M\	VUE) UCL	25.32		
1633			99	% Che	byshev (MVUE) UCL	31.61								
1634						N	ada Diadi.	F 116	N 04-41-41						
1635				Dot	0 00000			tion Free UC Distribution			1				
1636				Dat	а арреа	i to ioliow a	Discernible	Distribution	at 5 % Sigili	iicalice Leve	I				
1637						Nonna	rametric Dis	tribution Fre	e IICI s						
1638					95	5% CLT UCL	17.54	T T T T T T T T T T T T T T T T T T T			95% Jack	knife UCL	17.74		
1639			95	5% Star		otstrap UCL	17.41		95% Bootstrap-t UCL						
1640 1641						otstrap UCL	17.81			95% I	Percentile Boots	· ·	18.33 17.47		
1642				95%	BCA Bo	ootstrap UCL	17.67		·						
1643			90%	Cheby	shev(Me	an, Sd) UCL	19.86			95% Ch	ebyshev(Mean	, Sd) UCL	22.18		
1644			97.5%	Cheby	shev(Me	an, Sd) UCL	25.4			99% Ch	ebyshev(Mean	, Sd) UCL	31.73		
1645															
1646							Suggested	UCL to Use							
1647				!	95% Stu	dent's-t UCL	17.74								
1648															
1649		Note: Sugge	estions rega	arding	the selec	ction of a 95%	UCL are pr	ovided to hel	p the user to	select the m	ost appropriate	95% UCL.			
1650								ta size, data							
1651						-					Maichle, and L				
1652	Н	owever, simu	ulations res	sults wi	II not cov	er all Real W	orld data se	ts; for additio	nal insight t	he user may	want to consult	a statisticia	an.		
1653															
1654	U														
1655															
1656							General	Statistics							
1657 1658			To	tal Nur	nber of C	Observations	15			Numbe	r of Distinct Obs	servations	11		
1659											of Missing Obs		0		
1660						Minimum	0.7					Mean	1.373		
1661						Maximum	2.5					Median	1.2		
1662						SD	0.554				Std. Erro	or of Mean	0.143		
1663				Co	oefficien	t of Variation	0.403					Skewness	1.063		
1664															
1665								GOF Test							
1666						Test Statistic	0.86				lk GOF Test				
1667			5%			Critical Value	0.881		Data No		5% Significance	e Level			
1668						Test Statistic	0.223				GOF Test				
1669				5% Li	lliefors C	Critical Value	0.22	-0.0: :-		ot Normal at 5	5% Significance	e Level			
1670						Data Not	Normal at	5% Significa	nce Level						

	A B C D E I	F	G H I J K	1
1671	. 0 0 E	ı		
1672	Ass	suming Nor	nal Distribution	
1673	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
1674	95% Student's-t UCL	1.625	95% Adjusted-CLT UCL (Chen-1995)	1.65
1675			95% Modified-t UCL (Johnson-1978)	1.632
1676			<u> </u>	
1677			GOF Test	
1678	A-D Test Statistic	0.659	Anderson-Darling Gamma GOF Test	
1679	5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance	e Level
1680	K-S Test Statistic	0.194	Kolmogorov-Smirnov Gamma GOF Test	
1681	5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance	e Level
1682	Detected data appear	Gamma Di	stributed at 5% Significance Level	
1683		0	Chaticalica	
1684	1. b /A/I = V		Statistics	6.050
1685	k hat (MLE)	7.514	k star (bias corrected MLE)	6.056
1686	Theta hat (MLE) nu hat (MLE)	0.183	Theta star (bias corrected MLE) nu star (bias corrected)	0.227
1687	MLE Mean (bias corrected)	1.373	MLE Sd (bias corrected)	0.558
1688	MILE Mean (Dias corrected)	1.3/3	Approximate Chi Square Value (0.05)	151.5
1689	Adjusted Level of Significance	0.0324	Approximate Chi Square Value (0.05) Adjusted Chi Square Value	148.1
1690	Aujusted Level of Organicalice	0.0024	Aujusteu Offi Oquale Value	1 10.1
1691	Ass	suming Gam	ma Distribution	
1692 1693	95% Approximate Gamma UCL (use when n>=50)	1.647	95% Adjusted Gamma UCL (use when n<50)	1.685
1693			.,	
1695		Lognorma	GOF Test	
1695	Shapiro Wilk Test Statistic	0.929	Shapiro Wilk Lognormal GOF Test	
1697	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
1698	Lilliefors Test Statistic	0.171	Lilliefors Lognormal GOF Test	
1699	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
1700	Data appear	Lognormal	at 5% Significance Level	
1701				
1702			I Statistics	
1703	Minimum of Logged Data	-0.357	Mean of logged Data	0.249
1704	Maximum of Logged Data	0.916	SD of logged Data	0.373
1705		mala c. I	and Distribution	
1706			ormal Distribution	1.771
1707	95% Chabyshay (MV/IE) LICL	1.669	90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL	2.206
1708	95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL	2.703	97.5% C⊓ebysnev (MVUE) UCL	2.206
1709	33 /0 Chebyshev (MVOE) OCL	2.703		
1710	Nonnarama	tric Distribu	tion Free UCL Statistics	
1711	<u> </u>		Distribution at 5% Significance Level	
1712 1713				
1714	Nonpar	ametric Dis	tribution Free UCLs	
1714	95% CLT UCL	1.608	95% Jackknife UCL	1.625
1716	95% Standard Bootstrap UCL	1.6	95% Bootstrap-t UCL	1.715
1717	95% Hall's Bootstrap UCL	1.659	95% Percentile Bootstrap UCL	1.607
1718	95% BCA Bootstrap UCL	1.653		
1719	90% Chebyshev(Mean, Sd) UCL	1.802	95% Chebyshev(Mean, Sd) UCL	1.996
1720	97.5% Chebyshev(Mean, Sd) UCL	2.266	99% Chebyshev(Mean, Sd) UCL	2.795
1721			<u> </u>	
1722		Suggested	UCL to Use	
1723	95% Adjusted Gamma UCL	1.685		
1724				
1725			ovided to help the user to select the most appropriate 95% UCL.	
1726			a size, data distribution, and skewness.	
1727			ulation studies summarized in Singh, Maichle, and Lee (2006).	
1728	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticia	in.
1729				
1730				

	A B C D E	F	G	Н			I K	1 1
1731 V		Г	<u>u</u>	П		J	, N	
1731								
		General	Statistics					
1733	Total Number of Observations	15			Numb	er of Distino	t Observation:	13
1734					Numbe	er of Missin	g Observation:	s 0
1735	Minimum	14					Meai	
1736	Maximum	63					Media	
1737	SD	13.61				Std	. Error of Mear	
1738	Coefficient of Variation	0.332					Skewnes	
1739	333	0.002						0.002
1740		Normal	GOF Test					
1741	Shapiro Wilk Test Statistic	0.878	1		Shapiro W	/ilk GOF Te	est	
1742	5% Shapiro Wilk Critical Value	0.881		Data No	•		cance Level	
1743	Lilliefors Test Statistic	0.244				s GOF Test		
1744	5% Lilliefors Critical Value	0.22		Data No	ot Normal at	5% Signific	cance Level	
1745 1746			5% Significa					
1747 1748	Ass	suming Nor	mal Distribu	tion				
1748	95% Normal UCL	• • • • •			UCLs (Adi	usted for S	kewness)	
1750	95% Student's-t UCL	47.12					L (Chen-1995	45.84
1751							Johnson-1978	
1751			1			,		1
1753		Gamma	GOF Test					
1754	A-D Test Statistic	1.399		Ande	rson-Darlin	g Gamma (GOF Test	
1755	5% A-D Critical Value	0.738		ata Not Gam	ıma Distribu	ited at 5% S	Significance Le	vel
1756	K-S Test Statistic	0.301		Kolmog	orov-Smirn	ov Gamma	GOF Test	
1757	5% K-S Critical Value	0.222	С	ata Not Gam	ıma Distribu	ited at 5% S	Significance Le	vel
1758	Data Not Gamn	na Distribut	ed at 5% Sig	gnificance Le	evel			
1759								
1760		Gamma	Statistics					
1761	k hat (MLE)	6.88			k	star (bias	corrected MLE	5.549
1762	Theta hat (MLE)	5.95			Theta	star (bias	corrected MLE	7.377
1763	nu hat (MLE)	206.4				nu star (bias corrected	166.5
1764	MLE Mean (bias corrected)	40.93				MLE Sd (bias corrected	17.38
1765					Approximat	te Chi Squa	re Value (0.05	137.6
1766	Adjusted Level of Significance	0.0324			P	Adjusted Ch	i Square Value	134.4
1767								
1768	Ass	suming Gan	nma Distribu	ition				
1769	95% Approximate Gamma UCL (use when n>=50))	49.51		95% Ac	ljusted Gam	nma UCL (u	se when n<50	50.7
1770								
1771	<u> </u>		I GOF Test				OF T :	
1772	Shapiro Wilk Test Statistic	0.773				gnormal G		
1773	5% Shapiro Wilk Critical Value	0.881					ficance Level	
1774	Lilliefors Test Statistic	0.324				normal GO		
1775	5% Lilliefors Critical Value	0.22	EW Clasific		Lognormal	at 5% Signi	ficance Level	
1776	Data Not L	оўнонна а	t 5% Signific	Janue Level				
1777		Lognorma	d Stationies					
1778	Minimum of Logged Detail	2.639	al Statistics			M	of logged Det	3.638
1779	Minimum of Logged Data Maximum of Logged Data	4.143					of logged Data	
1780	waxiiiuiii oi Logged Data	4. 143				30	or rogged Data	U. 44 I
1781	Δεοι	ımina l oanı	ormal Distrib	ution				
1782	95% H-UCL	53.04	ai Disuit		90%	6 Chehysha	v (MVUE) UCI	56.11
1783	95% Chebyshev (MVUE) UCL	62.69					v (MVUE) UCI	
1784	99% Chebyshev (MVUE) UCL	89.77			37.070		,, 52, 501	750
1785	55.5 555755. (62) 662		I					1
1786 1787	Nonparame	tric Distribu	ition Free U	CL Statistics				
	Data do not fo							
1788 1789				(-			
1709								

1 1	Α	В	С	D	E	F	G H	I	J K	L
1790				•	Nonpa	rametric Dis	tribution Free UCLs	•		
1791				9	5% CLT UCL	46.71			95% Jackknife UCL	47.12
			95%	Standard B	ootstrap UCL	46.58			95% Bootstrap-t UCL	46
1792					ootstrap UCL	45.89		95%	Percentile Bootstrap UCL	46.2
1793					ootstrap UCL	45.8		0070	Crochine Booletap COL	10.2
1794								050/ 01		50.05
1795				, ,	ean, Sd) UCL	51.47			nebyshev(Mean, Sd) UCL	56.25
1796			97.5% Ch	ebyshev(Me	ean, Sd) UCL	62.88		99% CI	nebyshev(Mean, Sd) UCL	75.9
1797										
1798						Suggested	UCL to Use			
1799				95% Stu	udent's-t UCL	47.12			or 95% Modified-t UCL	46.99
1800										
1801		Note: Sugge	stions regard	ling the sele	ction of a 95%	UCL are pro	ovided to help the user	to select the m	nost appropriate 95% UCL	
							a size, data distribution			
1802		These recor							Maichle, and Lee (2006).	
1803	Н				·				want to consult a statisticia	an .
1804		owever, simu	ialions result	.5 WIII HOLCO	vei ali i teai vi	TOTIU Uata Se	is, for additional insign	t the user may	want to consult a statistici	aii.
1805										
1806		Note: For			<u> </u>		• • • • • • • • • • • • • • • • • • • •		nd Gamma) may not be	
1807			reliable.	Chen's and	Johnson's m	ethods provi	de adjustments for po	sitvely skewed	I data sets.	
1808										
1809										
1810	Zn									
1811										
1812						General	Statistics			
1813			Total	Number of	Observations	15		Numbe	r of Distinct Observations	15
									r of Missing Observations	0
1814					Minimum	267			Mean	1026
1815					Maximum	5020			Median	629
1816					SD	1210			Std. Error of Mean	312.5
1817				0 (6						
1818				Соепісіег	nt of Variation	1.18			Skewness	2.89
1819										
1820							GOF Test			
1821			S	hapiro Wilk	Test Statistic	0.623			lk GOF Test	
1822			5% SI	hapiro Wilk	Critical Value	0.881	Data	Not Normal at	5% Significance Level	
1823				Lilliefors	Test Statistic	0.285		Lilliefors	GOF Test	
1824			5	% Lilliefors	Critical Value	0.22	Data	Not Normal at	5% Significance Level	
1825					Data Not	Normal at 5	% Significance Level			
1826										
1827					As	suming Norr	nal Distribution			
1828			95% No	rmal UCL			95	5% UCLs (Adju	sted for Skewness)	
1829				95% Stu	udent's-t UCL	1576		95% Adjuste	ed-CLT UCL (Chen-1995)	1789
1830								95% Modifi	ed-t UCL (Johnson-1978)	1615
1831										
						Gamma	GOF Test			
1832				A-D	Test Statistic	0.834		derson-Darling	Gamma GOF Test	
1833					Critical Value	0.755			ed at 5% Significance Lev	ام
1834					Test Statistic	0.197			ov Gamma GOF Test	
1835					Critical Value	0.197			istributed at 5% Significan	ce l evel
1836							Distribution at 5% Sig			OO LEVEI
1837				Perecien 0	аса гоном Ар	рг. чанина і	Distribution at 3% SIG	micalice Leve	1	
1838						C	Otatiatia -			
1839					11		Statistics			
1840					k hat (MLE)	1.433			star (bias corrected MLE)	1.19
1841					eta hat (MLE)	716.1		Theta	star (bias corrected MLE)	861.7
1842					nu hat (MLE)	42.98			nu star (bias corrected)	35.71
1843			MI	LE Mean (bi	as corrected)	1026			MLE Sd (bias corrected)	940.2
1844								Approximate	Chi Square Value (0.05)	23.04
1845			Adjus	ted Level of	f Significance	0.0324		A	djusted Chi Square Value	21.79
. 5 10						<u> </u>				
1846					As	suming Gam	ma Distribution			
1846 1847						1590		Adjusted Gami	ma UCL (use when n<50)	1681
1847		95% Approxi	mate Gamm	a UCL (use	when n>=50)		23,0	,	,	
1847 1848		95% Approxi	mate Gamm	a UCL (use	when n>=50)	1000				
1847 1848 1849		95% Approxi	mate Gamm	a UCL (use	when n>=50)		I GOF Test			
1847 1848 1849 1850		95% Approxi			,	Lognorma	GOF Test	aniro Wille I	unormal GOE Toot	
1847 1848 1849 1850 1851	:	95% Approxi	S	hapiro Wilk	Test Statistic	Lognorma 0.913	St		gnormal GOF Test	
1847 1848 1849 1850		95% Approxi	S	hapiro Wilk	Test Statistic	Lognorma 0.913 0.881	St Data app	ear Lognormal	at 5% Significance Level	
1847 1848 1849 1850 1851		95% Approxi	S 5% SI	hapiro Wilk hapiro Wilk Lilliefors	Test Statistic Critical Value Test Statistic	Lognormal 0.913 0.881 0.15	St Data app	ear Lognormal Lilliefors Logn	at 5% Significance Level	
1847 1848 1849 1850 1851 1852		95% Approxi	S 5% SI	hapiro Wilk hapiro Wilk Lilliefors	Test Statistic Critical Value Test Statistic Critical Value	0.913 0.881 0.15 0.22	St Data app	ear Lognormal Lilliefors Lognormal	at 5% Significance Level	

	А	В	С	D	Е	F	G	Н	I		J	K	T	L
1856														
1857							l Statistics							
1858				Minimum of I		5.587						logged Da		6.545
1859			N	laximum of l	ogged Data	8.521					SD of	logged Da	а	0.831
1860														
1861							ormal Distrib	ution						
1862					95% H-UCL						Chebyshev (, ,		
1863				Chebyshev (1911			97	'.5% (Chebyshev ((MVUE) UC	L 23	25
1864			99% (Chebyshev (MVUE) UCL	3138								
1865														
1866					•		tion Free UC							
1867				Data appea	r to follow a	Discernible	Distribution	at 5% Signif	icance l	Level				
1868														
1869							tribution Fre	e UCLs						
1870					% CLT UCL							ackknife UC		
1871				Standard Bo	'	1532						otstrap-t UC		
1872				5% Hall's Bo		3352	95% Percentile Bootstrap UCL						L 15	37
1873				95% BCA Bo	'	1852								
1874				ebyshev(Me		1963					ebyshev(Me			
1875			97.5% Ch	ebyshev(Me	an, Sd) UCL	2977			999	% Ch	ebyshev(Me	ean, Sd) UC	L 41	35
1876														
1877							UCL to Use							
1878			959	% Adjusted (Gamma UCL	1681								
1879														
1880							normal) distri							
1881		When app	licable, it is s	uggested to	use a UCL b	ased upon a	distribution (e.g., gamma	ı) passin	ng bot	h GOF tests	s in ProUCL		
1882														
1883		Note: Sugge	stions regard									ate 95% U	L.	
1884							a size, data d							
1885			mmendations		<u>'</u>							`	<u>'</u>	
1886	Ho	wever, simu	lations result	s will not cov	er all Real V	Vorld data se	ts; for additio	nal insight th	ne user r	may v	vant to cons	ult a statist	cian.	
1887														

	A B C	D E	F	G	Н	I	J	K		L
1		UCL Stat	stics for Data	Sets with No	on-Detects					
2	Lloar Calacted Options									
3	User Selected Options Date/Time of Computation	ProUCL 5.111/16/2018	12.40.20 DM							
4	From File	WorkSheet.xls	12.40.30 PW							
5	Full Precision	OFF								
6	Confidence Coefficient	95%								
7	Number of Bootstrap Operations	2000								
8	Number of Bootstrap Operations	2000								
9										
10	B(a)P TPE									
12	()									
13			General	Statistics						
14	Total	Number of Observations	s 15			Numbe	r of Distinct Ob	oservations	1	5
15						Numbe	r of Missing Ob	servations	(0
16		Minimun	0.138					Mean	(0.866
17		Maximun	1.941					Median	(0.74
18		SI	0.565				Std. En	ror of Mean	(0.146
19		Coefficient of Variation	0.653					Skewness	(0.875
20										
21			Normal	GOF Test						
22		hapiro Wilk Test Statistic				-	ilk GOF Test			
23	5% S	napiro Wilk Critical Value			Data app		t 5% Significa	nce Level		
24		Lilliefors Test Statistic					GOF Test			
25	5	% Lilliefors Critical Value				ear Normal a	t 5% Significa	nce Level		
26		Data app	ear Normal a	t 5% Significa	ance Level					
27			aarmina Nas	mal Distributi						
28	05% Na	ormal UCL	ssuming Nor	mal Distribution		LICL o (Adio	sted for Skew	(DODO)		
29	55% NC	95% Student's-t UCI	1.123				ed-CLT UCL (C		-	1.141
30		33 % Student 3-t OCI	1.125			-	ed-t UCL (Johi	,		1.129
31						30 /0 WIOGIII	CG 1 00L (00III	13011 1370)		
32			Gamma	GOF Test						
33		A-D Test Statistic			Ande	rson-Darling	Gamma GOF	Test		
35		5% A-D Critical Value	0.746	Detected			istributed at 59		ce L	evel
36		K-S Test Statistic	0.124				ov Gamma GC			
37		5% K-S Critical Value	0.224	Detected			istributed at 59		ce L	evel
38		Detected data appear	ar Gamma Di	stributed at 5	% Significa	nce Level				
39										
40			Gamma	Statistics						
41		k hat (MLE	2.459			k	star (bias corre	ected MLE)	2	2.012
42		Theta hat (MLE	0.352			Theta	star (bias corre	ected MLE)	(0.431
43		nu hat (MLE	73.77				nu star (bias	corrected)		0.35
44	MI	E Mean (bias corrected	0.866				MLE Sd (bias			0.611
45							e Chi Square V			3.48
46	Adjus	ted Level of Significance	0.0324			A	djusted Chi Sq	uare Value	4	1.72
47										
48	050/ A		_	ma Distributi			1101.1	1 ==:	1	4.050
49	95% Approximate Gamma	UCL (use when n>=50)	1.202		95% Ac	Ijusted Gamı	ma UCL (use v	vhen n<50)	1	1.253
50										

	Α		В	С	D	Е	F	G	Н	ı	J	K	L
51							Lognormal	GOF Test					
52				S	Shapiro Wilk 1	Test Statistic	0.959		Shap	oiro Wilk Log	normal GOF	- Test	
53				5% S	hapiro Wilk C	Critical Value	0.881		Data appea	r Lognormal	at 5% Signif	icance Level	
54					Lilliefors 7	Test Statistic	0.108		Lil	liefors Logno	ormal GOF T	lest l	
55				5	% Lilliefors C	Critical Value	0.22		Data appea	r Lognormal	at 5% Signif	icance Level	
56						Data appear	Lognormal	at 5% Signif	icance Leve) 			
57													
58							Lognorma	Statistics					
59					Minimum of L	ogged Data	-1.981				Mean of	logged Data	-0.361
60				ı	Maximum of L	ogged Data	0.663				SD of	logged Data	0.72
61						Assı	ıming Logno	rmal Distrib	ution				
62						95% H-UCL	1.416			90%	Chehyshey ((MVUE) UCL	1.407
63				95%	Chebyshev (1.643				, ,	(MVUE) UCL	1.971
64					Chebyshev (2.615			97.576	Chebyshev (WIVOL) OCL	1.371
65				99 /0	Chebyshev (WIVUE) UCL	2.015						
66													
67							tric Distribut						
68					Data appea	r to follow a	Discernible I	Distribution a	at 5% Signif	icance Leve			
69													
70						Nonpa	ametric Dist	ribution Fre	e UCLs				
71						5% CLT UCL	1.106					ackknife UCL	1.123
72				95%	Standard Bo	otstrap UCL	1.104				95% Boo	otstrap-t UCL	1.198
73				S	5% Hall's Bo	otstrap UCL	1.162			95% F	Percentile Bo	ootstrap UCL	1.104
74					95% BCA Bo	otstrap UCL	1.14						
75				90% Ch	ebyshev(Me	an, Sd) UCL	1.304			95% Ch	ebyshev(Me	an, Sd) UCL	1.502
76				97.5% Ch	nebyshev(Me	an, Sd) UCL	1.778			99% Ch	ebyshev(Me	an, Sd) UCL	2.318
77													
78							Suggested	UCL to Use					
79					95% Stu	dent's-t UCL	1.123						
80		No	te: Sugge	stions regard	ling the selec	tion of a 95%	UCL are pro	ovided to hel	n the user to	select the m	nost appropri	ate 95% UCL	
81						itions are bas							<u> </u>
82		Т	hese recoi				•					d Lee (2006).	
83												sult a statisticia	
84		TIOW	ever, simu	iations result	is will flot cov	ei ali i teai vv	Unu uata set	s, ioi additio	ilai ilisigili ti	le user may	want to cons	uit a statisticio	
85													
86	=-												
87	F3												
88													
89							General	Statistics					
90				Total	Number of C	Observations	15					Observations	15
91										Number	of Missing C	Observations	0
92						Minimum	38					Mean	187.9
93				-	-	Maximum	419			-	-	Median	200
94						SD	112.2				Std. E	rror of Mean	28.96
95					Coefficient	of Variation	0.597					Skewness	0.279
96													
97							Normal C	OF Test					
98				S	Shapiro Wilk	Test Statistic	0.926			Shapiro Wi	lk GOF Test		
99					hapiro Wilk C		0.881		Data appe		t 5% Significa		
					•	Test Statistic	0.167				GOF Test		
100				5	% Lilliefors C		0.22		Data anne		t 5% Significa	ance I evel	
101					.,		ar Normal at	5% Signific			- 2.0 Orginilo		
102						sata appe	a. Homiai al	570 Olgillill					

	A B C D E	F	G H I J K	L
103				
104		suming Nor	mal Distribution	
105	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
106	95% Student's-t UCL	238.9	95% Adjusted-CLT UCL (Chen-1995)	237.8
107			95% Modified-t UCL (Johnson-1978)	239.3
108		Commo	COE Took	
109	A.D. Tank Okakishia		GOF Test Anderson-Darling Gamma GOF Test	
110	A-D Test Statistic 5% A-D Critical Value	0.647	Detected data appear Gamma Distributed at 5% Significance	a Laval
111	K-S Test Statistic	0.740	Kolmogorov-Smirnov Gamma GOF Test	e Level
112	5% K-S Critical Value	0.201	Detected data appear Gamma Distributed at 5% Significance	e I evel
113			stributed at 5% Significance Level	e Level
114	Detected data appear	Gaillilla Di	Subuted at 5% Significance Level	
115		Gamma	Statistics	
116	k hat (MLE)	2.423	k star (bias corrected MLE)	1.983
117	Theta hat (MLE)	77.56	Theta star (bias corrected MLE)	94.78
118	nu hat (MLE)	72.69	nu star (bias corrected)	59.49
119 120	MLE Mean (bias corrected)	187.9	MLE Sd (bias corrected)	133.5
121	, ,		Approximate Chi Square Value (0.05)	42.75
122	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	41.01
123				
124	Ass	suming Gan	nma Distribution	
125	95% Approximate Gamma UCL (use when n>=50))	261.5	95% Adjusted Gamma UCL (use when n<50)	272.6
126				
127		Lognorma	I GOF Test	
128	Shapiro Wilk Test Statistic	0.899	Shapiro Wilk Lognormal GOF Test	
129	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
130	Lilliefors Test Statistic	0.23	Lilliefors Lognormal GOF Test	
131	5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level	
132	Data appear Appro	ximate Logi	normal at 5% Significance Level	
133				
134			Il Statistics	
135	Minimum of Logged Data	3.638	Mean of logged Data	5.016
136	Maximum of Logged Data	6.038	SD of logged Data	0.746
137				
138			ormal Distribution	
139	95% H-UCL	319.2	90% Chebyshev (MVUE) UCL	313.9
140	95% Chebyshev (MVUE) UCL	367.9	97.5% Chebyshev (MVUE) UCL	442.8
141	99% Chebyshev (MVUE) UCL	590		
142	Namanana	ania Disanibu	talon Free HOL Chesistics	
143	•		tion Free UCL Statistics Distribution at 5% Significance Level	
144	Data appear to follow a r	Discernible	Distribution at 5% Significance Level	
145	Nonna	rametric Die	tribution Free UCLs	
146	95% CLT UCL	235.6	95% Jackknife UCL	238.9
147	95% Standard Bootstrap UCL	234.9	95% Bootstrap-t UCL	240
148	95% Hall's Bootstrap UCL	238.1	95% Percentile Bootstrap UCL	232.8
149	95% BCA Bootstrap UCL	236.1	30 % i Greentile Bootstap OCL	202.0
150	90% Chebyshev(Mean, Sd) UCL	274.8	95% Chebyshev(Mean, Sd) UCL	314.2
151	97.5% Chebyshev(Mean, Sd) UCL	368.8	99% Chebyshev(Mean, Sd) UCL	476.1
152				-
153 154		Suggested	UCL to Use	
155	95% Student's-t UCL	238.9		
156		<u> </u>	1	
157	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
158	Recommendations are bas	sed upon da	ta size, data distribution, and skewness.	
159	These recommendations are based upon the resul	Its of the sin	nulation studies summarized in Singh, Maichle, and Lee (2006).	
160	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticia	ın.
161				
101				

	А	В	С	D	Е	F	G	Н	I	J	K	L
1				L	JCL Statisti	cs for Data	Sets with	Non-Dete	ects			
3	He	er Selec	ted Options									
4			mputation		5.111/17/20	18 3:36:40	PM					
5			From File	WorkShe								
6		Full	Precision	OFF								
7			Coefficient	95%								
8	mber of Boo	otstrap C	Operations	2000								
9												
10	HMW PAH	<u> </u>										
12		-										
13						General	Statistics					
14			Total Nu	mber of Ol	bservations	15				Distinct Obs		15
15					Minimo	0.847			Number of	Missing Obs		0
16 17					Minimum Maximum	12.18					Mean Median	4.53 3.732
18					SD	3.08				Std. Erro	or of Mean	0.795
19			C	Coefficient	of Variation	0.68				(Skewness	1.154
20												
21							GOF Test					
22					est Statistic ritical Value	0.912 0.881		Data anno	-	ilk GOF Tes it 5% Signific		
23					est Statistic	0.881	'	рата арре		GOF Test	Jance Leve	
25					ritical Value	0.22	[Data appe		t 5% Signific	cance Leve	el
26					Data appea	Normal a	t 5% Signi	ficance Le	evel			
27												
28			050/ 11			uming Nor	mal Distrib		1101 - (4 -15			
30			95% NO	ormal UCL	ent's-t UCL	5.931				usted for Ske CLT UCL (Ch		6.091
31				30 % Otau	CIRS COOL	0.001				UCL (Johns		5.97
32											/	
33							GOF Test					
34					est Statistic	0.127				Gamma G		
35 36					ritical Value est Statistic	0.746				istributed at ov Gamma (-	cance Leve
37					ritical Value					istributed at		cance Lev
38			D	etected da	ata appear				nificance Le			
39												
40					k hat (MLE)	Gamma 2.358	Statistics		l, ata	r (bias correc	ated MLEV	1.931
41					a hat (MLE)	1.921				(bias correc	,	2.346
43					u hat (MLE)	70.75				u star (bias	,	57.93
44			MLE I		s corrected)	4.53				E Sd (bias		3.26
45								Арр		ni Square Va	. ,	41.44
46			Adjusted	Level of S	Significance	0.0324			Adjus	ted Chi Squ	are Value	39.72
47 48					Δεει	ımina Gan	nma Distrib	oution				
49	95% Appı	oximate	Gamma UC	CL (use wh		6.334			ed Gamma	UCL (use wh	hen n<50)	6.607
50	•			`								
51							I GOF Tes					
52					est Statistic	0.983	_			normal GO		
53					ritical Value est Statistic	0.881 0.106	Da			at 5% Signi		vel
54 55					ritical Value	0.100	Da			at 5% Signi		vel
56			0,01		ita appear l					at 070 Oigin	11041100 20	
57												
58							I Statistics	3				
59					ogged Data	-0.166				Mean of log		1.284
60			Max	ımum of Lo	ogged Data	2.5				SD of log	gged Data	0.729
61 62					Aeeur	ning Loans	ormal Distr	ibution				
63				g	95% H-UCL	7.434	a. Diali	.544011	90% Ch	ebyshev (M\	√UE) UCL	7.361
64			95% Che		IVUE) UCL	8.607				ebyshev (M\	,	10.34
65			99% Che	ebyshev (M	IVUE) UCL	13.74						
66												

	A B C D E	F	G	Н	ı	J	K	L
67	Nonparametr					Lovel		
68 69	Data appear to follow a Di	scernible	Distribution	at 5% Sig	nificance	Levei		
70	Nonpara	metric Dis	tribution Fr	ee UCLs				
71	95% CLT UCL	5.838				95% Jackl	knife UCL	5.931
72	95% Standard Bootstrap UCL	5.759				95% Bootsti	rap-t UCL	6.292
73	95% Hall's Bootstrap UCL	6.433			95% Pero	centile Boots	trap UCL	5.861
74	95% BCA Bootstrap UCL	6.051			F0/ OL 1	1 (14	0 1) 1101	7.000
75	90% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL	6.916 9.496				vshev(Mean, vshev(Mean,		
76 77	97.3% Chebyshev(Mean, 3d) OCL	3.430		3.	3 76 Cheby	Silev(ivicari,	3u) 0CL	12.44
78	S	Suggested	UCL to Use	Э				
79	95% Student's-t UCL	5.931						
80								
81	Note: Suggestions regarding the selection of a 95% U						propriate	95% UCL.
82	Recommendations are based These recommendations are based upon the results				·		o and la	(2006)
83 84	However, simulations results will not cover all Real Wor					_		
85	iowovor, ominationo rocalto will not cover all rical viol	na aata oo	io, ioi additi	orial inloigh	110 0001	may want to	Coriodic	- Clatioticiai
86								
87	LMW PAHs							
88								
89	Total Number of Observations		Statistics		lab av af	Distinct Obs		15
90	Total Number of Observations	15				Distinct Obs Missing Obs		
91 92	Minimum	0.916			uniber or	Wilsoling Obs	Mean	-
93	Maximum	12.77					Median	
94	SD	3.764				Std. Erro	r of Mean	0.972
95	Coefficient of Variation	0.653				5	Skewness	0.792
96								
97	Chamina Wills Tank Chakinkin		GOF Test		hamira \A/i	Ur COE Tool	1	
98	Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	0.901	D		-	Ik GOF Test t 5% Signific		ام
100	Lilliefors Test Statistic	0.185				GOF Test	ance Lev	
101	5% Lilliefors Critical Value	0.22	D			t 5% Signific	ance Lev	el
102	Data appear	Normal at	5% Signifi	cance Lev	əl			
103								
104	Assu 95% Normal UCL	ıming Nori	mal Distribu		Ol o (Adiu	atad for Cka		
105 106	95% Student's-t UCL	7.476				sted for Ske LT UCL (Ch		7.576
107	30% Cladent 1 002	7.470				UCL (Johns		
108	-							
109			GOF Test					
110	A-D Test Statistic	0.227				Gamma GC		
111	5% A-D Critical Value K-S Test Statistic	0.746	etected da			stributed at v Gamma G		
112 113	5% K-S Critical Value		etected da			stributed at		
114	Detected data appear 0						- · · J	
115				-				
116			Statistics					
117	k hat (MLE)	2.398				(bias correc		
118	Theta hat (MLE) nu hat (MLE)	2.404 71.95				(bias correctus)		
119 120	MLE Mean (bias corrected)	5.765				E Sd (bias c	,	
121	(2.22 556664)	33		Appro		i Square Va		
122	Adjusted Level of Significance	0.0324				ted Chi Squ		
123								
124			ma Distrib		0-	101 /		0.070
125	95% Approximate Gamma UCL (use when n>=50))	8.036	95	% Adjusted	Gamma (JCL (use wh	ien n<50)	8.379
126 127		Lognorma	I GOF Test					
128	Shapiro Wilk Test Statistic	0.96			Wilk Loa	normal GOI	F Test	
129	5% Shapiro Wilk Critical Value	0.881	Dat	<u>-</u>		at 5% Signif		evel
130	Lilliefors Test Statistic	0.11				ormal GOF		
131	5% Lilliefors Critical Value	0.22				at 5% Signif	ficance Le	evel
132	Data appear L	.ognormal	at 5% Sign	rticance Le	vel			

	Α	В	С	D	Е	F	G	Н	I	J	K	L	
133													
134						Lognorma	l Statistics						
135			Min	imum of Lo	gged Data	-0.0877				Mean of lo	gged Data	1.529	
136			Max	imum of Lo	gged Data	2.547				SD of lo	gged Data	0.732	
137													
138						ning Logno	rmal Distri	bution					
139					5% H-UCL	9.556			90% Ch	ebyshev (M	VUE) UCL	9.448	
140			95% Che	ebyshev (M	VUE) UCL	11.05			97.5% Ch	ebyshev (M	VUE) UCL	13.28	
141			99% Che	ebyshev (M	VUE) UCL	17.66							
142													
143					-	ric Distribu							
144	Data appear to follow a Discernible Distribution at 5% Significance Level												
145													
146					Nonpara	metric Dist	ribution Fr	ee UCLs					
147				95%	CLT UCL	7.363				95% Jack	knife UCL	7.476	
148			95% Sta	indard Boo	tstrap UCL	7.281				95% Boots	trap-t UCL	7.903	
149			95%	Hall's Boo	tstrap UCL	7.581			95% Per	centile Boot	strap UCL	7.279	
150			95%	6 BCA Boo	tstrap UCL	7.586							
151		Ç	90% Cheby	/shev(Meaı	n, Sd) UCL	8.68		9	95% Cheb	yshev(Mean	ı, Sd) UCL	10	
152		97	7.5% Cheby	/shev(Meai	n, Sd) UCL	11.83		,	99% Cheb	yshev(Mean	ı, Sd) UCL	15.43	
153													
154					5	Suggested	UCL to Us	е					
155				95% Stude	ent's-t UCL	7.476							
156													
157	Note: Sug	gestions r	egarding th	ne selection	of a 95% l	JCL are pro	ovided to h	elp the use	er to select	the most ap	opropriate 9	95% UCL.	
158			Recon	nmendatior	ns are base	d upon dat	a size, data	a distribution	on, and ske	ewness.			
159				•						Singh, Maich		, ,	
160	lowever, si	mulations	results will	not cover a	all Real Wo	rld data set	s; for addit	ional insig	nt the user	may want to	o consult a	statisticiar	
161	·												

	Α	В	С	D	E		F	G	H	I	J	K	L
1					UCL S	atis	tics for Data	Sets with r	lon-Detects				
2													
3			ected Option			100	40.00.444						
4	Date/	Time of C	Computation		5.111/15/20	18 8	:48:09 AM						
5			From File		et_a.xls								
6			ull Precision										
7			Coefficien										
8	Number of	Bootstrap	Operation	2000									
9													
10	PCBs												
11													
12								Statistics			(5)		
13			10	tal Number o			15			Numbe		Observations	
14					ber of Dete		12					Non-Detects	3
15				Number of I			10			Numbe		Non-Detects	1
16					linimum De		0.03					n Non-Detect	
17					aximum De		0.65					n Non-Detect	0.02
18				Va	riance Dete		0.0404				Percent	Non-Detects	20%
19					Mean Dete		0.186					SD Detects	0.201
20					ledian Dete		0.1					CV Detects	1.082
21					wness Dete		1.722					rtosis Detects	
22				Mean of L	ogged Dete	cts	-2.123				SD of Log	gged Detects	0.945
23													
24								t on Detects	s Only				
25					k Test Stati		0.733				ik GOF Tes		
26			5%	Shapiro Wil			0.859		Detected Da			nificance Leve	el
27				Lilliefo	s Test Stati	stic	0.281				GOF Test		
28				5% Lilliefor	s Critical Va		0.243				al at 5% Sigr	nificance Leve	el
29					Detected	Data	Not Norma	ıl at 5% Sigi	nificance Lev	/el			
30													
31			Kapla	n-Meier (KM				ritical Value	es and other	•			
32					KM Me	ean	0.153			KN	/I Standard E	Error of Mean	0.0498
33					KM	SD	0.185				95% KN	M (BCA) UCL	0.243
34				9	5% KM (t) U	CL	0.24			95% KM (F	Percentile Bo	ootstrap) UCL	0.235
35				95	% KM (z) U	CL	0.235				95% KM Bo	otstrap t UCL	0.364
36					hebyshev U		0.302					ebyshev UCL	0.37
37				97.5% KM C	hebyshev U	CL	0.463			9	99% KM Che	ebyshev UCL	0.648
38													
39					Gamma G	OF		etected Obs	ervations Or	•			
40				A-	D Test Stati	stic	0.618			nderson-Da			
41					Critical Va		0.751	Detecte				5% Significar	ice Level
42					S Test Stati		0.211			Kolmogorov-			
43					6 Critical Va		0.251				istributed at	5% Significar	ice Level
44				Detect	ed data ap	pear	Gamma Di	stributed at	5% Significa	nce Level			
45													
46							Statistics or	Detected [Data Only				
47					k hat (M	,	1.277					rrected MLE)	1.013
48				Т	heta hat (M	LE)	0.146			Theta	star (bias co	rrected MLE)	0.183
49					nu hat (M	LE)	30.65				nu star (bi	ias corrected)	24.32
50					Mean (dete	cts)	0.186						
51													

	Α	В	С	D	E	F	G	H		J	K	L
1					UCL Statis	tics for Data	Sets with N	on-Detect	S			
2				T								
3			cted Options									
4	Date	e/Time of Co	•		11/14/2018 4	1:02:11 PM						
5			From File	WorkSheet_	_b.xls							
6			I Precision	OFF								
7		Confidence (95%								
8	Number o	f Bootstrap (Operations	2000								
9	- 0											
10	F2											
11						Cananal	Statistics					
12			Total	Number of C)haan satiana	14	Statistics		Niconala	r of Distinct	Observations	11
13			Total			10			Numbe			11
14			Ni	ımber of Dist	er of Detects	10			Numb		Non-Detects	1
15			INU		mum Detect	0.06			INUITID		n Non-Detect	0.05
16					mum Detect	230					n Non-Detect	0.05
17					nce Detects	5228					: Non-Detects	28.57%
18					ean Detects	24.28				Percent	SD Detects	72.31
19					dian Detects	0.86					CV Detects	2.978
20					ess Detects	3.158				Kur	tosis Detects	9.98
21				Mean of Log		0.0369					gged Detects	2.387
22				ivicall of Log	ged Detects	0.0303				3D 01 L0	gged Detects	2.307
23					Norm	al COE Tes	t on Detects	Only				
24			S	hapiro Wilk T		0.385	l on Detects	Oilly	Shaniro W	ilk GOF Tes		
25				hapiro Wilk C		0.842	Г	Detected D			nificance Leve	اد
26			0,000	•	est Statistic	0.497		20100104 2		GOF Test		,
27			5	% Lilliefors C		0.262		Detected D			nificance Leve	el
28				D	etected Data	Not Norma	│ al at 5% Sign					
30												
31			Kaplan-l	Meier (KM) S	Statistics usir	ng Normal C	ritical Value	s and othe	r Nonparame	tric UCLs		
32					KM Mean	17.36			KI	M Standard E	Error of Mean	16.62
33					KM SD	59				95% KN	M (BCA) UCL	50.02
34				95%	KM (t) UCL	46.79			95% KM (F	Percentile Bo	ootstrap) UCL	49.73
35				95%	KM (z) UCL	44.7				95% KM Bo	otstrap t UCL	1482
36			g	00% KM Che	byshev UCL	67.22				95% KM Che	ebyshev UCL	89.81
37			97.	.5% KM Che	byshev UCL	121.2				99% KM Che	ebyshev UCL	182.7
38												
39				G	amma GOF	Tests on De	etected Obse	ervations (Only			
40				A-D 1	est Statistic	1.492			Anderson-Da	-		
41				5% A-D C	critical Value	0.843	Detecte	ed Data No			% Significanc	e Level
42					est Statistic	0.359			Kolmogorov			
43					critical Value	0.293				tributed at 5	% Significanc	e Level
44				Detecte	d Data Not C	Gamma Dist	ributed at 59	% Significa	nce Level			
45												
46			· ·	· ·			Detected D	ata Only	·		·	
47					k hat (MLE)	0.229				•	rrected MLE)	0.227
48					ta hat (MLE)	106.2			Theta		rrected MLE)	107.1
49					u hat (MLE)	4.571				nu star (bi	as corrected)	4.533
50				Me	an (detects)	24.28						
51												

	A B C D E Gamma ROS	F Statistics u	G sing Imputed	H Non-Detect	l ts	J	K	L
52	GROS may not be used when data so					multiple DLs		
53	GROS may not be used when kstar of detects is s			-		-		
54 55	For such situations, GROS r						,	
56	This is especi							
57	For gamma distributed detected data, BTVs a					tion on KM e	estimates	
58	Minimum	0.01					Mean	17.35
59	Maximum	230					Median	0.28
60	SD	61.23					CV	3.53
61	k hat (MLE)	0.18			k s	star (bias co	rrected MLE)	0.189
62	Theta hat (MLE)	96.12			Theta	star (bias co	rrected MLE)	91.58
63	nu hat (MLE)	5.053				nu star (bia	as corrected)	5.304
64	Adjusted Level of Significance (β)	0.0312						
65	Approximate Chi Square Value (5.30, α)	1.295			-	-	alue (5.30, β)	1.054
66	95% Gamma Approximate UCL (use when n>=50)	71.05		95% Gai	mma Adjust	ed UCL (use	when n<50)	87.33
67								
68	Estimates of G		meters using	KM Estima	tes		05 ((4)	
69	Mean (KM)	17.36				0.5	SD (KM)	59
70	Variance (KM)	3481 0.0866				SE C	of Mean (KM)	16.62 0.116
71	k hat (KM)	2.424					k star (KM)	3.238
72	nu hat (KM) theta hat (KM)	2.424					nu star (KM) eta star (KM)	150.1
73	80% gamma percentile (KM)	14.58			90%		rcentile (KM)	48.66
74	95% gamma percentile (KM)	99.5					rcentile (KM)	256.1
75	30% gamma percentale (KW)	33.0				gamma pe	recritic (rtivi)	200.1
76 77	Gamm	a Kaplan-M	eier (KM) Sta	atistics				
78	Approximate Chi Square Value (3.24, α)	0.446	, ,		Adjusted C	hi Square Va	alue (3.24, β)	0.337
79	95% Gamma Approximate KM-UCL (use when n>=50)	126	9	95% Gamma	Adjusted K	M-UCL (use	when n<50)	166.7
80			I					
81	Lognormal GO		etected Obs	ervations O				
82	Shapiro Wilk Test Statistic	0.907			· = ·	lk GOF Test		
83	5% Shapiro Wilk Critical Value	0.842	Dete	cted Data ap	-		Significance L	evel
84	Lilliefors Test Statistic	0.192				GOF Test		
85	5% Lilliefors Critical Value	0.262		<u>'</u>		ormal at 5% S	Significance L	evel
86	Detected Data ap	pear Logno	rmai at 5% S	ignificance	Level			
87	Lognormal RO	C Ctatiation	Lloina Imputa	d Non Doto	oto			
88	Mean in Original Scale	17.35		d Non-Dete	cis	Mean	in Log Scale	-1.645
89	SD in Original Scale	61.23					in Log Scale	3.463
90	95% t UCL (assumes normality of ROS data)	46.33			95% [ootstrap UCL	50.06
91	95% BCA Bootstrap UCL	66.55					otstrap t UCL	1488
92	95% H-UCL (Log ROS)					22.0200	. J	
93								
95	Statistics using KM estimates	on Logged	Data and Ass	suming Logr	normal Distr	ibution		
96	KM Mean (logged)	-0.83					M Geo Mean	0.436
97	KM SD (logged)	2.354			95% (Critical H Val	lue (KM-Log)	5.395
98	KM Standard Error of Mean (logged)	0.663				95% H-U	CL (KM -Log)	235.6
99	KM SD (logged)	2.354			95% (Critical H Val	lue (KM-Log)	5.395
100	KM Standard Error of Mean (logged)	0.663						
101		I.	1					
101								

	Α	В	(0)		E	F	G		Н		I		J	工	K	工	L
102				D. (0.1					DL/2 S	tatistics					_					
103				DL/2 N					47.05				ı	DL/2 Log	- I rai					1.000
104								Scale	17.35									Log Scal		-1.028
105				F0/				Scale	61.23									Log Scal		2.645
106				5% t U	`			• • •	46.33	d			المصا	.!			-H %د	-Stat UC		963.1
107				DL/Z IS	s not a	recor	mmen	aea m	ethod, provi	aea for c	omp	ansons a	ina i	nstoricai	reas	sons				
108							None		tric Distribu	tion Eros		l Ctotiotic								
109					Doto	atad D	-		Lognormal I					noo l ove	N.					
110					Deter	Cleu L	Jala a	ppear	Logiloilliai	Distribute	u at	5% Sigili	IIICa	lice Leve	7 1					
111									Suggested	LICL to I	lea								—	
112				999	% KM	(Cheh	vshev	v) UCI	182.7	001 10 0									\top	
113				33	70 14141	(dilici)	узпеч)	102.7										\perp	
114		Note: Sugges	stions r	egardir	na the	select	tion of	a 95%	UCL are pr	ovided to	heli	n the user	to s	elect the	mos	t annro	priate	95% U	CI	
115		- Toto: ouggot		_	_				ed upon da							, арріо	Priate			
116		These recor	mmend													aichle, a	and L	ee (200f	<u></u> ô).	
117 118	H	owever, simu					-											,		n.
119		,								*										
120	F3																			
121																				
122									General	Statistics	S									
123				Total I	Numbe	er of C	bserv	ations	14					Numb	er of	Distinc	t Obs	servation	S	11
124					١	Numbe	er of D	etects	10						N	umber o	of Nor	n-Detect	s	4
125				Nu	ımber	of Dist	tinct D	etects	10					Numl	ber o	f Distino	ct Nor	n-Detect	:s	1
126						Mini	mum [Detect	0.02							Minimu	um No	on-Detec	ct	0.1
127						Maxi	mum [Detect	216							Maximu	um No	on-Detec	ct	0.1
128						Varia	nce D	etects	4588							Percer	nt Nor	n-Detect	S	28.57%
129						M	ean D	etects	23.31								SI	D Detect	S	67.73
130						Med	dian D	etects	1.355								C/	V Detect	S	2.906
131					5	Skewn	ess D	etects	3.158							Kı	urtosi	is Detect	S	9.978
132				N	Mean	of Log	ged D	etects	0.294							SD of L	.ogge	d Detect	S	2.473
133																				
134									al GOF Tes	st on Dete	ects	Only								
135					hapiro				0.39					Shapiro V						
136				5% Sh	•				0.842			etected D)ata				•	ance Le	vel	
137								tatistic	0.503					Lilliefor						
138				5%	% Lillie				0.262	1 - 1 50/ 6		etected D			nal a	t 5% Si	gnifica	ance Le	vel	
139						ט	etecte	ed Data	Not Norma	ai at 5% s	Sign	mcance L	.eve	l						
140			V-	mlan N	Anina ((VAA) C	Nation!		a Namal C	Salahan Ma			N			LICLA				
141			r/a	ihiaii-N	vieler ((IXIVI) S		Mean	16.66	JILICAI VA	iues	anu othe	SI IN				1 Erro	r of Mea	n	15.58
142								(M SD	55.32					r	VIVI O			BCA) UC		47.61
143						95%		t) UCL	44.25				(95% KM ((Perc		`			47.01
144) UCL	42.29					. J / J KIVI (rap t UC		669
145				91	0% KN				63.41									shev UC		84.58
146					5% KN				114									shev UC		171.7
147				J		. 5.101	., 0.10	,,,							337	01				
148						G	amma	GOF	Tests on D	etected C	Dbse	ervations (Onl	,						
149								tatistic	1.2					derson-D	arlin	g GOF	Test			
150								Value	0.835	Det	tecte	ed Data No							nce	Level
151								tatistic	0.36					lmogoro						
152 153					5%			Value	0.291	Det	tecte	ed Data No						Significar	ice	Level
153 154									Gamma Dis											
154												J								

	Α	В	С	D	E	F	G		Н		I	J		K	L
155															
156						Statistics or	Detected	d Data	Only						
157					k hat (MLE)	0.249						`		cted MLE)	
158					a hat (MLE)	93.63					Theta	star (bias	correc	cted MLE)	96.75
159					u hat (MLE)	4.979						nu star	(bias o	corrected)	4.819
160				Me	an (detects)	23.31									
161															
162				G	amma ROS	Statistics us	sing Impu	ited No	n-Dete	cts					
163			-	not be used				-							
164		GROS may	not be used	when kstar of	of detects is	small such a	s <1.0, es	peciall	y when	the sar	nple si	ze is sma	all (e.g	., <15-20)	
165			Fo	r such situati	ons, GROS	method may	yield inco	rrect v	alues of	UCLs	and B	TVs			
166				Т	his is especi	ally true whe	n the sam	nple siz	ze is sma	all.					
167		For gam	nma distribut	ed detected of	data, BTVs a	nd UCLs ma	y be com	puted ι	using ga	ımma d	distribu	tion on K	(M esti	mates	
168					Minimum	0.01								Mean	16.65
169					Maximum	216								Median	0.505
170					SD	57.4								CV	3.447
171					k hat (MLE)	0.189					k s	star (bias	correc	cted MLE)	0.196
172				Thet	a hat (MLE)	87.92				-	Theta	star (bias	correc	cted MLE)	84.77
173				n	u hat (MLE)	5.303						nu star	(bias	corrected)	5.5
174			Adjusted	Level of Sign	nificance (β)	0.0312									
175		Ap	proximate CI	ni Square Va	lue (5.50, α)	1.39				Adjus	sted Cl	hi Square	e Value	e (5.50, β)	1.137
176	9	95% Gamma	Approximate	e UCL (use w	hen n>=50)	65.89			95% Ga	amma .	Adjust	ed UCL (use wh	nen n<50)	80.57
177															
178				Es	timates of G	amma Para	meters us	sing KN	/ Estima	ates					
179					Mean (KM)	16.66								SD (KM)	55.32
180				Va	riance (KM)	3060						S	SE of M	lean (KM)	15.58
181					k hat (KM)	0.0907							k	star (KM)	0.119
182					nu hat (KM)	2.539							nu	star (KM)	3.328
183				the	eta hat (KM)	183.7							theta	star (KM)	140.1
184			80%	gamma per	centile (KM)	14.45					90%	6 gamma	perce	ntile (KM)	47.06
185			95%	gamma per	centile (KM)	95.16					99%	6 gamma	perce	ntile (KM)	242.3
186															
187					Gamm	a Kaplan-M	eier (KM)	Statist	tics						
188		Ap	proximate CI	ni Square Va	lue (3.33, α)	0.476				Adjus	sted Cl	hi Square	e Value	ε (3.33, β)	0.361
189	95%	Gamma App	roximate KM	1-UCL (use w	hen n>=50)	116.5		95%	6 Gamm	na Adju	sted K	M-UCL (use wh	nen n<50)	153.7
190															
191				Lo	gnormal GC	F Test on D	etected C	Observ	ations C	Only					
192			S	hapiro Wilk T	est Statistic	0.96				Shap	oiro Wi	lk GOF 1	Test		
193			5% SI	hapiro Wilk C	ritical Value	0.842	D	etecte	d Data a	appear	Logno	rmal at 5	5% Sigi	nificance	Level
194				Lilliefors T	est Statistic	0.183				Lill	liefors	GOF Te	st		
195			5	% Lilliefors C	ritical Value	0.262	D	etecte	d Data a	appear	Logno	rmal at 5	5% Sigi	nificance	Level
196				Dete	cted Data ap	pear Logno	rmal at 59	% Sign	ificance	Level					
197															
198				Log	gnormal RO	S Statistics	Jsing Imp	outed N	Non-Det	ects					
199				Mean in O	riginal Scale	16.66						Me	ean in I	Log Scale	-1.034
200				SD in O	riginal Scale	57.4							SD in I	Log Scale	3.063
201		95% t U	ICL (assume	s normality o	f ROS data)	43.83					95% F	Percentile	e Boots	strap UCL	47.11
202			(95% BCA Bo	otstrap UCL	63.27						95%	Bootst	rap t UCL	684.2
203				95% H-UCL	(Log ROS)	13376									
204						I	<u> </u>								1
205			Statis	tics using KN	/I estimates	on Logged I	Data and	Assum	ning Log	norma	l Distr	ibution			
206				KM Me	ean (logged)	-0.908							KM C	Geo Mean	0.403
207				KM	SD (logged)	2.746					95% (Critical H	Value	(KM-Log)	6.21
208			KM Standar	d Error of Me	ean (logged)	0.774						95% H	I-UCL ((KM -Log)	1987
209					SD (logged)	2.746					95% (Critical H	Value	(KM-Log)	6.21
210			KM Standar	d Error of Me		0.774									
Z 1U					(- 331)										

	Α	В	С	D	E	F	G	Н		J	K	L
211												
212						DL/2 S	tatistics					
213			DL/2	Normal		т			DL/2 Log-	Transformed		
214					riginal Scale	16.66					in Log Scale	
215					riginal Scale	57.4					in Log Scale	
216				`	es normality)	43.83					% H-Stat UCL	926.1
217			DL/2 i	s not a reco	mmended m	ethod, provi	ded for com	parisons and	d historical r	easons		
218												
219						etric Distribu						
220				Detected [Data appear	Lognormal [Distributed a	t 5% Signific	cance Level			
221												
222							UCL to Use					T
223			99	1% KM (Cheb	yshev) UCL	171.7						
224												
225	N	lote: Sugge:									riate 95% UC	L.
226					tions are bas	•		•			(2222)	
227											nd Lee (2006)	
228	Ho	wever, simu	ılations result	s will not cov	er all Real W	orld data set	ts; for additio	nal insight tl	ne user may	want to cons	sult a statistic	ian.
229												
230	mTPH											
231							<u> </u>					
232			-	<u> </u>			Statistics			(5)		10
233			I otal		Observations	14			Numbe		Observations	-
234					er of Detects	9					Non-Detects	_
235			N		tinct Detects	9			Numbe		Non-Detects	
236					mum Detect	0.3					n Non-Detect	-
237					mum Detect						n Non-Detect	-
238					ince Detects					Percent	Non-Detects	
239					lean Detects	53.06					SD Detects	
240					dian Detects	3.3				17	CV Detects	
241					ness Detects	2.996					rtosis Detects	
242				Mean of Log	ged Detects	1.325				SD of Log	gged Detects	2.161
243					Mann	OOF T	1 D-11-	Only				
244				hamina \A/ills		nal GOF Tes 0.412	on Detects	Only	Chanira W	ilk GOF Tes		
245					Test Statistic Critical Value	0.412	Г	Ostastad Da	•		nificance Leve	
246			5% 5		Test Statistic	0.829	L			GOF Test	illicance Leve	
247			-		Critical Value	0.498	Г	Ostastad Da			nificance Leve	
248					etected Data					ai at 5% Sigi	IIIIcarice Leve	
249					elected Date	a NOL NOTTIA	ii at 5% Sigii	illicance Lev	761			
250			Kanlan-	Major (KM)	Statistics usi	na Normal C	ritical Value	e and other	Nonnarame	tric LICLe		
251			rapiail-	moioi (IVIVI)	KM Mean	34.14	nicai value	o ana ouiei	•		Error of Mean	32.47
252					KM SD	114.6			rxiv		M (BCA) UCL	
253				95%	KM (t) UCL	91.65			95% KM /E		otstrap) UCL	97.51
254					KM (z) UCL	87.56			•		otstrap t UCL	
255			(byshev UCL	131.6					ebyshev UCL	
256					byshev UCL	236.9					ebysnev UCL ebyshev UCL	
257			37	.o /o Kivi Cile	Dyanev UCL	200.9			;	JJ /U INIVI CITE	JUYSHEV UCL	337.2
258					amma GOF	Tests on Da	atected Obse	arvatione ∩	nlv			
259					Test Statistic					rling GOF T	est	
260					Critical Value		Detect			_	% Significand	e l evel
261					Test Statistic		Detecti			-Smirnov GC		
262					Critical Value	0.304	Detect				% Significand	e l evel
263					ed Data Not					anduted at 3	, o oigiiiileane	O FOAGI
264				Detecte	ou Dala NUL	Gamma DISL	induicu al 37	o oigiiiiledii	CG FEAGI			
265												

	Α	В	С	D	E	F	G	Н	I	J	K	L
266					k hat (MLE)	0.266	Detected Da	ata Only	le .	star (bias co	rooted MLE)	0.251
267				The	ta hat (MLE)	199.6				star (bias coi	,	211.2
268					nu hat (MLE)	4.784			Tileta	•	as corrected)	4.522
269					ean (detects)	53.06				Tiu Stai (bio		4.022
270					San (dotooto)	00.00						
271					Gamma ROS	Statistics us	sing Imputed	Non-Detec	cts			
272 273			GROS may				6 NDs with ma			t multiple DLs	 S	
274		GROS may					s <1.0, espec	-		-		
275							yield incorrec					
276				-	This is especi	ally true whe	n the sample	size is sma	all.			
277		For gam	nma distribut	ed detected	data, BTVs a	nd UCLs ma	y be compute	ed using ga	mma distribi	ution on KM e	estimates	
278					Minimum	0.01					Mean	34.11
279					Maximum	447					Median	0.85
280					SD	118.9					CV	3.485
281					k hat (MLE)	0.174				star (bias co		0.184
282					eta hat (MLE)	196.1			Theta	star (bias co		185.1
283					nu hat (MLE)	4.87				nu star (bia	as corrected)	5.16
284			-	-	ınificance (β)	0.0312			A 12			0.000
285					alue (5.16, α)	1.227		050/ 0		chi Square Va	, ,,,	0.994
286		95% Gamma	Approximat	e UCL (use v	when n>=50)	143.5		95% Ga	amma Adjus	ted UCL (use	when n<50)	177.1
287					timatas of C	amma Dara	meters using	VM Estima	nto o			
288				E	Mean (KM)	34.14	meters using	KIVI ESUITIO	1162		SD (KM)	114.6
289				V	ariance (KM)					SE o	of Mean (KM)	32.47
290				•	k hat (KM)	0.0888					k star (KM)	0.117
291					nu hat (KM)	2.487					nu star (KM)	3.288
292				th	eta hat (KM)	384.4					eta star (KM)	290.8
293 294			80%		rcentile (KM)	29.21			909	% gamma pe	` '	96.14
295			95%	6 gamma pe	rcentile (KM)	195.4			999	% gamma pe	rcentile (KM)	499.8
296												
297					Gamm	a Kaplan-M	eier (KM) Sta	tistics				
298		Ap	proximate C	hi Square Va	alue (3.29, α)	0.462			Adjusted C	chi Square Va	alue (3.29, β)	0.35
299	95%	Gamma App	roximate KN	1-UCL (use v	when n>=50)	242.7	9	95% Gamm	a Adjusted ł	KM-UCL (use	when n<50)	320.6
300												
301							etected Obse	ervations C	-			
302				•	Test Statistic	0.897	_		•	ilk GOF Test		
303			5% S		Critical Value	0.829	Detec	cted Data a	• •		Significance L	_evel
304			-		Test Statistic Critical Value	0.192 0.274	Data	ated Date a		GOF Test	Ciamificanas I	aval.
305							rmal at 5% Si		• •	omai at 5% s	Significance L	-evei
306				Dete	cieu Daia ap	pear Logilo	IIIIai at 3 /0 Si	igillicarice	revei			
307				Lo	gnormal RO	S Statistics	Using Impute	d Non-Dete	ects			
308					riginal Scale	34.12	gpato			Mean	in Log Scale	-0.66
309					riginal Scale	118.9					in Log Scale	3.344
310 311		95% t U	ICL (assume		of ROS data)	90.39			95%		ootstrap UCL	97.32
312			!	95% BCA Bo	ootstrap UCL	130.2				95% Boo	otstrap t UCL	1979
313				95% H-UC	L (Log ROS)	141032						
314						<u>I</u>	1					<u> </u>
315			Statis	tics using K	M estimates		Data and Ass	uming Log	normal Dist	ribution		
316					ean (logged)	0.0294					M Geo Mean	1.03
317					SD (logged)	2.385			95%		ue (KM-Log)	5.46
318			KM Standar		ean (logged)	0.676					CL (KM -Log)	656.3
319					SD (logged)	2.385			95%	Critical H Val	ue (KM-Log)	5.46
320			KM Standar	d Error of M	ean (logged)	0.676						
321												

	Α	В	С	D	Е	F	G	Н	l	J	K	L			
322						DL/2 S	Statistics								
323			DL/2	Vormal					DL/2 Log-1	Fransformed					
324				Mean in C	riginal Scale	34.13				Mean	in Log Scale	-0.218			
325				SD in C	Original Scale	118.9				SD	in Log Scale	2.737			
326			95% t l	JCL (Assum	es normality)	90.39				95%	H-Stat UCL	3733			
327			DL/2 i	s not a reco	mmended m	ethod, prov	ided for com	parisons an	d historical r	easons					
328		Name and Allerthaday Francisco													
329		Nonparametric Distribution Free UCL Statistics													
330				Detected I	Data appear	Lognormal	Distributed a	t 5% Signifi	cance Level						
331															
332						Suggested	UCL to Use	ı							
333			99	% KM (Chel	byshev) UCL	357.2									
334															
335	1	Note: Sugges	stions regard	ing the selec	ction of a 95%	6 UCL are p	rovided to he	lp the user to	select the n	nost appropr	iate 95% UC	L.			
336			R	ecommenda	ations are ba	sed upon da	ta size, data	distribution,	and skewnes	SS.					
337		These recor	mmendations	are based ι	upon the resu	ılts of the sin	nulation stud	ies summari	zed in Singh,	, Maichle, an	d Lee (2006)				
338	Ho	wever, simu	lations result	s will not cov	er all Real W	orld data se	ts; for addition	nal insight t	he user may	want to cons	sult a statistic	ian.			
339															

															_	
	Α	В	С	D	l ⊨ Samma RC	F Statistics u	Sing Imputer	H d Non-Detec	rts.			J		K		L
52			GPOS may			set has > 50°				e at r	multir	ala DI				
53		GROS ma				s small such a								<15-20))	
54		artoo ma				method may						Siriali ((c.g.,	10-20	')	
55						cially true who	-			u D1	vs					
56		For an	mmo diotribu			and UCLs m				ributi	ion o	n KM	octim	notoc		
57		FUI Yai	IIIIIa uistiibu	ieu ueiecieu	Minimur		ay be compu	teu using ga	IIIIIa uisi	iibut	1011 0	III KIVI	esum	Mea	- n	0.151
58					Maximur											0.131
59														Media		1.278
60					S										.v	
61				T1	k hat (MLE	,					,			ted MLI		0.696
62					ta hat (MLE	,			In	eta s	•			ted MLI		0.216
63					nu hat (MLE	•					nu	star (b	ias c	orrecte	d)	20.89
64				Level of Sig		•										
65			oroximate Ch			´			Adjusted							10.66
66		95% Gamma	a Approximat	e UCL (use v	vhen n>=50	0.273		95% G	amma Ad	ljuste	ed U	CL (us	e wh	en n<5	0)	0.295
67																
68				Es	timates of	Gamma Para	meters using	g KM Estima	ites							
69					Mean (KM	0.153								SD (KI	-	0.185
70				Va	ariance (KM	0.0341						SE	of Me	ean (KN	vI)	0.0498
71					k hat (KM	0.684							k s	star (KN	N)	0.592
72					nu hat (KM	20.53							nu s	star (KN	N)	17.76
73				th	eta hat (KM	0.223						tl	heta :	star (KN	vI)	0.258
74			80%	6 gamma pe	centile (KM	0.252				90%	gan	nma p	ercer	ntile (KN	VI)	0.398
75			95%	6 gamma pe	centile (KM	0.552				99%	gan	nma p	ercer	ntile (KN	vI)	0.924
76																
77	Gamma Kaplan-Meier (KM) Statistics							-								
78		App	oroximate Ch	i Square Val	ue (17.76, d	9.215			Adjusted	Chi	Squ	are Va	alue (17.76,	β)	8.466
79	95%	Gamma Ap	proximate KN	Л-UCL (use v	vhen n>=50	0.294		95% Gamm	na Adjuste	ed K	M-U	CL (us	e wh	en n<5	0)	0.32
80																-
81				Lo	gnormal G	OF Test on D	Detected Obs	servations C	nly							
82			S	Shapiro Wilk	Test Statist	c 0.947			Shapiro	Wil	k GC	OF Tes	st			
83			5% S	hapiro Wilk (Critical Valu	e 0.859	Det	tected Data a	appear Lo	gno	rmal	at 5%	Sign	ificance	e Lev	/el
84				Lilliefors	Test Statist	c 0.159			Lillief	ors (GOF	Test				
85			5	5% Lilliefors (Critical Valu	e 0.243	Det	tected Data a	appear Lo	gno	rmal	at 5%	Sign	ificance	e Lev	/el
86				Dete	cted Data	appear Logno	ormal at 5%	Significance	Level							
87																
88				Lo	gnormal R	OS Statistics	Using Imput	ed Non-Dete	ects							
89					riginal Scal							Mear	n in L	og Sca	le	-2.579
90					riginal Scal									og Sca		1.273
91		95% t l	JCL (assume		•				95	5% F	Perce			trap UC		0.228
				95% BCA Bo										ap t UC		0.362
92				95% H-UC											+	
93					, . 3 3 .	,										
94			Statis	tics usina K	M estimate	s on Logged	Data and As	sumina Loa	normal D	istril	butio	n				
95			Cialic		ean (logged				u. D	II			(M C	eo Mea	an	0.0837
96					SD (logged	,			ΩF	5% C	rition			(KM-Lo		2.874
97			KM Standa	rd Error of M		-				- /0 C				KM -Lo		0.344
98			Nivi Statitud			•			0.0	50/ (
99			VM Ctor 1-		SD (logged	· _			95	J70 C	JIIIC	aı⊓ Vâ	aiue ((KM-Lo	y)	2.874
100			Kivi Standa	rd Error of M	ean (logged	0.291									\perp	
101																

	A B C D E	F	G	Н	I	J K	L
102		DL/2 S	tatistics		B1 (2 :		
103	DL/2 Normal	0.151			DL/2 Log-T	ransformed	0.610
104	Mean in Original Scale	0.151				Mean in Log Scale	-2.619
105	SD in Original Scale	0.193				SD in Log Scale 95% H-Stat UCL	1.326
106	95% t UCL (Assumes normality)	0.238	dod for corr	orioona and	biotorical		0.564
107	DL/2 is not a recommended me	einoa, provi	uea tor comp	ansons and	i nistofical re	SUSSUES	
108	Namasana	stria Diatriko	tion Eros IIO	l Ctatistics			
109	Nonparame Detected Data appea		tion Free UC		nce I cycl		
110	ретестел рата арреа	Gamilia Di	auipuleu al C	w Signinca	IICO LOVOI		
111		Suggested	UCL to Use				
112	95% KM Adjusted Gamma UCL	0.32	001 10 030		95% GRO	S Adjusted Gamma UCL	0.295
113	30% Nin / Nijasida danina 00E	J.JL			20.5 0.10	ajacica dallilla OOL	3.200
114	Note: Suggestions regarding the selection of a 95%	UCL are nr	ovided to heli	o the user to	select the m	ost appropriate 95% UCL	
115	Recommendations are bas						
116	These recommendations are based upon the resu						
117	However, simulations results will not cover all Real W						an.
119					,		
120	1-Meth						
121							
122		General	Statistics				
123	Total Number of Observations	15			Numbe	r of Distinct Observations	7
124	Number of Detects	9				Number of Non-Detects	6
125	Number of Distinct Detects	7			Numbe	er of Distinct Non-Detects	1
126	Minimum Detect	0.05				Minimum Non-Detect	0.05
127	Maximum Detect	0.27				Maximum Non-Detect	0.05
128	Variance Detects	0.00644				Percent Non-Detects	40%
129	Mean Detects	0.122				SD Detects	0.0803
130	Median Detects	0.08				CV Detects	0.657
131	Skewness Detects	0.96			·	Kurtosis Detects	-0.586
132	Mean of Logged Detects	-2.283				SD of Logged Detects	0.626
133							
134			t on Detects	Only			
135	Shapiro Wilk Test Statistic	0.826				lk GOF Test	
136	5% Shapiro Wilk Critical Value	0.829		Detected Dat		al at 5% Significance Leve	·I
137	Lilliefors Test Statistic	0.256				GOF Test	
138	5% Lilliefors Critical Value	0.274				nal at 5% Significance Le	/el
139	Detected Data appear	Approximat	e normai at	o% Significa	Ince Level		
140	Konlan Major (KM) Statistics usin	a Normal C	ritical Value	and other	Monnoromat	ric IICI e	
141	Kaplan-Meier (KM) Statistics usir KM Mean	0.0933	nucai vaiues	s and other i		Inc UCLS 1 Standard Error of Mean	0.0100
142	KM Mean KM SD	0.0933			KIV	95% KM (BCA) UCL	0.0188
143	95% KM (t) UCL	0.0685			95% KM /D	Percentile Bootstrap) UCL	0.122
144	95% KM (z) UCL	0.126				95% KM Bootstrap t UCL	0.125
145	90% KM Chebyshev UCL	0.124				95% KM Chebyshev UCL	0.175
146	97.5% KM Chebyshev UCL	0.13				99% KM Chebyshev UCL	0.173
147	37.378 KWI GIIGDYSIIEV UCL	0.21				Till Gliobyshev GCL	0.20
148	Gamma GOF	Tests on De	etected Ohse	rvations On	lv		
149	A-D Test Statistic	0.625			-	rling GOF Test	
150	5% A-D Critical Value	0.727	Detected			stributed at 5% Significan	ce Level
151	K-S Test Statistic	0.238	23100100			Smirnov GOF	
152	5% K-S Critical Value	0.281	Detected			stributed at 5% Significan	ce Level
153	Detected data appear						
154	sococca adm appoin		ut t				

	A B C D E	F	G H I J K	L
155				
156			Detected Data Only	
157	k hat (MLE)	2.924	k star (bias corrected MLE)	2.023
158	Theta hat (MLE)	0.0418	Theta star (bias corrected MLE)	0.0604
159	nu hat (MLE)	52.63	nu star (bias corrected)	36.42
160	Mean (detects)	0.122		
161	0 P00	04-4-4	in a large and Mars Bode at	
162			sing Imputed Non-Detects NDs with many tied observations at multiple DLs	
163	<u> </u>		s <1.0, especially when the sample size is small (e.g., <15-20)	
164			yield incorrect values of UCLs and BTVs	
165			n the sample size is small.	
166	<u> </u>	•	y be computed using gamma distribution on KM estimates	
167	Minimum	0.01	Mean	0.0773
168	Maximum	0.27	Median	0.06
169	SD	0.0832	CV	1.076
170	k hat (MLE)	0.897	k star (bias corrected MLE)	0.762
171	Theta hat (MLE)	0.0862	Theta star (bias corrected MLE)	0.101
172	nu hat (MLE)	26.91	nu star (bias corrected)	22.86
173	Adjusted Level of Significance (β)	0.0324	(5.00 551155563)	
174	Approximate Chi Square Value (22.86, α)	12.99	Adjusted Chi Square Value (22.86, β)	12.08
175	95% Gamma Approximate UCL (use when n>=50)	0.136	95% Gamma Adjusted UCL (use when n<50)	0.146
176 177	, , , ,		, , , , , , , , , , , , , , , , , , ,	
177	Estimates of G	amma Parar	meters using KM Estimates	
179	Mean (KM)	0.0933	SD (KM)	0.0685
180	Variance (KM)	0.00469	SE of Mean (KM)	0.0188
181	k hat (KM)	1.858	k star (KM)	1.531
182	nu hat (KM)	55.73	nu star (KM)	45.92
183	theta hat (KM)	0.0502	theta star (KM)	0.061
184	80% gamma percentile (KM)	0.144	90% gamma percentile (KM)	0.194
185	95% gamma percentile (KM)	0.241	99% gamma percentile (KM)	0.35
186	-		1	
187	Gamm	a Kaplan-M	eier (KM) Statistics	
188	Approximate Chi Square Value (45.92, α)	31.37	Adjusted Chi Square Value (45.92, β)	29.9
189	95% Gamma Approximate KM-UCL (use when n>=50)	0.137	95% Gamma Adjusted KM-UCL (use when n<50)	0.143
190				
191	Lognormal GO	F Test on D	etected Observations Only	
192	Shapiro Wilk Test Statistic	0.884	Shapiro Wilk GOF Test	
193	5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Le	evel
194	Lilliefors Test Statistic	0.207	Lilliefors GOF Test	
195	5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Le	evel
196	Detected Data ap	pear Logno	rmal at 5% Significance Level	
197				
198	-		Jsing Imputed Non-Detects	
199	Mean in Original Scale	0.0816	Mean in Log Scale	-2.956
200	SD in Original Scale	0.0798	SD in Log Scale	1.018
201	95% t UCL (assumes normality of ROS data)	0.118	95% Percentile Bootstrap UCL	0.116
202	95% BCA Bootstrap UCL 95% H-UCL (Log ROS)	0.12	95% Bootstrap t UCL	0.132
203	95% H-UCL (LOG RUS)	0.186		
204	Statistics using VM estimates	on Logged F	Data and Assuming Lognormal Distribution	
205	KM Mean (logged)	-2.568	KM Geo Mean	0.0767
206	KM SD (logged)	0.575	95% Critical H Value (KM-Log)	2.152
207	KM Standard Error of Mean (logged)	0.575	95% H-UCL (KM -Log)	0.126
208	KM SD (logged)	0.136	95% Critical H Value (KM-Log)	2.152
209	KM Standard Error of Mean (logged)	0.575	35 /6 Citical II Value (KWI-LOY)	2.102
210	Kivi Sianuaru Erroi di Mean (logged)	U. 106		

	Α	В	С	-	D	T E	- 1	F	G		Н	1		.1		K	т —	_
211				_							·· <u> </u>			J		- 13	_	
212								DL/2 S	tatistics									
213			DL/	/2 No	mal							DL/2	Log-T	ransform	ned			
214				1	Mean in C	Original	Scale	0.0833								og Scale	- (-2.845
						Original		0.0782								og Scale		0.856
215			95%	t UC	L (Assum			0.119								Stat UCL		0.149
216							• • • • • • • • • • • • • • • • • • • •	ethod, provi	ded for com	paris	ons and	d histor	rical re					
217																		
218						Nonp	arame	tric Distribu	tion Free U	CL SI	atistics							
219				Detec	ted Data	•		ximate Nor					nce Le	evel				
220 221																		
222								Suggested	UCL to Use	,								
223					959	% KM (t)		0.126									T	
224							1											
225			When	a dat	a set folk	ows an a	approxi	imate (e.g., ı	normal) disti	ibutio	n passi	ng one	of the	GOF tes	t			
226		When app	olicable, it i	is sug	gested to	use a l	JCL ba	sed upon a	distribution	(e.g.,	gamma	a) passi	ng bot	h GOF te	ests in	ProUCL		
227																		
228		Note: Sugge	estions rega	arding	the sele	ction of	a 95%	UCL are pr	ovided to he	lp the	user to	select	the m	ost appro	priate	95% UC	L.	
229				Rec	commend	lations a	are bas	ed upon dat	ta size, data	distril	bution,	and ske	ewnes	S.				
230		These reco	mmendation	ons a	re based	upon th	e resu	Its of the sin	nulation stud	ies sı	ımmariz	zed in S	Singh,	Maichle,	and Le	e (2006)		
231	Н	lowever, sim	ulations res	sults v	vill not co	ver all F	Real W	orld data se	ts; for addition	onal ir	nsight th	ne user	may v	vant to co	onsult a	a statistic	ian.	
232																		
233	2-Meth																	
234																		
235								General	Statistics									
236			То	tal Nu	umber of	Observa	ations	15				N	umber	of Distin	ct Obs	ervations	3	11
237					Numb	er of De	etects	14						Number	of No	n-Detects	3	1
238				Num	ber of Dis	stinct De	etects	11				١	Numbe	r of Disti	nct No	n-Detects	3	1
239					Mir	nimum D	Detect	0.01						Minin	num No	on-Detec	t (0.01
240					Max	ximum [Detect	0.38						Maxim	num No	on-Detec	t	0.01
241					Vari	ance De	etects	0.0107						Perce	ent No	n-Detects	3	6.667%
242					N	Mean De	etects	0.105							SI	Detects	3	0.103
243						edian De		0.07							C/	V Detects	3	0.985
244						ness De		1.736								s Detects		2.945
245				Me	ean of Lo	gged De	etects	-2.688						SD of	Logge	d Detects	3	1.014
246																		
247								al GOF Tes	t on Detect	s Only	y							
248			F0/		piro Wilk			0.806		<u> </u>				k GOF T				
249			5%		piro Wilk			0.874		Dete	cted Da					ance Lev	eı	
250					Lilliefors			0.272		D-4-	-t- d D-			GOF Tes		1	1	
251				5%	Lilliefors			0.226	l at E0/ Cia				Norma	at 5% S	significa	ance Lev	eı	
252						Detecte	d Data	Not Norma	ii at 5% Sig	nımca	nce Lev	/ei						
253			Vonlo	n Ma	ior (KM)	Ctatiati	00 Hole	g Normal C	ritical Value		d other	Monno	romot	ria I ICI a				
254			Каріа	II I-IVIE	IEI (KIVI)		Mean	0.0987	liucai vaiue	55 all	J OUIEI	Мопра				r of Mear		0.0266
255							M SD	0.0987					Γ\IV			CA) UCL		0.0266
256					QE	% KM (t)		0.0992				95%	KM /D			trap) UCL		0.144
257						6 KM (z)		0.143				JJ /0	•			rap t UCL		0.143
258				90%	6 KM Che			0.142								shev UCL		0.215
259					6 KM Che			0.265								shev UCL		0.363
260				307		- J J J 110 V	552	0.200						- /0 / (14/ (Juy		1	
261						Gamma	GOF	Tests on De	etected Ohs	ervat	ions Or	niv						
262						Test St		0.251				•	n-Dar	ling GOF	- Test			
263					5% A-D			0.755	Detecte	ed dat						Significa	nce l	Level
264						Test St		0.163						Smirnov		<u> </u>		
265					5% K-S			0.234	Detecte	ed dat						Significa	nce I	Level
266								Gamma Di								J		
267											J							

000	A B C D E	F	G H I J K	L
268	Gamma	Statistics or	n Detected Data Only	
270	k hat (MLE)	1.292	k star (bias corrected MLE)	1.063
271	Theta hat (MLE)	0.0813	Theta star (bias corrected MLE)	0.0988
272	nu hat (MLE) Mean (detects)	36.18 0.105	nu star (bias corrected)	29.76
273 274	inean (detects)	0.103		
274	Gamma ROS	Statistics u	sing Imputed Non-Detects	
276	-		% NDs with many tied observations at multiple DLs	
277			s <1.0, especially when the sample size is small (e.g., <15-20)	
278			yield incorrect values of UCLs and BTVs en the sample size is small.	
279			ay be computed using gamma distribution on KM estimates	
281	Minimum	0.01	Mean	0.0987
282	Maximum	0.38	Median	0.07
283	SD k bot (MLF)	0.103 1.138	CV	1.041 0.955
284	k hat (MLE) Theta hat (MLE)	0.0867	k star (bias corrected MLE) Theta star (bias corrected MLE)	0.955
285	nu hat (MLE)	34.13	nu star (bias corrected)	28.64
287	Adjusted Level of Significance (β)	0.0324		
288	Approximate Chi Square Value (28.64, α)	17.42	Adjusted Chi Square Value (28.64, β)	16.35
289	95% Gamma Approximate UCL (use when n>=50)	0.162	95% Gamma Adjusted UCL (use when n<50)	0.173
290	Estimates of G	iamma Para	meters using KM Estimates	
292	Mean (KM)	0.0987	SD (KM)	0.0992
293	Variance (KM)	0.00984	SE of Mean (KM)	0.0266
294	k hat (KM)	0.99	k star (KM)	0.836
295	nu hat (KM) theta hat (KM)	29.69 0.0997	nu star (KM) theta star (KM)	25.08 0.118
296 297	80% gamma percentile (KM)	0.161	90% gamma percentile (KM)	0.237
298	95% gamma percentile (KM)	0.315	99% gamma percentile (KM)	0.498
299				
300			leier (KM) Statistics	10.7
301	Approximate Chi Square Value (25.08, α) 95% Gamma Approximate KM-UCL (use when n>=50)	14.67 0.169	Adjusted Chi Square Value (25.08, β) 95% Gamma Adjusted KM-UCL (use when n<50)	13.7 0.181
302				
304			Detected Observations Only	
305	Shapiro Wilk Test Statistic		Shapiro Wilk GOF Test	
306	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.874	Detected Data appear Lognormal at 5% Significance Le	vei
307	5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Le	vel
309	Detected Data ap	pear Logno	ormal at 5% Significance Level	
310				
311	Lognormal RO Mean in Original Scale	S Statistics 0.0984	Using Imputed Non-Detects Mean in Log Scale	-2.854
312	SD in Original Scale	0.103	SD in Log Scale	1.169
314	95% t UCL (assumes normality of ROS data)	0.145	95% Percentile Bootstrap UCL	0.143
315	95% BCA Bootstrap UCL	0.157	95% Bootstrap t UCL	0.181
316	95% H-UCL (Log ROS)	0.293		
317	Statistics using KM estimates	on Logged	Data and Assuming Lognormal Distribution	
319	KM Mean (logged)	-2.816	KM Geo Mean	0.0598
320	KM SD (logged)	1.058	95% Critical H Value (KM-Log)	2.837
321	KM Standard Error of Mean (logged)	0.283	95% H-UCL (KM -Log)	0.234
322	KM SD (logged) KM Standard Error of Mean (logged)	1.058 0.283	95% Critical H Value (KM-Log)	2.837
323	Standard Error or Mean (rogged)	J.200		
325		DL/2 S	statistics	
326	DL/2 Normal		DL/2 Log-Transformed	
327	Mean in Original Scale SD in Original Scale	0.0983	Mean in Log Scale SD in Log Scale	-2.862 1.187
328	95% t UCL (Assumes normality)	0.103	95% H-Stat UCL	0.304
329			ded for comparisons and historical reasons	
331				
332	<u> </u>		ttion Free UCL Statistics	
333	Detected Data appea	r Gamma D	istributed at 5% Significance Level	
334		Suggested	UCL to Use	
335	95% KM Adjusted Gamma UCL	0.181	95% GROS Adjusted Gamma UCL	0.173
JJU			-	

	ABCDE	F	GHIJK	L
337				·
338	Note: Suggestions regarding the selection of a 95%	UCL are pro	ovided to help the user to select the most appropriate 95% UCL.	
339	Recommendations are bas	ed upon dat	ta size, data distribution, and skewness.	
340	These recommendations are based upon the resul	Its of the sim	nulation studies summarized in Singh, Maichle, and Lee (2006).	
341	However, simulations results will not cover all Real W	orld data set	ts; for additional insight the user may want to consult a statisticiar	٦.
342				
343	Acenaphthene			
344				
345		General	Statistics	
346	Total Number of Observations	15	Number of Distinct Observations	13
347	Number of Detects	12	Number of Non-Detects	3
348	Number of Distinct Detects	12	Number of Distinct Non-Detects	1
349	Minimum Detect	0.0478	Minimum Non-Detect	0.00671
350	Maximum Detect	0.728	Maximum Non-Detect	0.00671
351	Variance Detects	0.0357	Percent Non-Detects	20%
352	Mean Detects	0.245	SD Detects	0.189
353	Median Detects	0.194	CV Detects	0.772
354	Skewness Detects	1.79	Kurtosis Detects	3.424
355	Mean of Logged Detects	-1.646	SD of Logged Detects	0.729
356				
357	Norm	al GOF Tes	t on Detects Only	
358	Shapiro Wilk Test Statistic	0.82	Shapiro Wilk GOF Test	
359	5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level	
360	Lilliefors Test Statistic	0.261	Lilliefors GOF Test	
361	5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Level	
362	Detected Data	Not Norma	al at 5% Significance Level	
363				
364	Kaplan-Meier (KM) Statistics usin	g Normal C	critical Values and other Nonparametric UCLs	
365	KM Mean	0.197	KM Standard Error of Mean	0.0506
366	KM SD	0.188	95% KM (BCA) UCL	0.283
367	95% KM (t) UCL	0.286	95% KM (Percentile Bootstrap) UCL	0.284
368	95% KM (z) UCL	0.28	95% KM Bootstrap t UCL	0.343
369	90% KM Chebyshev UCL	0.349	95% KM Chebyshev UCL	0.418
370	97.5% KM Chebyshev UCL	0.513	99% KM Chebyshev UCL	0.701
371			<u> </u>	
372	Gamma GOF	Tests on De	etected Observations Only	
373	A-D Test Statistic	0.268	Anderson-Darling GOF Test	
374	5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance	e Level
375	K-S Test Statistic	0.17	Kolmogorov-Smirnov GOF	
	5% K-S Critical Value	0.248	Detected data appear Gamma Distributed at 5% Significance	e Level
376				
376 377	Detected data appear	Gamma Di	stributed at 5% Significance Level	

	A B C D E	F	G H I J K	L
379			n Detected Data Only	
380	k hat (MLE)	2.248	k star (bias corrected MLE)	1.741
381	Theta hat (MLE)	0.109	Theta star (bias corrected MLE)	0.141
382	nu hat (MLE)	53.95	nu star (bias corrected)	41.79
383	Mean (detects)	0.245		
384	Commo DOS	Ctatiatias	sing Imputed Non Detecto	
385			sing Imputed Non-Detects 6 NDs with many tied observations at multiple DLs	
386	-		s <1.0, especially when the sample size is small (e.g., <15-20)	
387	-		yield incorrect values of UCLs and BTVs	
388			en the sample size is small.	
389	<u> </u>	•	by be computed using gamma distribution on KM estimates	
390 391	Minimum	0.01	Mean	0.198
392	Maximum	0.728	Median	0.168
393	SD	0.194	CV	0.979
394	k hat (MLE)	0.942	k star (bias corrected MLE)	0.798
395	Theta hat (MLE)	0.21	Theta star (bias corrected MLE)	0.248
396	nu hat (MLE)	28.25	nu star (bias corrected)	23.93
397	Adjusted Level of Significance (β)	0.0324		
398	Approximate Chi Square Value (23.93, α)	13.8	Adjusted Chi Square Value (23.93, β)	12.86
399	95% Gamma Approximate UCL (use when n>=50)	0.343	95% Gamma Adjusted UCL (use when n<50)	0.368
400				
401			meters using KM Estimates	
402	Mean (KM)	0.197	SD (KM)	0.188
403	Variance (KM)	0.0352	SE of Mean (KM)	0.0506
404	k hat (KM)	1.104	k star (KM)	0.927
405	nu hat (KM) theta hat (KM)	33.11 0.179	nu star (KM) theta star (KM)	27.82 0.213
406	80% gamma percentile (KM)	0.179	90% gamma percentile (KM)	0.462
407	95% gamma percentile (KM)	0.607	99% gamma percentile (KM)	0.943
408	55.0 5 2 (*,			
410	Gamm	a Kaplan-M	eier (KM) Statistics	
411	Approximate Chi Square Value (27.82, α)	16.79	Adjusted Chi Square Value (27.82, β)	15.74
412	95% Gamma Approximate KM-UCL (use when n>=50)	0.327	95% Gamma Adjusted KM-UCL (use when n<50)	0.348
413			-	
414	Lognormal GO	F Test on D	etected Observations Only	
415	Shapiro Wilk Test Statistic	0.984	Shapiro Wilk GOF Test	
416	5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Le	evel
417	Lilliefors Test Statistic	0.139	Lilliefors GOF Test	
418	5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Le	evel
419	Detected Data ap	pear Logno	rmal at 5% Significance Level	
420	Lognormal ROS	S Statietice I	Using Imputed Non-Detects	
421	Mean in Original Scale	0.203	Mean in Log Scale	-1.993
422	SD in Original Scale	0.189	SD in Log Scale	0.973
423	95% t UCL (assumes normality of ROS data)	0.289	95% Percentile Bootstrap UCL	0.284
424 425	95% BCA Bootstrap UCL	0.304	95% Bootstrap t UCL	0.346
426	95% H-UCL (Log ROS)	0.442	,	
427				
428	Statistics using KM estimates	on Logged I	Data and Assuming Lognormal Distribution	
429	KM Mean (logged)	-2.318	KM Geo Mean	0.0985
430	KM SD (logged)	1.481	95% Critical H Value (KM-Log)	3.577
431	KM Standard Error of Mean (logged)	0.399	95% H-UCL (KM -Log)	1.215
432	KM SD (logged)	1.481	95% Critical H Value (KM-Log)	3.577
433	KM Standard Error of Mean (logged)	0.399		
434				

	A B C D E	F	G	Н	1	JK	T L
435			tatistics		•		
436	DL/2 Normal				DL/2 Log-1	ransformed	
437	Mean in Original Scale	0.196				Mean in Log Scale	-2.456
438	SD in Original Scale	0.195				SD in Log Scale	1.797
439	95% t UCL (Assumes normality)	0.285				95% H-Stat UCI	3.199
440	DL/2 is not a recommended me	ethod, provi	ded for comp	parisons and	historical re	easons	
441							
442	Nonparame	tric Distribu	tion Free UC	L Statistics			
443	Detected Data appear	r Gamma D	istributed at	5% Significa	nce Level		
444							
445		Suggested	UCL to Use				
446	95% KM Adjusted Gamma UCL	0.348			95% GRC	S Adjusted Gamma UCI	0.368
447							
448	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to hel	p the user to	select the m	ost appropriate 95% UC	L.
449	Recommendations are bas	sed upon da	ta size, data	distribution, a	nd skewnes	S.	
450	These recommendations are based upon the resu	lts of the sin	nulation studi	es summariz	ed in Singh,	Maichle, and Lee (2006)	
451	However, simulations results will not cover all Real W	orld data se	ts; for additio	nal insight th	e user may	want to consult a statistic	ian.
452							
453	Acenaphthylene						
454							
455		General	Statistics				
456	Total Number of Observations	15			Numbe	r of Distinct Observations	14
457	Number of Detects	14				Number of Non-Detects	1
458	Number of Distinct Detects	13			Numbe	er of Distinct Non-Detects	1
459	Minimum Detect	0.02				Minimum Non-Detec	t 0.004
460	Maximum Detect	0.465				Maximum Non-Detec	t 0.004
461	Variance Detects	0.0124				Percent Non-Detects	6.667%
462	Mean Detects	0.0856				SD Detects	
463	Median Detects	0.059				CV Detects	
464	Skewness Detects	3.493				Kurtosis Detects	
465	Mean of Logged Detects	-2.805				SD of Logged Detects	0.729
466							
467			t on Detects	Only			
468	Shapiro Wilk Test Statistic	0.484			•	lk GOF Test	
469	5% Shapiro Wilk Critical Value	0.874		Detected Dat		al at 5% Significance Lev	el
470	Lilliefors Test Statistic	0.395				GOF Test	
471	5% Lilliefors Critical Value	0.226				al at 5% Significance Lev	el
472	Detected Data	a Not Norma	ai at 5% Sign	IITICANCE LEV	еі		
473	Kantan Malan (KM) Oberkakan mala	NI C	_lat \		· · · · · · · · · · · · · · · · · · ·	W- 1101 -	
474	Kaplan-Meier (KM) Statistics usin	-	nucai value	s and other		A Standard Error of Mear	0.0202
475	KM Mean	0.0801			KI		
476	KM SD 95% KM (t) UCL	0.106			Q50/ L/M /F	95% KM (BCA) UCI	
477						ercentile Bootstrap) UCI 95% KM Bootstrap t UCI	
478	95% KM (z) UCL 90% KM Chebyshev UCL	0.127				95% KM Chebyshev UCI	
479	90% KM Chebyshev UCL	0.165					
480	97.3% KWI Chebyshev OCL	0.207				99% KM Chebyshev UCI	0.302
481	Gamma GOF	Teete on D	atected Obse	arvatione On	h		
482	A-D Test Statistic	1.349	CIGCIGA ODSI		-	rling GOF Test	
483	5% A-D Critical Value	0.75	Detect			tributed at 5% Significand	re I evel
484	K-S Test Statistic	0.73	Detect			Smirnov GOF	~ L0701
485	5% K-S Critical Value	0.273	Detect			tributed at 5% Significand	re I evel
486	Detected Data Not 0					and a compriside	~ L0701
487	Detected Data Not (Jannila DISI	induiou at 07	- Olyminodik	~ 544		
488							

	A B C D E	F	G H I J K	L
489			Detected Data Only	1.00=
490	k hat (MLE)	1.59	k star (bias corrected MLE)	1.297
491	Theta hat (MLE)	0.0538	Theta star (bias corrected MLE)	0.066
492	nu hat (MLE)	44.51	nu star (bias corrected)	36.31
493	Mean (detects)	0.0856		
494	Gamma POS	Statistics II	sing Imputed Non-Detects	
495			6 NDs with many tied observations at multiple DLs	
496	-		is <1.0, especially when the sample size is small (e.g., <15-20)	
497	-		yield incorrect values of UCLs and BTVs	
498			en the sample size is small.	
499 500		•	ay be computed using gamma distribution on KM estimates	
501	Minimum	0.01	Mean	0.0805
502	Maximum	0.465	Median	0.058
503	SD	0.109	CV	1.355
504	k hat (MLE)	1.375	k star (bias corrected MLE)	1.145
505	Theta hat (MLE)	0.0586	Theta star (bias corrected MLE)	0.0704
506	nu hat (MLE)	41.26	nu star (bias corrected)	34.34
507	Adjusted Level of Significance (β)	0.0324		
508	Approximate Chi Square Value (34.34, α)	21.94	Adjusted Chi Square Value (34.34, β)	20.72
509	95% Gamma Approximate UCL (use when n>=50)	0.126	95% Gamma Adjusted UCL (use when n<50)	0.133
510				
511			meters using KM Estimates	
512	Mean (KM)	0.0801	SD (KM)	0.106
513	Variance (KM)	0.0112	SE of Mean (KM)	0.0283
514	k hat (KM)	0.575	k star (KM)	0.505
515	nu hat (KM)	17.25 0.139	nu star (KM)	15.14
516	theta hat (KM) 80% gamma percentile (KM)	0.139	theta star (KM) 90% gamma percentile (KM)	0.159
517	95% gamma percentile (KM)	0.132	99% gamma percentile (KM)	0.529
518	33 / gamma percentile (KW)	0.507	33% gamma percentile (KW)	0.020
519	Gamm	a Kaplan-M	eier (KM) Statistics	
520 521	Approximate Chi Square Value (15.14, α)	7.356	Adjusted Chi Square Value (15.14, β)	6.697
522	95% Gamma Approximate KM-UCL (use when n>=50)	0.165	95% Gamma Adjusted KM-UCL (use when n<50)	0.181
523	i			
524	Lognormal GO	F Test on D	Detected Observations Only	
525	Shapiro Wilk Test Statistic	0.868	Shapiro Wilk GOF Test	
526	5% Shapiro Wilk Critical Value	0.874	Detected Data Not Lognormal at 5% Significance Leve	el
527	Lilliefors Test Statistic	0.197	Lilliefors GOF Test	
528	5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Le	vel
529	Detected Data appear A	pproximate	Lognormal at 5% Significance Level	
530				
531			Using Imputed Non-Detects	0.040
532	Mean in Original Scale	0.0806	Mean in Log Scale	-2.916
533	SD in Original Scale 95% t UCL (assumes normality of ROS data)	0.109	SD in Log Scale 95% Percentile Bootstrap UCL	0.824
534	95% BCA Bootstrap UCL	0.13	95% Pootstrap t UCL	0.133
535	95% H-UCL (Log ROS)	0.104	35 % Bootsuap t OCL	0.234
536	33 % 11-00E (E0g 1103)	0.101		
537	Statistics using KM estimates	on Loaaed	Data and Assuming Lognormal Distribution	
538 539	KM Mean (logged)	-2.986	KM Geo Mean	0.0505
540	KM SD (logged)	0.959	95% Critical H Value (KM-Log)	2.68
541	KM Standard Error of Mean (logged)	0.257	95% H-UCL (KM -Log)	0.159
542	KM SD (logged)	0.959	95% Critical H Value (KM-Log)	2.68
543	KM Standard Error of Mean (logged)	0.257		
544				

Second Part	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
Mean in Original Scale 0.08	n Log Scale H-Stat UCL ate 95% UCL. Lee (2006). ult a statistician bbservations Non-Detects Non-Detects Non-Detects	1.127 0.221
SD in Original Scale 0.109 SD is	n Log Scale H-Stat UCL ate 95% UCL. Lee (2006). ult a statistician bbservations Non-Detects Non-Detects Non-Detects	1.127 0.221
95% t UCL (Assumes normality) 0.13 95% on DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided for comparisons and historical reasons DL/2 is not a recommended method, provided to help the user to select the most appropriate DL/2 is not a provided UCL to Use DL/2 is not a provided to help the user to select the most appropriate DL/2 is not a fixed distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendations are based upon data size, data distribution, and skewness. Recommendation and size of the simulation studies summarized in Singh, Maichle, and Distribution and data sets, for additional insight the user may want to consult for the simulation studies summarized in Singh, Maichle, and Recommendation and data sets, for additional insight the user may want to consult for the simulation studies summarized in Singh, Maichle, and Recommendations are based upon data size, data distribution, and skewness. Recommendation and data sets, for additional insight the user on select the	H-Stat UCL ate 95% UCL. Lee (2006). ult a statistician observations Non-Detects Non-Detects	0.221
DL/2 is not a recommended method, provided for comparisons and historical reasons SS2	ate 95% UCL. Lee (2006). July a statistician Deservations Non-Detects Non-Detects Non-Detects	1. 2 14 1
SS1	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
Secondary Seco	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
Detected Data appear Approximate Lognormal Distributed at 5% Significance Level	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
Suggested UCL to Use	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
Suggested UCL to Use	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects	2 14 1
See	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects Ch a data set	2 14 1
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriated by the user to select the most appropriate by the user to select the user may want to consume the user may want to consume the user may want to consume the user of Distinct Oracle to the user appropriate by the user appropriate by the user appropriate by the user appropriate by the user to self-user to self-user appropriate by the user to self-	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects Ch a data set	2 14 1
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to help the user to select the most approprial provided to subject the most approprial provided to subject the provided help the user to select the most approprial provided to subject the simulation, and discharged the subject to subject the simulation, and selection subject to subject the simulation studies summarized in Singh, Maichle, and However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult to consult the user may want to consult the user may want to consult the user of Distinct One	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects Ch a data set	2 14 1
Recommendations are based upon data size, data distribution, and skewness.	Lee (2006). Ult a statistician Disservations Non-Detects Non-Detects Ch a data set	2 14 1
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and However, simulations results will not cover all Real World data sets; for additional insight the user may want to consumate the simulations results will not cover all Real World data sets; for additional insight the user may want to consumate the simulations results will not cover all Real World data sets; for additional insight the user may want to consumate the simulations are because the simulation studies as the simulation studies are may want to consumate the simulation studies as the simulation studies as the simulation studies as the simulation studies as the simulation studies and sets are may want to consumate the simulation studies as the simulation of Distinct Ones and the simulation studies are may want to consumate as the simulation studies as the simulation of Distinct Ones and the simulation studies are may want to consume the simulation studies as the simulation of Distinct Ones and the simulation studies as the simulation and the user may want to consume the simulation studies as the simulation studies as the simulation studies as the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and the user may want to consume the simulation and	Observations Non-Detects Non-Detects Ch a data set	2 14 1
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consults	Observations Non-Detects Non-Detects Ch a data set	2 14 1
Sec	Observations Non-Detects Non-Detects Ch a data set	2 14 1
Section	Non-Detects Non-Detects ch a data setl	14
Section Sect	Non-Detects Non-Detects ch a data setl	14
See Statistics See Statistics See Statistics	Non-Detects Non-Detects ch a data setl	14
Social Processes Social Number of Observations 15	Non-Detects Non-Detects ch a data setl	14
See Number of Detects 1	Non-Detects Non-Detects ch a data setl	14
Number of Distinct Net	Non-Detects	1
Social	ch a data set!	
Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on successful.		
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters		
S772 S78 The data set for variable Acridine was not processed! S74 S75 S76 S77 Anth S78 S79 General Statistics S80 Total Number of Observations 15 Number of Distinct Of S81 Number of Missing Of S82 Minimum 0.05 S83 Maximum 1.01 S84 S0 0.249 Std. En S85 Coefficient of Variation 0.687 S86 S87 Normal GOF Test Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test Shapiro Wilk GOF Test Shapiro Wilk GOF Test S74 Shapiro Wilk GOF Test S88 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test S74 Shapiro Wilk GOF Test S75 S68 S88		
573 The data set for variable Acridine was not processed! 574 575 576 577 577 Anth 578 General Statistics 580 Total Number of Observations 15 Number of Distinct One of Missing One		
574 575 576 577 Anth 578 579 General Statistics 580 Total Number of Observations 15 Number of Distinct O 581 Number of Missing O 582 Minimum 0.05 583 Maximum 1.01 584 SD 0.249 Std. Er 585 Coefficient of Variation 0.687 586 Normal GOF Test 588 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		
575 576 577 Anth 578 General Statistics 580 Total Number of Observations 15 Number of Distinct On Statistics 581 Number of Missing On Statistics Number of Missing On Statistics 582 Maximum 1.01 583 Maximum 1.01 584 SD 0.249 Std. End 585 Coefficient of Variation 0.687 586 Normal GOF Test 588 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		
576 577 Anth 578 General Statistics 580 Total Number of Observations 15 Number of Distinct On Number of Missing On Number of Miss		
S77 578 General Statistics 580 Total Number of Observations 15 Number of Distinct On Statistics 581 Number of Missing On Statistics Number of Missing On Statistics 582 Maximum Statistics 1.01 583 Maximum Statistics 1.01 584 SD 0.249 Std. En Statistics 585 Coefficient of Variation Statistics 0.687 586 Normal GOF Test 588 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		
579 General Statistics 580 Total Number of Observations 15 Number of Distinct On Number of Missing On Number of M		
Total Number of Observations 15		
Number of Missing O		
582 Minimum 0.05 583 Maximum 1.01 584 SD 0.249 Std. En 585 Coefficient of Variation 0.687 586 Normal GOF Test 587 Normal GOF Test 588 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		15
583 Maximum 1.01 584 SD 0.249 Std. Er 585 Coefficient of Variation 0.687 586 Normal GOF Test 587 Normal GOF Test 588 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		0
Std. En	Mean	0.363
Solution	Median	0.28
586 Normal GOF Test 587 Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		0.0643
Normal GOF Test Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test	Skewness	1.439
Shapiro Wilk Test Statistic 0.877 Shapiro Wilk GOF Test		
588		
5% Shapiro Wilk Critical Value 0.881 Data Not Normal at 5% Significant		
1 illiefore Test Statistic 0.210		
590 Lilliefors rest Statusuc 0.219 Lilliefors GOF Test 591 5% Lilliefors Critical Value 0.22 Data appear Normal at 5% Significa	ance Level	
591 Data appear Approximate Normal at 5% Significance Level		
593		
594 Assuming Normal Distribution		
595 95% Normal UCL 95% UCLs (Adjusted for Sket	wness)	
596 95% Student's-t UCL 0.476 95% Adjusted-CLT UCL (Chen-1995)	0.494
597 95% Modified-t UCL (Joh	nson-1978)	0.48
598	L	
599 Gamma GOF Test		
A-D Test Statistic 0.239 Anderson-Darling Gamma GO		
5% A-D Critical Value 0.746 Detected data appear Gamma Distributed at 5	F Test	
K-S Test Statistic 0.138 Kolmogorov-Smirnov Gamma Go	% Significance	e Level
602	i% Significance OF Test	
603 5% K-S Critical Value 0.224 Detected data appear Gamma Distributed at 5 604 Detected data appear Gamma Distributed at 5% Significance Level	i% Significance OF Test	

	A B C D E	Е	G	Н				1	K		
605	A B C B L	ı	G		<u>'</u>		J		IX.		
606		Gamma	Statistics								
607	k hat (MLE)	2.438				k star	(bias co	rected	MLE)	1.9	995
608	Theta hat (MLE)	0.149			Th	eta star	(bias co	rrected	MLE)	0.	182
609	nu hat (MLE)	73.15				nı	u star (bia	as corr	ected)	59	.85
610	MLE Mean (bias corrected)	0.363				ML	E Sd (bia	as corr	ected)	0.2	257
611					Approxir	nate Ch	i Square	Value	(0.05)	43.	.06
612	Adjusted Level of Significance	0.0324				Adjus	ted Chi S	quare	Value	41.	.31
613											
614	Ass	suming Gam	nma Distrib	ution							
615	95% Approximate Gamma UCL (use when n>=50))	0.504		95% Ad	ljusted G	amma l	JCL (use	when	n<50)	0.9	525
616											
617		Lognorma	I GOF Test								
618	Shapiro Wilk Test Statistic	0.959		Sha	piro Wilk	Lognor	mal GOI	- Test			
619	5% Shapiro Wilk Critical Value	0.881		Data appea	ar Lognor	mal at §	5% Signif	icance	Level		
620	Lilliefors Test Statistic	0.137		Li	liefors Lo	ognorm	al GOF 1	Test			
621	5% Lilliefors Critical Value	0.22		Data appea	ar Lognor	mal at §	5% Signif	icance	Level		
622	Data appear	Lognormal	at 5% Sign	ificance Leve	el						
623											
624		Lognorma	l Statistics								
625	Minimum of Logged Data	-2.996					Mean of			-1.2	
626	Maximum of Logged Data	0.00995					SD of	logge	d Data	0.	723
627											
628		ıming Logno	ormal Distri	bution							
629	95% H-UCL	0.594					ebyshev (0.	
630	95% Chebyshev (MVUE) UCL	0.689			97.	5% Che	ebyshev (MVUE) UCL	0.8	827
631	99% Chebyshev (MVUE) UCL	1.097									
632											
633	`			ICL Statistics							
634	Data appear to follow a	Discernible	Distribution	at 5% Signii	icance L	evel					
635	N			1101 -							
636	Nonpar 95% CLT UCL	ametric Dis	tribution Fr	ee UCLS			000/ 1-		- 1101		476
637		0.468					95% Ja				524
638	95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL	0.466			01		95% Boo				475
639	95% BCA Bootstrap UCL	0.495			9.	5 % FEIG	Jenule Do	JOISHA	p occ	0.4	+/5
640	90% Chebyshev(Mean, Sd) UCL	0.495			05%	Choby	/shev(Me	an Sa	1) LICI	0.0	643
641	97.5% Chebyshev(Mean, Sd) UCL	0.764					shev(Me		·		002
642	57.5% Griebyshev(Mean, 3u) OCL	0.704			337	- Crieby	5110 V (1VIC	Jan, 00	., 552		
643		Suggested	UCL to Use	A							
644	95% Student's-t UCL	0.476		-							
645	5575 States R5-1 OCE	0.170								l	
646	When a data set follows an approx	imate (e.a ı	normal) dist	ribution passi	ng one o	f the GC	OF test				
647	When applicable, it is suggested to use a UCL ba	, ,		•	•			in Pro	UCL		
648	,, , , , , , , , , , , , , , , , , , , ,	F		. 5,5-	, ,						
649 650	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to he	elp the user to	select th	ne most	appropri	ate 95	% UCL		
651	Recommendations are bas			<u>. </u>							
652	These recommendations are based upon the resu						ichle, and	Lee (2006).		
653	However, simulations results will not cover all Real W					•		,		an.	
654						-					
655											
บบบ											

	A B C D E	F	GHIJK	
656	B(a)A	Г	G H I J K	L
657				
658		General	Statistics	
659	Total Number of Observations	15	Number of Distinct Observations	14
660			Number of Missing Observations	0
661	Minimum	0.11	Mean	0.675
662	Maximum	1.55	Median	0.58
663	SD	0.447	Std. Error of Mean	0.115
664	Coefficient of Variation	0.662	Skewness	0.949
665				
666		Normal (GOF Test	
	Shapiro Wilk Test Statistic	0.868	Shapiro Wilk GOF Test	
667	5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level	
668	Lilliefors Test Statistic	0.242	Lilliefors GOF Test	
669	5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level	
670	Data Not	Normal at 5	∣ 5% Significance Level	
671				
672 673	Ass	suming Non	mal Distribution	
674	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
	95% Student's-t UCL	0.879	95% Adjusted-CLT UCL (Chen-1995)	0.895
675			95% Modified-t UCL (Johnson-1978)	0.883
676 677				
678		Gamma	GOF Test	
679	A-D Test Statistic	0.436	Anderson-Darling Gamma GOF Test	
680	5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance	e Level
681	K-S Test Statistic	0.164	Kolmogorov-Smirnov Gamma GOF Test	
682	5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance	e Level
683	Detected data appear	Gamma Di	stributed at 5% Significance Level	
684			-	
685		Gamma	Statistics	
686	k hat (MLE)	2.501	k star (bias corrected MLE)	2.045
687	Theta hat (MLE)	0.27	Theta star (bias corrected MLE)	0.33
688	nu hat (MLE)	75.04	nu star (bias corrected)	61.36
689	MLE Mean (bias corrected)	0.675	MLE Sd (bias corrected)	0.472
690			Approximate Chi Square Value (0.05)	44.35
691	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	42.57
692				
693	Ass	suming Gam	nma Distribution	
694	95% Approximate Gamma UCL (use when n>=50)	0.934	95% Adjusted Gamma UCL (use when n<50)	0.973
695				
696		Lognorma	I GOF Test	
697	Shapiro Wilk Test Statistic	0.943	Shapiro Wilk Lognormal GOF Test	
698	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
699	Lilliefors Test Statistic	0.131	Lilliefors Lognormal GOF Test	
700	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
701	Data appear	Lognormal	at 5% Significance Level	
702				
703		Lognorma	l Statistics	
704	Minimum of Logged Data	-2.207	Mean of logged Data	-0.606
705	Maximum of Logged Data	0.438	SD of logged Data	0.704
706				
707			ormal Distribution	
708	95% H-UCL	1.081	90% Chebyshev (MVUE) UCL	1.08
709	95% Chebyshev (MVUE) UCL	1.259	97.5% Chebyshev (MVUE) UCL	1.507
710	99% Chebyshev (MVUE) UCL	1.994		
711				
712	-		tion Free UCL Statistics	
713	Data appear to follow a l	Discernible	Distribution at 5% Significance Level	
714		-		

	A B C D E	F	G H I J K	L
715	•		tribution Free UCLs	0.970
716	95% CLT UCL	0.865	95% Jackknife UCL	0.879
717	95% Standard Bootstrap UCL	0.883	95% Bootstrap-t UCL	0.939
718	95% Hall's Bootstrap UCL 95% BCA Bootstrap UCL	0.894	95% Percentile Bootstrap UCL	0.675
719	<u>'</u>	1.022	0F0/ Chahyahay/Maan Cd) HCI	1.179
720	90% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL	1.022	95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL	1.824
721	97.5% Chebyshev(weah, 3u) OCL	1.390	99 % Chebyshev(Mean, 3u) OCL	1.024
722		Suggested	UCL to Use	
723	95% Adjusted Gamma UCL	0.973	002 10 030	
724	33% Adjusted Callina OCE	0.575		
725	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
726 727			a size, data distribution, and skewness.	
728		•	nulation studies summarized in Singh, Maichle, and Lee (2006).	
729	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statistician.	
730				
731				
732	B(a)P			
733				
734		General	Statistics	
735	Total Number of Observations	15	Number of Distinct Observations	15
736			Number of Missing Observations	0
737	Minimum	0.1	Mean	0.625
738	Maximum	1.42	Median	0.52
739	SD	0.405	Std. Error of Mean	0.105
740	Coefficient of Variation	0.648	Skewness	0.879
741				
742			GOF Test	
743	Shapiro Wilk Test Statistic	0.896	Shapiro Wilk GOF Test	
744	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
745	Lilliefors Test Statistic	0.199	Lilliefors GOF Test	
746	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	
747	Data appe	ar Normai a	t 5% Significance Level	
748	Δο	eumina Nor	mal Distribution	
749	95% Normal UCL	Sulling Non	95% UCLs (Adjusted for Skewness)	
750	95% Student's-t UCL	0.81	95% Adjusted-CLT UCL (Chen-1995)	0.823
751	30% Statem 1 30E	0.01	95% Modified-t UCL (Johnson-1978)	0.814
752			0070 1110011100 1 0 0 2 (0011110011 1070)	
753 754		Gamma	GOF Test	
755	A-D Test Statistic	0.26	Anderson-Darling Gamma GOF Test	
756	5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance	Level
757	K-S Test Statistic	0.127	Kolmogorov-Smirnov Gamma GOF Test	
758	5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance	Level
759	Detected data appea	r Gamma Di	stributed at 5% Significance Level	
760				
761		Gamma	Statistics	
762	k hat (MLE)	2.492	k star (bias corrected MLE)	2.038
763	Theta hat (MLE)	0.251	Theta star (bias corrected MLE)	0.307
764	nu hat (MLE)	74.76	nu star (bias corrected)	61.14
765	MLE Mean (bias corrected)	0.625	MLE Sd (bias corrected)	0.438
766			Approximate Chi Square Value (0.05)	44.16
767	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	42.38
768				
769			ma Distribution	
770	95% Approximate Gamma UCL (use when n>=50))	0.866	95% Adjusted Gamma UCL (use when n<50)	0.902
771				

	A B C D E	F	G	Н	ı	J	K	L		
772	<u> </u>		I GOF Test		1 1400	1655				
773	Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	0.959				normal GOF				
774	Sinapiro Wilk Childar Value Lilliefors Test Statistic	0.861				at 5% Significa				
775	5% Lilliefors Critical Value	0.11	Lilliefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level							
776 777		r Lognormal at 5% Significance Level								
778										
779		Lognorma	al Statistics							
780	Minimum of Logged Data	-2.303				Mean of lo	gged Data	-0.683		
781	Maximum of Logged Data	0.351				SD of lo	gged Data	0.715		
782	Acces	ımina I oanı	ormal Distrib	ution						
783	95% H-UCL	1.017	omai distrib	uuon	90%	Chebyshev (M	VUE) UCL	1.013		
784	95% Chebyshev (MVUE) UCL	1.182				Chebyshev (M		1.417		
785 786	99% Chebyshev (MVUE) UCL	1.879				, ,	,			
787										
788	Nonparame	etric Distribu	tion Free UC	L Statistics						
789	Data appear to follow a	Discernible	Distribution a	at 5% Signif	icance Leve	l				
790										
791	Nonpai 95% CLT UCL	0.798	tribution Fre	e UCLs		OE9/ look	kknifa LICI	0.81		
792	95% Standard Bootstrap UCL	0.798				95% Boots	kknife UCL	0.847		
793	95% Hall's Bootstrap UCL	0.813			95% I	Percentile Boo		0.798		
794 795	95% BCA Bootstrap UCL	0.806								
796	90% Chebyshev(Mean, Sd) UCL	0.939			95% Ch	nebyshev(Mear	n, Sd) UCL	1.082		
797	97.5% Chebyshev(Mean, Sd) UCL	1.279			99% Ch	nebyshev(Mear	n, Sd) UCL	1.667		
798										
799			UCL to Use					I		
800	95% Student's-t UCL	0.81								
801	Note: Suggestions regarding the selection of a 95%	UCL are no	ovided to hel	n the user to	select the m	nost appropriate	e 95% UCI			
802	Recommendations are base							••		
804	These recommendations are based upon the resu						ee (2006).			
805	However, simulations results will not cover all Real W	orld data se	ts; for additio	nal insight th	ie user may v	want to consult	t a statisticia	an.		
806										
807										
808	B(b)F									
809		General	Statistics							
810	Total Number of Observations	15	Ctationco		Numbe	r of Distinct Ob	servations	14		
811 812	.00					r of Missing Ob		0		
813	Minimum	0.11					Mean	0.587		
814	Maximum	1.23					Median	0.49		
815	SD	0.357					or of Mean	0.0921		
816	Coefficient of Variation	0.607					Skewness	0.748		
817		Nemari	00E T+							
818	Shapiro Wilk Test Statistic	0.895	GOF Test		Shaniro Mi	lk GOF Test				
819	5% Shapiro Wilk Critical Value	0.895		Data appe		t 5% Significar	nce Level			
820 821	Lilliefors Test Statistic	0.197		266		GOF Test				
822	5% Lilliefors Critical Value	0.22		Data appe		t 5% Significar	nce Level			
823	Data appe	ar Normal a	t 5% Signific	ance Level						
824										
825		suming Nor	mal Distribut							
826	95% Normal UCL	0.740				sted for Skew		0.750		
827	95% Student's-t UCL	0.749				ed-CLT UCL (C		0.758		
828					ao /o ivioditie	ed-t UCL (Johr	19/8)	0.752		
829										

П	A B C D E	F	G H I J K	L			
830	X 5 0 5 E		GOF Test				
831	A-D Test Statistic	0.307	Anderson-Darling Gamma GOF Test				
832	5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance	e Level			
833	K-S Test Statistic	0.146	Kolmogorov-Smirnov Gamma GOF Test				
834	5% K-S Critical Value	0.223	Detected data appear Gamma Distributed at 5% Significance Leve				
835	Detected data appear	Gamma Di	stributed at 5% Significance Level				
836							
837		Gamma	Statistics				
838	k hat (MLE)	2.814	k star (bias corrected MLE)	2.296			
839	Theta hat (MLE)	0.209	Theta star (bias corrected MLE)	0.256			
840	nu hat (MLE)	84.43	nu star (bias corrected)	68.88			
841	MLE Mean (bias corrected)	0.587	MLE Sd (bias corrected)	0.388			
842			Approximate Chi Square Value (0.05)	50.77			
843	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	48.86			
844							
845			nma Distribution				
846	95% Approximate Gamma UCL (use when n>=50))	0.797	95% Adjusted Gamma UCL (use when n<50)	0.828			
847							
848	OL : MEILT LOUGE		I GOF Test				
849	Shapiro Wilk Test Statistic	0.953	Shapiro Wilk Lognormal GOF Test				
850	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.881	Data appear Lognormal at 5% Significance Level				
851	5% Lilliefors Critical Value	0.127	Lilliefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level				
852			at 5% Significance Level				
853	рака арреат	Logiloillai	at 5 % Significance Level				
854		Lognorms	Il Statistics				
855	Minimum of Logged Data	-2.207	Mean of logged Data	-0.72			
856	Maximum of Logged Data	0.207	SD of logged Data	0.667			
857			22 3 1 2 3 2 2 2 2 2				
858 859	Assu	ıming Logno	ormal Distribution				
860	95% H-UCL	0.909	90% Chebyshev (MVUE) UCL	0.921			
861	95% Chebyshev (MVUE) UCL	1.068	97.5% Chebyshev (MVUE) UCL	1.271			
862	99% Chebyshev (MVUE) UCL	1.671					
863							
864	Nonparame	tric Distribu	tion Free UCL Statistics				
865	Data appear to follow a	Discernible	Distribution at 5% Significance Level				
866							
867	Nonpar	ametric Dis	tribution Free UCLs				
868	95% CLT UCL	0.739	95% Jackknife UCL	0.749			
869	95% Standard Bootstrap UCL	0.73	95% Bootstrap-t UCL	0.79			
870	95% Hall's Bootstrap UCL	0.74	95% Percentile Bootstrap UCL	0.733			
871	95% BCA Bootstrap UCL	0.759					
872	90% Chebyshev(Mean, Sd) UCL	0.864	95% Chebyshev(Mean, Sd) UCL	0.989			
873	97.5% Chebyshev(Mean, Sd) UCL	1.162	99% Chebyshev(Mean, Sd) UCL	1.503			
874							
875			UCL to Use				
876	95% Student's-t UCL	0.749					
877	N	1101					
878			ovided to help the user to select the most appropriate 95% UCL.				
879			ta size, data distribution, and skewness.				
880			nulation studies summarized in Singh, Maichle, and Lee (2006).				
881	However, simulations results will not cover all Real W	oria data se	ts; for additional insight the user may want to consult a statistician	l.			
882							
883							

	A B C D E	F	G H I J K	1
884	B(bj)F			
885				
886		General	Statistics	
887	Total Number of Observations	15	Number of Distinct Observations	15
888			Number of Missing Observations	0
889	Minimum	0.17	Mean	0.874
890	Maximum	1.96	Median	8.0
891	SD	0.54	Std. Error of Mean	0.139
892	Coefficient of Variation	0.617	Skewness	0.828
893				
894			GOF Test	
895	Shapiro Wilk Test Statistic	0.914	Shapiro Wilk GOF Test	
896	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
897	Lilliefors Test Statistic	0.185	Lilliefors GOF Test	
898	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	
899	Data appea	r Normal a	t 5% Significance Level	
900				
901		suming Nor	mal Distribution	
902	95% Normal UCL	1 110	95% UCLs (Adjusted for Skewness)	1 105
903	95% Student's-t UCL	1.119	95% Adjusted-CLT UCL (Chen-1995)	1.135
904			95% Modified-t UCL (Johnson-1978)	1.124
905		0	GOF Test	
906	A-D Test Statistic	0.219	Anderson-Darling Gamma GOF Test	
907	5% A-D Critical Value	0.219	Detected data appear Gamma Distributed at 5% Significance	a Lavial
908	K-S Test Statistic	0.745	Kolmogorov-Smirnov Gamma GOF Test	e Levei
909	5% K-S Critical Value	0.113	Detected data appear Gamma Distributed at 5% Significance	o Lovol
910			stributed at 5% Significance Level	e Level
911	Detected data appear	Gaiiiiia Di	Subded at 0% Oignineance Level	
912		Gamma	Statistics	
913	k hat (MLE)	2.744	k star (bias corrected MLE)	2.239
914	Theta hat (MLE)	0.319	Theta star (bias corrected MLE)	0.39
915	nu hat (MLE)	82.31	nu star (bias corrected)	67.18
916	MLE Mean (bias corrected)	0.874	MLE Sd (bias corrected)	0.584
918	<u>'</u>		Approximate Chi Square Value (0.05)	49.32
919	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	47.44
920				
921	Ass	uming Gan	nma Distribution	
922	95% Approximate Gamma UCL (use when n>=50))	1.191	95% Adjusted Gamma UCL (use when n<50)	1.238
923				
924		Lognorma	I GOF Test	
925	Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Lognormal GOF Test	
926	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
927	Lilliefors Test Statistic	0.102	Lilliefors Lognormal GOF Test	
928	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
929	Data appear	Lognormal	at 5% Significance Level	
930				
931		Lognorma	ll Statistics	
932	Minimum of Logged Data	-1.772	Mean of logged Data	-0.328
933	Maximum of Logged Data	0.673	SD of logged Data	0.674
934				
935			ormal Distribution	
936	95% H-UCL	1.362	90% Chebyshev (MVUE) UCL	1.376
937	95% Chebyshev (MVUE) UCL	1.596	97.5% Chebyshev (MVUE) UCL	1.903
938	99% Chebyshev (MVUE) UCL	2.505		
939				
940	-		tion Free UCL Statistics	
941	Data appear to follow a I	Discernible	Distribution at 5% Significance Level	
942				

	A B C D E	F	G H I J K L						
943	Nonpai	rametric Dis	tribution Free UCLs						
944	95% CLT UCL	1.103	95% Jackknife UCL 1.119						
945	95% Standard Bootstrap UCL	1.094	95% Bootstrap-t UCL 1.167						
946	95% Hall's Bootstrap UCL	1.132	95% Percentile Bootstrap UCL 1.105						
947	95% BCA Bootstrap UCL	1.122							
948	90% Chebyshev(Mean, Sd) UCL	1.292	95% Chebyshev(Mean, Sd) UCL 1.481						
949	97.5% Chebyshev(Mean, Sd) UCL	1.744	99% Chebyshev(Mean, Sd) UCL 2.26						
950									
951		Suggested	UCL to Use						
952	95% Student's-t UCL	1.119							
953									
954			rovided to help the user to select the most appropriate 95% UCL.						
955		•	ta size, data distribution, and skewness.						
956	<u> </u>		nulation studies summarized in Singh, Maichle, and Lee (2006).						
957	However, simulations results will not cover all Real W	orld data se	ets; for additional insight the user may want to consult a statistician.						
958									
959	D(a)D								
300	B(e)P								
961		General	Statistics						
962	Total Number of Observations	15	Number of Distinct Observations 13						
963	Total Number of Observations	10	Number of Missing Observations 0						
964	Minimum	0.08	Mean 0.45						
965	Maximum	0.93	Median 0.37						
966	SD	0.26	Std. Error of Mean 0.0671						
967 968	Coefficient of Variation	0.577	Skewness 0.692						
969									
970		Normal (GOF Test						
971	Shapiro Wilk Test Statistic	0.911 Shapiro Wilk GOF Test							
972	5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level						
973	Lilliefors Test Statistic	0.197	Lilliefors GOF Test						
974	5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level						
975	Data appea	ar Normal a	t 5% Significance Level						
976									
977		suming Nor	mal Distribution						
978	95% Normal UCL		95% UCLs (Adjusted for Skewness)						
979	95% Student's-t UCL	0.568	95% Adjusted-CLT UCL (Chen-1995) 0.573						
980			95% Modified-t UCL (Johnson-1978) 0.57						
981									
982	A D.T. (O) S S		GOF Test						
983	A-D Test Statistic	0.317	Anderson-Darling Gamma GOF Test						
984	5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level Kolmogorov-Smirnov Gamma GOF Test						
985	K-S Test Statistic 5% K-S Critical Value	0.135							
986			Detected data appear Gamma Distributed at 5% Significance Level istributed at 5% Significance Level						
987	Detected data appear	Jannilla Di	CONTRACTOR OF COMMISSION FOR COMMISSION OF C						
988		Gamma	Statistics						
989	k hat (MLE)	2.969	k star (bias corrected MLE) 2.419						
990	Theta hat (MLE)	0.152	Theta star (bias corrected MLE) 0.186						
991	nu hat (MLE)	89.06	nu star (bias corrected) 72.58						
992	MLE Mean (bias corrected)	0.45	MLE Sd (bias corrected) 0.289						
993	, , , , , , , , , , , , , , , , , , , ,		Approximate Chi Square Value (0.05) 53.96						
995	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value 51.99						
996	-		· · · · · · · · · · · · · · · · · · ·						
997	Ass	suming Gan	nma Distribution						
998	95% Approximate Gamma UCL (use when n>=50))	0.605	95% Adjusted Gamma UCL (use when n<50) 0.628						
999									

1000	A B C D E	F	G H I J K	L
			I GOF Test	
1001	Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Lognormal GOF Test	
1002	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
1003	Lilliefors Test Statistic	0.165	Lilliefors Lognormal GOF Test	
1004	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
1005	''	Lognormai	at 5% Significance Level	
1006		Lognorms	al Statistics	
1007	Minimum of Logged Data	-2.526	Mean of logged Data	-0.976
1008	Maximum of Logged Data	-0.0726	SD of logged Data	0.66
1009	Maximum of Edgged Data	0.0720	OD 61 logged Data	0.00
1010	Ass	umina Loan	ormal Distribution	
1011	95% H-UCL	0.697	90% Chebyshev (MVUE) UCL	0.707
1013	95% Chebyshev (MVUE) UCL	0.819	97.5% Chebyshev (MVUE) UCL	0.974
1014	99% Chebyshev (MVUE) UCL	1.279		
1015				
1016	Nonparame	etric Distribu	tion Free UCL Statistics	
1017	Data appear to follow a	Discernible	Distribution at 5% Significance Level	
1018				
1019	Nonpa	rametric Dis	tribution Free UCLs	
1020	95% CLT UCL	0.56	95% Jackknife UCL	0.568
1021	95% Standard Bootstrap UCL	0.557	95% Bootstrap-t UCL	0.584
1022	95% Hall's Bootstrap UCL	0.569	95% Percentile Bootstrap UCL	0.561
1023	95% BCA Bootstrap UCL	0.565		
1024	90% Chebyshev(Mean, Sd) UCL	0.651	95% Chebyshev(Mean, Sd) UCL	0.742
1025	97.5% Chebyshev(Mean, Sd) UCL	0.869	99% Chebyshev(Mean, Sd) UCL	1.118
1026		0	HOL to Hon	
1027	95% Student's-t UCL	0.568	UCL to Use	
1028	95 % Student S-LOCE	0.308		
1029	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	rovided to help the user to select the most appropriate 95% UCL.	
1030	** * *		ta size, data distribution, and skewness.	
1031			nulation studies summarized in Singh, Maichle, and Lee (2006).	
1033	However, simulations results will not cover all Real V	orld data se	ets; for additional insight the user may want to consult a statisticial	
1034				n.
				n.
	B(ghi)P			n.
	B(ghi)P			n.
1035			Statistics	
1035 1036	Total Number of Observations	15	Number of Distinct Observations	11
1035 1036 1037	Total Number of Observations Number of Detects	15 10	Number of Distinct Observations Number of Non-Detects	11 5
1035 1036 1037 1038	Total Number of Observations Number of Detects Number of Distinct Detects	15 10 10	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects	11 5 1
1035 1036 1037 1038 1039 1040	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect	15 10 10 0.28	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect	11 5 1 0.01
1035 1036 1037 1038 1039 1040 1041	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect	15 10 10 0.28 0.86	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect	11 5 1 0.01 0.01
1035 1036 1037 1038 1039 1040 1041 1042 1043	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects	15 10 10 0.28 0.86 0.0452	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects	11 5 1 0.01 0.01 33.33%
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects	15 10 10 0.28 0.86 0.0452 0.502	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects	11 5 1 0.01 0.01 33.33% 0.213
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects	15 10 10 0.28 0.86 0.0452 0.502 0.405	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects	11 5 1 0.01 0.01 33.33% 0.213 0.423
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects	15 10 10 0.28 0.86 0.0452 0.502	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects	11 5 1 0.01 0.01 33.33% 0.213
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects	15 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Nom Shapiro Wilk Test Statistic	15 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects CV Detects Kurtosis Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Nom Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	15 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Leve	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic	15 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 mal GOF Tes 0.876 0.842 0.267	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1050 1051 1052 1053	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Data appear	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 mal GOF Tes 0.876 0.842 0.267 0.262 Approximate	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1050 1051 1052 1053 1054	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Critical Value Detected Data appear	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 mal GOF Tes 0.876 0.842 0.267 0.262 Approximation	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1050 1051 1052 1053 1054 1055	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Critical Value Detected Data appear	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 mal GOF Tes 0.876 0.842 0.267 0.262 Approximation of the control of the c	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level Critical Values and other Nonparametric UCLs KM Standard Error of Mean	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1050 1051 1052 1053 1054 1055 1056	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Critical Value Detected Data appear Kaplan-Meier (KM) Statistics usi KM Mean KM SD	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 nal GOF Tes 0.876 0.842 0.267 0.262 Approximation of the control of the co	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level Critical Values and other Nonparametric UCLs KM Standard Error of Mean 95% KM (BCA) UCL	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1050 1051 1052 1053 1054 1055 1056 1057	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Data appear Kaplan-Meier (KM) Statistics usi KM Mean KM SD 95% KM (t) UCL	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 nal GOF Tes 0.876 0.842 0.267 0.262 Approximation 0.338 0.284 0.474	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level Eritical Values and other Nonparametric UCLs KM Standard Error of Mean 95% KM (BCA) UCL 95% KM (Percentile Bootstrap) UCL	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1050 1051 1052 1053 1054 1055 1056 1057 1058	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Nom Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Data appear Kaplan-Meier (KM) Statistics usi KM Mean KM SD 95% KM (t) UCL	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 nal GOF Tes 0.876 0.842 0.267 0.262 Approximation 0.338 0.284 0.474 0.465	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level KM Standard Error of Mean 95% KM (BCA) UCL 95% KM (Percentile Bootstrap) UCL	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417
1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059	Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Mean Detects Median Detects Skewness Detects Mean of Logged Detects Mean of Logged Detects Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Data appear Kaplan-Meier (KM) Statistics usi KM Mean KM SD 95% KM (t) UCL	15 10 10 0.28 0.86 0.0452 0.502 0.405 0.596 -0.768 nal GOF Tes 0.876 0.842 0.267 0.262 Approximation 0.338 0.284 0.474	Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects SD of Logged Detects SD of Logged Detects St on Detects Only Shapiro Wilk GOF Test Detected Data appear Normal at 5% Significance Level Lilliefors GOF Test Detected Data Not Normal at 5% Significance Level te Normal at 5% Significance Level Eritical Values and other Nonparametric UCLs KM Standard Error of Mean 95% KM (BCA) UCL 95% KM (Percentile Bootstrap) UCL	11 5 1 0.01 0.01 33.33% 0.213 0.423 -1.326 0.417

	A B C D E	F	G H I J K I						
1000	A B C D E	F	G H I I J K I	L					
1063	Gamma GOE	Teete on De	etected Observations Only						
1064			Anderson-Darling GOF Test						
1065	A-D Test Statistic	0.533							
1066	5% A-D Critical Value	0.728	Detected data appear Gamma Distributed at 5% Significano	e Level					
1067	K-S Test Statistic	0.242	Kolmogorov-Smirnov GOF						
1068	5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance	e Level					
1069	Detected data appear	Gamma Di	stributed at 5% Significance Level						
1070									
1071	Gamma	Statistics on	Detected Data Only						
1071	k hat (MLE)	6.48	k star (bias corrected MLE)	4.603					
	Theta hat (MLE)	0.0775	Theta star (bias corrected MLE)						
1073	nu hat (MLE)	129.6	nu star (bias corrected)	0.109 92.05					
1074	Mean (detects)	0.502	nu star (bias corrected)	32.03					
1075	Wearr (detects)	0.502							
1076	0	0	to Local District						
1077			sing Imputed Non-Detects						
1078			NDs with many tied observations at multiple DLs						
1079	GROS may not be used when kstar of detects is s	small such a	s <1.0, especially when the sample size is small (e.g., <15-20)						
1080	For such situations, GROS r	nethod may	yield incorrect values of UCLs and BTVs						
1081	This is especia	ally true whe	n the sample size is small.						
1082	For gamma distributed detected data, BTVs a	nd UCLs ma	y be computed using gamma distribution on KM estimates						
1083	Minimum	0.01	Mean	0.36					
	Maximum	0.86	Median	0.32					
1084	SD	0.271	CV	0.755					
1085	k hat (MLE)	1.101	k star (bias corrected MLE)	0.735					
1086	, ,		· · · · · · · · · · · · · · · · · · ·						
1087	Theta hat (MLE)	0.327	Theta star (bias corrected MLE)	0.389					
1088	nu hat (MLE)	33.02	nu star (bias corrected)	27.75					
1089	Adjusted Level of Significance (β)	0.0324							
1090	Approximate Chi Square Value (27.75, α)	16.74	Adjusted Chi Square Value (27.75, β)	15.69					
1091	95% Gamma Approximate UCL (use when n>=50)	0.596	95% Gamma Adjusted UCL (use when n<50)	0.636					
1092			1						
1093	Estimates of G	amma Parai	meters using KM Estimates						
	Mean (KM)	0.338	SD (KM)	0.284					
1094	Variance (KM)	0.0809	SE of Mean (KM)	0.0774					
1095	k hat (KM)	1.412	k star (KM)						
1096	· · ·		` '	1.174					
1097	nu hat (KM)	42.37	nu star (KM)	35.23					
1098	theta hat (KM)	0.239	theta star (KM)	0.288					
1099	80% gamma percentile (KM)	0.536	90% gamma percentile (KM)	0.748					
1100	95% gamma percentile (KM)	0.957	99% gamma percentile (KM)	1.437					
1101									
1102	Gamm	a Kaplan-M	eier (KM) Statistics						
1103	Approximate Chi Square Value (35.23, α)	22.65	Adjusted Chi Square Value (35.23, β)	21.41					
	95% Gamma Approximate KM-UCL (use when n>=50)	0.526	95% Gamma Adjusted KM-UCL (use when n<50)	0.556					
1104			<u> </u>						
1105	Lognormal GO	F Test on D	etected Observations Only						
1106	Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test						
1107	•		<u> </u>	u.al					
1108	5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Le	vei					
1109	Lilliefors Test Statistic	0.216	Lilliefors GOF Test						
1110	5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Le	evel					
1111	Detected Data ap	pear Logno	rmal at 5% Significance Level						
1112									
1113	Lognormal ROS	Statistics I	Jsing Imputed Non-Detects						
1114	Mean in Original Scale	0.389	Mean in Log Scale	-1.124					
	SD in Original Scale	0.238	SD in Log Scale	0.636					
1115	95% t UCL (assumes normality of ROS data)	0.498	95% Percentile Bootstrap UCL	0.489					
1116	95% BCA Bootstrap UCL	0.492	95% Bootstrap t UCL	0.518					
1117	95% H-UCL (Log ROS)	0.492	33 /0 DOUISHAP LOCE	0.010					
1118	95% N-UCL (LUG ROS)	0.00							
1119	2								
1120			Data and Assuming Lognormal Distribution						
1121	KM Mean (logged)	-2.047	KM Geo Mean	0.129					
1122	KM SD (logged)	1.837	95% Critical H Value (KM-Log)	4.248					
1123	KM Standard Error of Mean (logged)	0.5	95% H-UCL (KM -Log)	5.622					
1124	KM SD (logged)	1.837	95% Critical H Value (KM-Log)	4.248					
	KM Standard Error of Mean (logged)	0.5	,						
1125	(1991-1)								
1126									

	Α	В	С	D	Е	F	G	Н		J	K	L
1127		-				DL/2 S	tatistics					
1128			DL/2	Normal					DL/2 Log-	ransformed		
1129				Mean in O	riginal Scale	0.336					in Log Scale	-2.278
					riginal Scale	0.296					in Log Scale	2.236
1130			95% t I	UCL (Assume		0.471					H-Stat UCL	25.14
1131				is not a reco	• • • • • • • • • • • • • • • • • • • •		ded for com	narieone and	l hietorical r		711 Oldi OOL	20.17
1132			DUZ	15 110t a 16c0	illillerided ill	eulou, provi	ueu ioi com	parisons and	i ilistoricai i	5030113		
1133					Mannanam	atula Diatulbu	tion Fron I I	O Ctatiatian				
1134					•	etric Distribu						
1135			De	tected Data	appear Appr	oximate Nor	mai Distribu	ted at 5% Si	gnincance L	evei		
1136												
1137							UCL to Use					
1138				95%	KM (t) UCL	0.474						
1139												
1140			When a	data set follo	ws an approx	imate (e.g., ı	normal) distri	bution passi	ng one of the	GOF test		
1141		When app	olicable, it is s	suggested to	use a UCL b	ased upon a	distribution ((e.g., gamma) passing bo	th GOF tests	in ProUCL	
1142												
1143		Note: Sugge	estions regard	ding the selec	ction of a 95%	6 UCL are pr	ovided to he	lp the user to	select the n	ost appropri	ate 95% UCL.	
1144			F	Recommenda	ations are ba	sed upon dat	ta size, data	distribution, a	and skewnes	S.		
1145		These reco	mmendation	s are based i	upon the resu	ılts of the sin	nulation studi	es summariz	ed in Singh,	Maichle, and	d Lee (2006).	
1146		However, sim	ulations resul	Its will not cov	er all Real V	orld data se	ts; for addition	nal insight th	e user may	want to cons	ult a statisticia	in.
1147												
1148												
11/0	B(k)F											
1150												
1151						General	Statistics					
			Total	Number of C	Observations	15			Numbe	r of Distinct (Observations	14
1152											Observations	0
1153					Minimum	0.05			0.325			
1154					Maximum	0.72			0.323			
1155					SD	0.72				C+A E	Median Error of Mean	0.0469
1156				Coofficien	t of Variation	0.162				Olu. L	Skewness	0.0409
1157				Coefficient	t Of Variation	0.556					Skewiless	0.722
1158						M 1 4	20F T4					
1159							GOF Test					
1160				Shapiro Wilk		0.958				ik GOF Test		
1161			5% S	Shapiro Wilk (0.881		Data appe		t 5% Signific	ance Level	
1162					Test Statistic	0.134				GOF Test		
1163				5% Lilliefors (0.22			ear Normal a	t 5% Signific	ance Level	
1164					Data appe	ar Normal a	t 5% Signific	ance Level				
1165												
1166					As	suming Non	mal Distribut	tion				
1167			95% No	ormal UCL				95%	UCLs (Adju	sted for Ske	wness)	
1168				95% Stu	dent's-t UCL	0.408			95% Adjuste	d-CLT UCL	(Chen-1995)	0.412
1169									95% Modifi	ed-t UCL (Jo	hnson-1978)	0.409
1170						1						
1171						Gamma	GOF Test					
1172				A-D	Test Statistic	0.171		Ande	son-Darling	Gamma GC	F Test	
1173				5% A-D (Critical Value	0.745	Detecte	d data appea	r Gamma D	istributed at	5% Significand	ce Level
1174				K-S	Test Statistic	0.124		Kolmog	orov-Smirne	ov Gamma G	OF Test	
1175				5% K-S (Critical Value	0.223	Detecte	d data appea	r Gamma D	istributed at	5% Significand	ce Level
1176				Detected	l data appea	r Gamma Di	stributed at	5% Significa	nce Level			
1177 1178						Gamma	Statistics					
					k hat (MLE)	2.991			k	star (bias co	rrected MLE)	2.438
1179				The	ta hat (MLE)	0.109					rrected MLE)	0.133
1180					nu hat (MLE)	89.74					as corrected)	73.13
1181			I.A	LE Mean (bia		0.325				•	as corrected)	0.208
1182			ivi	can (Dic	.c corrected)	0.020			Annrovimet		Value (0.05)	54.43
1183			۸di···	sted Level of	Significance	0.0324			• •		Square Value	52.45
1184			Auju	SIEU LEVEI OT	OignilledIICE	0.0324			А	ujusi c u CIII S	quare value	52.40
1185					A -	oumis = Os	ma Dist-II	tion				
1186		0E0/ A '	mata O-	LIOL 6		suming Gam	ıına Distribu		iunta -l C	ma 1101 /	udan - FO	0.454
1187		95% Approxi	mate Gamma	UCL (use w	nen n>=50))	0.437		95% Ad	justed Gami	πa UCL (use	when n<50)	0.454
1188												

1189	Α	В	С	D	Е	F	G	Н	I	J	K	L	
4400							GOF Test						
1190			S	Shapiro Wilk Te	est Statistic	0.936		Sha	piro Wilk Log	gnormal GOF	Test		
1191			5% S	hapiro Wilk Cri	itical Value	0.881		Data appea	ar Lognorma	l at 5% Signifi	cance Level		
1192				Lilliefors Te	est Statistic	0.163		Li	lliefors Logn	ormal GOF T	est		
1193			5	5% Lilliefors Cri	itical Value	0.22		Data appea	ar Lognorma	l at 5% Signifi	cance Level		
1194				D	ata appear	Lognormal	at 5% Signifi	cance Leve	el				
1195													
1196						Lognorma	l Statistics						
1197				Minimum of Lo	gged Data	-2.996				Mean of I	logged Data	-1.299	
1198			N	Maximum of Lo	gged Data	-0.329				SD of I	logged Data	0.675	
1199													
1200					Assu	ıming Logno	rmal Distribu	ition					
1200				9:	5% H-UCL	0.516			90%	Chebyshev (I	MVUE) UCL	0.521	
			95%	Chebyshev (M	VUE) UCL	0.605				Chebyshev (I		0.721	
1202 1203			99%	Chebyshev (M	VUE) UCL	0.95				• •	,		
1203				, ,	,								
1204					Nonparame	etric Distribu	tion Free UC	L Statistics	1				
										al .			
1206													
1207	Nonparametric Distribution Free UCLs												
1208				95%	CLT UCL	0.402				95% Ja	ckknife UCL	0.408	
1209			95%	Standard Boot		0.397					tstrap-t UCL	0.424	
1210				95% Hall's Boot		0.424			95%	Percentile Bo		0.402	
1211				95% BCA Boot		0.41			3370	T CICCITUIC DO	otstrap OOL	0.402	
1212				ebyshev(Mear		0.466			0E% CF	nebyshev(Mea	an ed/IICI	0.53	
1213				ebyshev(Mear	. ,	0.400						0.53	
1214			97.5% CI	iebysnev(iviear	1, Su) UCL	0.016			99% CI	nebyshev(Mea	an, Su) UCL	0.792	
1215						Currented	LICI to Line						
1216				050/ 04-4-			UCL to Use						
1217				95% Stude	ent's-t UCL	0.408							
1218													
1219		Note: Sugge		ding the selection							ite 95% UCL		
1220				Recommendati		•							
1221				s are based up					•		. ,		
1222		However, simu	ulations resul	ts will not cove	r all Real W	orld data se	ts; for additior	nal insight t	ne user may	want to consu	ılt a statisticia	ın.	
1223													
1224													
1225													
	Chry												
1226	Cnry												
	Cnry						Statistics						
1226	Cnry		Total	Number of Ob	oservations	General 15	Statistics			er of Distinct C		15	
1226 1227	Cnry		Total	Number of Ob		15	Statistics			er of Distinct C	bservations	0	
1226 1227 1228	Cnry		Total	Number of Ob	Minimum	15 0.14	Statistics				Observations Mean	0 0.769	
1226 1227 1228 1229	Cnry		Total	Number of Ob	Minimum Maximum	0.14 1.7	Statistics			er of Missing C	Observations Mean Median	0 0.769 0.66	
1226 1227 1228 1229 1230	Cnry		Total		Minimum Maximum SD	0.14 1.7 0.482	Statistics			er of Missing C	Mean Median rror of Mean	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231	Crity		Total	Number of Ob	Minimum Maximum SD	0.14 1.7	Statistics			er of Missing C	Observations Mean Median	0 0.769 0.66	
1226 1227 1228 1229 1230 1231 1232	Crity		Total		Minimum Maximum SD	0.14 1.7 0.482 0.627				er of Missing C	Mean Median rror of Mean	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233	Cnry			Coefficient o	Minimum Maximum SD of Variation	0.14 1.7 0.482 0.627	Statistics GOF Test		Numbe	or of Missing C	Mean Median rror of Mean	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233	Chry				Minimum Maximum SD of Variation	0.14 1.7 0.482 0.627			Numbe	er of Missing C	Mean Median rror of Mean	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235	Chry		ę	Coefficient o	Minimum Maximum SD of Variation	0.14 1.7 0.482 0.627		Data app	Numbe	or of Missing C	Mean Median rror of Mean Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te Shapiro Wilk Cri Lilliefors Te	Minimum Maximum SD of Variation est Statistic itical Value est Statistic	15 0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223			Numbe Shapiro W ear Normal a	std. En	Mean Median Median Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237	Chry		\$ 5% S	Coefficient c Shapiro Wilk Te shapiro Wilk Cri	Minimum Maximum SD of Variation est Statistic itical Value est Statistic	15 0.14 1.7 0.482 0.627 Normal C 0.884 0.881			Numbe Shapiro W ear Normal a	std. En	Mean Median Median Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te Shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value	0.14 1.7 0.482 0.627 Normal 0 0.884 0.881 0.223		Data N	Shapiro W ear Normal at Lilliefors ot Normal at	std. En	Mean Median Median Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te Shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value	0.14 1.7 0.482 0.627 Normal 0 0.884 0.881 0.223	GOF Test	Data N	Shapiro W ear Normal at Lilliefors ot Normal at	std. En	Mean Median Median Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te Shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value uppear Appl	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at	std. En	Mean Median Median Skewness	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te Shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value uppear Appl	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at	std. En	Mean Median rror of Mean Skewness ance Level	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241	Chry		\$ 5% S	Coefficient of Coeffi	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value ppear App	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at Level	std. Ei Std. Ei ilk GOF Test at 5% Significa GOF Test 5% Significan	Mean Median rror of Mean Skewness ance Level ce Level	0 0.769 0.66 0.124	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri Data a	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value ppear App	0.14 1.7 0.482 0.627 Normal (0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at Level	Std. En Std. E	Mean Median rror of Mean Skewness ance Level ce Level wness) Chen-1995)	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1248 1249 1241 1242 1243 1244 1245	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri Data a	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value ppear App	0.14 1.7 0.482 0.627 Normal (0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at Level	Std. En Std. E	Mean Median rror of Mean Skewness ance Level ce Level wness) Chen-1995)	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1248 1249 1241 1242 1243 1244 1245 1246	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri Data a	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value ppear App	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	GOF Test	Data No	Shapiro W ear Normal at Lilliefors ot Normal at Level	Std. En Std. E	Mean Median rror of Mean Skewness ance Level ce Level wness) Chen-1995)	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244 1245 1246 1247	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri Data a pormal UCL 95% Stude	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value ppear App	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	GOF Test rmal at 5% S mal Distributi	Data No ignificance on 95%	Shapiro W ear Normal at Lilliefors ot Normal at Level 6 UCLs (Adju 95% Adjuste	Std. En Std. E	Mean Median Median Rror of Mean Skewness Ance Level Ce Level Wness) Chen-1995) Inson-1978)	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244 1245 1246 1247 1248	Chry		\$ 5% S	Coefficient of Shapiro Wilk Te shapiro Wilk Cri Lilliefors Te 5% Lilliefors Cri Data a pormal UCL 95% Stude	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value est Statistic itical Value	15 0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No	rmal at 5% S mal Distributi	Data Ni paignificance on 95%	Shapiro W ear Normal at Lilliefors ot Normal at Level 5 UCLs (Adjuste 95% Adjuste 95% Modifi	Std. En	Mean Median Median Skewness Mean Skewness Ance Level Ce Level When Median M	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244 1245 1246 1247 1248	Chry		\$ 5% S	Coefficient of Coeffi	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value est Statistic itical Value	0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No 0.988 Gamma C 0.332	rmal at 5% S mal Distributi	Data Ni ignificance on 95% Ande	Shapiro W ear Normal at Lilliefors ot Normal at Level 5 UCLs (Adjuste 95% Adjuste 95% Modifi	Std. En Std. E	Mean Median Median Rror of Mean Skewness Ance Level Ce Level Wess Chen-1995) Inson-1978) F Test % Significan	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249 1250			\$ 5% S	Coefficient of Coeffi	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value appear Appi As:	15 0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate Normal Normal C 0.988 Gamma C 0.332 0.745	mal at 5% S mal Distributi GOF Test Detected	Data Ni ignificance on 95% Ande i data appe Kolmog	Shapiro W ear Normal at Lilliefors ot Normal at Level 5 UCLs (Adjuste 95% Adjuste 95% Modifi rson-Darling ar Gamma D gorov-Smirne	Std. En Std	Median Me	0 0.769 0.66 0.124 0.918	
1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1240 1241 1242 1243 1244 1245 1246 1247 1248			\$ 5% S	Coefficient of Coeffi	Minimum Maximum SD of Variation est Statistic itical Value est Statistic itical Value appear App As: ent's-t UCL est Statistic itical Value est Statistic itical Value est Statistic	15 0.14 1.7 0.482 0.627 Normal C 0.884 0.881 0.223 0.22 roximate No suming Normal C 0.988 Gamma C 0.332 0.745 0.147 0.224	mal at 5% S mal Distributi GOF Test Detected	Data Ni ignificance on 95% Ande i data appe Kolmog i data appe	Shapiro W ear Normal at Lilliefors ot Normal at Level 5 UCLs (Adjuste 95% Adjuste 95% Modifi rson-Darling ar Gamma D gorov-Smirne ar Gamma D	Std. En Std	Median Me	0 0.769 0.66 0.124 0.918	

	A B C D E	F	G H I J K	1
1252		Г		
1253		Gamma	Statistics	
1254	k hat (MLE)	2.763	k star (bias corrected MLE)	2.255
1255	Theta hat (MLE)	0.278	Theta star (bias corrected MLE)	0.341
1256	nu hat (MLE)	82.9	nu star (bias corrected)	67.65
1257	MLE Mean (bias corrected)	0.769	MLE Sd (bias corrected)	0.512
1258	MLE Mean (bias corrected)	0.709	, , ,	49.72
1259	Adicated Lavel of Comitions	0.0004	Approximate Chi Square Value (0.05)	
1260	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	47.83
1261		' 0	Poladili od o	
1262			ma Distribution	1.00=
1263	95% Approximate Gamma UCL (use when n>=50))	1.046	95% Adjusted Gamma UCL (use when n<50)	1.087
1264				
1265	0		GOF Test	
1266	Shapiro Wilk Test Statistic	0.955	Shapiro Wilk Lognormal GOF Test	
1267	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
1268	Lilliefors Test Statistic	0.108	Lilliefors Lognormal GOF Test	
1269	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
1270	Data appear	r Lognormal	at 5% Significance Level	
1271				
1272			I Statistics	
1273	Minimum of Logged Data	-1.966	Mean of logged Data	-0.455
1274	Maximum of Logged Data	0.531	SD of logged Data	0.668
1275				
1276			rmal Distribution	
1277	95% H-UCL	1.188	90% Chebyshev (MVUE) UCL	1.203
1278	95% Chebyshev (MVUE) UCL	1.394	97.5% Chebyshev (MVUE) UCL	1.66
1279	99% Chebyshev (MVUE) UCL	2.183		
1280				
1281	Nonparame	etric Distribu	tion Free UCL Statistics	
1282	Data appear to follow a	Discernible	Distribution at 5% Significance Level	
1283				
1284	Nonpar	rametric Dis	tribution Free UCLs	
1285	95% CLT UCL	0.973	95% Jackknife UCL	0.988
1286	95% Standard Bootstrap UCL	0.971	95% Bootstrap-t UCL	1.054
1287	95% Hall's Bootstrap UCL	0.996	95% Percentile Bootstrap UCL	0.983
1288	95% BCA Bootstrap UCL	1.007		
1289	90% Chebyshev(Mean, Sd) UCL	1.142	95% Chebyshev(Mean, Sd) UCL	1.311
1290	97.5% Chebyshev(Mean, Sd) UCL	1.546	99% Chebyshev(Mean, Sd) UCL	2.007
1291				
1292		Suggested	UCL to Use	
1293	95% Student's-t UCL	0.988		
1294			·	
1295	When a data set follows an approx	imate (e.g., ı	normal) distribution passing one of the GOF test	
1296	When applicable, it is suggested to use a UCL ba	ased upon a	distribution (e.g., gamma) passing both GOF tests in ProUCL	
1297				
1298	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
1299	Recommendations are bas	sed upon dat	a size, data distribution, and skewness.	
1300	These recommendations are based upon the resu	ılts of the sin	ulation studies summarized in Singh, Maichle, and Lee (2006).	
1301	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticiar	n.
1302				
	Dibenz			
1304				
1305		General	Statistics	
1306	Total Number of Observations	15	Number of Distinct Observations	1
1307	Number of Detects	0	Number of Non-Detects	15
1308	Number of Distinct Detects	0	Number of Distinct Non-Detects	1
1309				
1310	Warning: All observations are Non-Detect	ts (NDs), the	refore all statistics and estimates should also be NDs!	
1311	Specifically, sample mean, UCLs, UPLs, and	d other stati	stics are also NDs lying below the largest detection limit!	
1312	The Project Team may decide to use alternative si	ite specific v	alues to estimate environmental parameters (e.g., EPC, BTV).	
1313				
1314	The data set for	or variable [Dibenz was not processed!	
1315				
1316				

	Α	В		: 1	D	1	E	F	G	Н			ı .ı	l K	一	
1317				•				·								
1318	Fluoranther	ne														
1319																
1320								General	Statistics							
1321				Total	Number o	f Obse	rvations	15		Number of Distinct Observations						14
1322										Number of Missing Observations						0
1323							linimum	0.3								1.669
1324						M	aximum	3.93					044	Media Error of Mea		1.37
1325					Coefficie	ont of \	SD /ariation	1.137 0.682					Sta.	Skewne		0.294
1326					Coemicie	ent or v	anauon	0.002						Skewile	55	0.659
1327								Normal	GOF Test							
1328 1329				SI	hapiro Wil	k Test	Statistic	0.901			Shapiro	o Wi	lk GOF Te	st		
1330				5% Sh	napiro Will	k Critica	al Value	0.881		Data ap	•			icance Leve	i	
1331					Lilliefor	s Test	Statistic	0.173			Lilliet	fors	GOF Test			
1332				59	% Lilliefors	s Critica	al Value	0.22		Data ap	ear Norm	nal a	t 5% Signifi	icance Leve	ī	
1333						Da	ta appea	ar Normal a	t 5% Signifi	cance Leve						
1334	Assuming Normal Distribution															
1335	Assuming Normal Distribution 95% Normal UCL 95% UCLs (Adjusted for Skewness)															
1336			95	% No						959	•			•		
1337					95% S	itudent'	's-t UCL	2.186						L (Chen-199		2.221
1338											95% M	oaitie	eu-t UCL (J	ohnson-197	0)	2.197
1339								Gamma	COE Teet							
1340		Gamma GOF Test A-D Test Statistic 0.216 Anderson-Darling Gamma GOF Test														
1341							al Value	0.746	Detecte					t 5% Signific	ance	Level
1343					K-9	S Test	Statistic	0.117					v Gamma			
1344					5% K-S	S Critica	al Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level						Level	
1345					Detect	ed data	a appear	Gamma D	stributed at	5% Signific	ance Lev	el			-	-
1346																
1347									Statistics							
1348							at (MLE)	2.256					•	orrected ML		1.849
1349					T		at (MLE)	0.74	Theta star (bias corrected MLE)							0.903
1350				MI	E Mean (at (MLE)	1.669					•	oias correcte		55.47 1.227
1351				IVIL	.L IVICAII (I	bias co	necteu)	1.009			Annroxir	mate	•	e Value (0.0		39.35
1352				Adjus	ted Level	of Sign	ificance	0.0324			, ibb.ox			Square Val		37.69
1353 1354																
1355							Ass	suming Gan	nma Distribu	ıtion						
1356	9	5% Approx	imate Ga	amma	UCL (use	when	n>=50))	2.352		95% A	djusted G	amr	na UCL (us	se when n<5	0)	2.456
1357																
1358									I GOF Test							
1359					hapiro Wil			0.968			•		normal GC			
1360				5% Sh	napiro Will			0.881						ificance Lev	el	
1361				E	Lilliefor Lilliefors		Statistic	0.116	1				ormal GOF	Test nificance Lev	(a)	
1362				٥,	/o LIIII C IOIS				at 5% Signi	- ::		ııııdl	ar J/o Sigr	micarice LeV	G1	
1363						Jak	. appear	_ognomial	2. 0 /0 Oigili							
1364 1365								Lognorma	al Statistics							
1366				٨	/linimum c	of Logg	ed Data	-1.204	1				Mean	of logged Da	ta	0.274
1367					laximum c			1.369						of logged Da		0.749
1368									1							
1369							Assu	ıming Logn	ormal Distrib	oution						
1370							H-UCL	2.799	, , ,					2.749		
1371					Chebyshe	•	,	3.223	, , ,					3.881		
1372				99% C	Chebyshe	v (MVU	E) UCL	5.174							\perp	
1373								Ada Directi	Nam F	01 04-4-4						
1374					Doto		•		tion Free U			01.00	1			
1375					рака арр	ear (0 1	OIIOW 8	PISCHUIDIG	Distribution	atu% SigN	mcance L	.eve	•			
1376																

	A B C D E	F	G H		L
1377	Nonpa	rametric Dis	tribution Free UCLs		
1378	95% CLT UCL	2.152		95% Jackknife UCL	2.186
1379	95% Standard Bootstrap UCL	2.136		95% Bootstrap-t UCL	2.282
1380	95% Hall's Bootstrap UCL	2.212		95% Percentile Bootstrap UCL	2.153
1381	95% BCA Bootstrap UCL	2.183			
1382	90% Chebyshev(Mean, Sd) UCL	2.55		95% Chebyshev(Mean, Sd) UCL	2.949
1383	97.5% Chebyshev(Mean, Sd) UCL	3.503		99% Chebyshev(Mean, Sd) UCL	4.591
1384					
1385		Suggested	UCL to Use		
1386	95% Student's-t UCL	2.186			
1387					
1388	Note: Suggestions regarding the selection of a 95%	6 UCL are pr	ovided to help the us	ser to select the most appropriate 95% UCL	
1389	Recommendations are base	sed upon da	ta size, data distribut	ion, and skewness.	
1390	These recommendations are based upon the resu	ılts of the sin	nulation studies sum	marized in Singh, Maichle, and Lee (2006).	
1391	However, simulations results will not cover all Real V	orld data se	ts; for additional insi	ght the user may want to consult a statisticia	an.
1392					
1393					
1394	Fluorene				
1395					
1396		General	Statistics		
1397	Total Number of Observations	15		Number of Distinct Observations	14
1398				Number of Missing Observations	0
1399	Minimum	0.03		Mean	0.251
1400	Maximum	0.94		Median	0.19
1401	SD	0.23		Std. Error of Mean	0.0593
1402	Coefficient of Variation	0.916		Skewness	2.17
1403			I .		
1404		Normal (GOF Test		
1405	Shapiro Wilk Test Statistic	0.78		Shapiro Wilk GOF Test	
1406	5% Shapiro Wilk Critical Value	0.881	Da	ta Not Normal at 5% Significance Level	
1407	Lilliefors Test Statistic	0.217		Lilliefors GOF Test	
1408	5% Lilliefors Critical Value	0.22		appear Normal at 5% Significance Level	
1409	Data appear App	roximate No	rmal at 5% Significa	ance Level	
1410					
1411		suming Non	mal Distribution		
1412	95% Normal UCL	0.055		95% UCLs (Adjusted for Skewness)	2 22 4
1413	95% Student's-t UCL	0.355		95% Adjusted-CLT UCL (Chen-1995)	0.384
1414				95% Modified-t UCL (Johnson-1978)	0.361
1415		Commo	GOF Test		
1416	A-D Test Statistic	0.206		Inderson-Darling Gamma GOF Test	
1417	5% A-D Critical Value	0.752		appear Gamma Distributed at 5% Significan	ce I evel
1418	K-S Test Statistic	0.112		Imogorov-Smirnov Gamma GOF Test	CC LCVCI
1419	5% K-S Critical Value	0.225		appear Gamma Distributed at 5% Significan	ce l evel
1420	Detected data appea				
1421 1422					
1423		Gamma	Statistics		
1424	k hat (MLE)	1.644		k star (bias corrected MLE)	1.359
1425	Theta hat (MLE)	0.153		Theta star (bias corrected MLE)	0.184
1426	nu hat (MLE)	49.31		nu star (bias corrected)	40.78
1427	MLE Mean (bias corrected)	0.251		MLE Sd (bias corrected)	0.215
1428	, ,	<u> </u>		Approximate Chi Square Value (0.05)	27.15
1429	Adjusted Level of Significance	0.0324		Adjusted Chi Square Value	25.78
1430	-		I		
1431	As	suming Gan	nma Distribution		
1432	95% Approximate Gamma UCL (use when n>=50))	0.377	95	% Adjusted Gamma UCL (use when n<50)	0.396
1433		1	1	·	1
1434		Lognorma	GOF Test		
1435	Shapiro Wilk Test Statistic	0.989		Shapiro Wilk Lognormal GOF Test	
1436	5% Shapiro Wilk Critical Value	0.881	Data a	ppear Lognormal at 5% Significance Level	
1437	Lilliefors Test Statistic	0.0888		Lilliefors Lognormal GOF Test	
1437		0.00	Б.	1 1 500 00 10 1 1	
1438	5% Lilliefors Critical Value	0.22	Data a	ppear Lognormal at 5% Significance Level	

	Α	В	С		D	Е	F	G	Н	l	J	K	L
1440							Lognorms	al Statistics					
1441				Min	imum of	Logged Data	-3.507	i otationos			Mean o	of logged Data	-1.718
1442 1443						Logged Data	-0.0619					of logged Data	0.871
1443						- 33						- 33	
1445						Ass	suming Lognormal Distribution						
1446						95% H-UCL	L 0.474 90% Chebyshev (MVUE) UCL 0.43						0.438
1447			9:	5% Che	ebyshev (MVUE) UCL	0.521			97.5%	Chebyshev	(MVUE) UCL	0.637
1448			99	9% Che	ebyshev (MVUE) UCL	0.864						
1449													
1450				Da				tion Free UC Distribution			-I		
1451				Da	ita appea	ir to lollow a	Discernible	Distribution	at 5% Signii	ilcarice Leve) 1		
1452 1453						Nonpa	rametric Dis	tribution Fre	e UCLs				
1454					95	5% CLT UCL	0.348				95% 、	Jackknife UCL	0.355
1455			9	5% Sta	ndard Bo	ootstrap UCL	0.345				95% Bo	ootstrap-t UCL	0.44
1456				95%	Hall's Bo	ootstrap UCL	0.836			95%	Percentile E	Bootstrap UCL	0.361
1457						ootstrap UCL	0.386						
1458					` `	an, Sd) UCL	0.428					ean, Sd) UCL	0.509
1459	-		97.5%	Cheby	/shev(Me	an, Sd) UCL	0.621			99% C	hebyshev(N	lean, Sd) UCL	0.84
1460							Suggested	UCL to Use					
1461					95% Stu	dent's-t UCL	0.355	OCL IO OSE					
1462 1463							0.000						
1464			Whei	n a data	set follo	ws an approx	ximate (e.g.,	normal) distri	bution passi	ng one of the	e GOF test		-
1465		When ap	pplicable, it	is sug	gested to	use a UCL b	ased upon a	distribution (e.g., gamma	a) passing bo	oth GOF tes	ts in ProUCL	
1466													
1467		Note: Sugg	gestions re						•			riate 95% UCL	
1468								ta size, data				(0000)	
1469												nd Lee (2006).	
1470		nowever, sin	nuiauons re	esuits w	/III HOL CO	ver all Rear v	vonu uata se	ets, for additio	mai insigni u	ie usei may	want to con	sult a statisticia	ın.
1471 1472	Indeno												
1472													
1474							General	Statistics					
1475			T	otal Nu	mber of (Observations	15			Numbe	er of Distinct	Observations	10
1476						er of Detects	9					f Non-Detects	6
1477				Numl		tinct Detects				Numb		t Non-Detects	1
1478						imum Detect	0.29					m Non-Detect	0.01
1479						ance Detects						t Non-Detects	40%
1480 1481						lean Detects						SD Detects	0.309
1482					Me	dian Detects	0.53					CV Detects	0.473
1483					Skewi	ness Detects	0.647				Κι	rtosis Detects	-1.105
1484				Ме	an of Log	ged Detects	-0.527				SD of Lo	ogged Detects	0.475
1485													
1486				Oh-	-i VACII.			t on Detects	Only	Ohanina M	CIL OOF To		
1487			5		'	Test Statistic Critical Value		D	etected Data	•	rmal at 5% S	st Significance Le	vel
1488 1489	ļ					Test Statistic			J.Co.eu Dala		GOF Test	grimodrice Le	
1490				5% I	Lilliefors (Critical Value	0.274	De	etected Data	a appear Noi	rmal at 5% S	Significance Le	vel
1491					De	tected Data	appear Norr	nal at 5% Si	gnificance L	.evel			
1492													
1493			Kap	lan-Mei	ier (KM)			ritical Value	s and other	•			
1494						KM Mean				K		Error of Mean	0.106
1495					QE 0	KM SD 6 KM (t) UCL	0.387 0.582			95% KM /		M (BCA) UCL ootstrap) UCL	0.565 0.564
1496						KM (z) UCL	0.562			30 W KIVI (I		ootstrap t UCL	0.592
1497 1498				90%		byshev UCL	0.713					ebyshev UCL	0.857
1498						byshev UCL	1.057					ebyshev UCL	1.45
1500							1	1					
1501						Gamma GOF	Tests on D	etected Obse	ervations O	nly			
1502						Test Statistic				Inderson-Da			_
1503						Critical Value		Detecte				5% Significan	ce Level
1504						Test Statistic		D-: :		Kolmogorov			an Loure
1505						Critical Value					distributed a	5% Significan	ce Level
1506					Detected	и иака арреа	ıı Gamma Di	stributed at	o% Significa	IIICO LOVOI			

	A B C D E	F	G H I J K	L
1507				
1508			n Detected Data Only	
1509	k hat (MLE)	5.18	k star (bias corrected MLE)	3.528
1510	Theta hat (MLE) nu hat (MLE)	0.126 93.25	Theta star (bias corrected MLE) nu star (bias corrected)	0.185 63.5
1511	Mean (detects)	0.652	nu star (bias correcteu)	05.5
1512	Wedit (detects)	0.002		
1513 1514	Gamma ROS	Statistics u	sing Imputed Non-Detects	
1515	GROS may not be used when data s	et has > 50%	% NDs with many tied observations at multiple DLs	
1516	GROS may not be used when kstar of detects is	small such a	is <1.0, especially when the sample size is small (e.g., <15-20)	
1517	For such situations, GROS	method may	yield incorrect values of UCLs and BTVs	
1518	This is espec	ially true whe	en the sample size is small.	
1519			ay be computed using gamma distribution on KM estimates	
1520	Minimum	0.01	Mean	0.414
1521	Maximum SD	1.13 0.384	Median CV	0.38
1522	k hat (MLE)	0.364	k star (bias corrected MLE)	0.928
1523	Theta hat (MLE)	0.714	Theta star (bias corrected MLE)	0.672
1524 1525	nu hat (MLE)	21.41	nu star (bias corrected)	18.46
1526	Adjusted Level of Significance (β)	0.0324		
1527	Approximate Chi Square Value (18.46, α)	9.726	Adjusted Chi Square Value (18.46, β)	8.953
1528	95% Gamma Approximate UCL (use when n>=50)	0.785	95% Gamma Adjusted UCL (use when n<50)	0.853
1529				
1530	Estimates of G	iamma Para	meters using KM Estimates	
1531	Mean (KM)	0.395	SD (KM)	0.387
1532	Variance (KM)	0.15	SE of Mean (KM)	0.106
1533	k hat (KM)	1.044	k star (KM)	0.879
1534	nu hat (KM) theta hat (KM)	31.31 0.379	nu star (KM) theta star (KM)	26.38 0.45
1535	80% gamma percentile (KM)	0.579	90% gamma percentile (KM)	0.43
1536	95% gamma percentile (KM)	1.24	99% gamma percentile (KM)	1.944
1537 1538	3 / /			
1539	Gamm	na Kaplan-M	eier (KM) Statistics	
1540	Approximate Chi Square Value (26.38, α)	15.67	Adjusted Chi Square Value (26.38, β)	14.66
1541	95% Gamma Approximate KM-UCL (use when n>=50)	0.665	95% Gamma Adjusted KM-UCL (use when n<50)	0.711
1542				
1543			Detected Observations Only	
1544	Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	0.95 0.829	Shapiro Wilk GOF Test Detected Data appear Lognormal at 5% Significance Le	wol
1545	Lilliefors Test Statistic		Lilliefors GOF Test	vei
1546 1547	5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Le	vel
1548		ppear Logno	ormal at 5% Significance Level	
1549				
1550	Lognormal RO	S Statistics	Using Imputed Non-Detects	
1551	Mean in Original Scale	0.46	Mean in Log Scale	-1.042
1552	SD in Original Scale	0.339	SD in Log Scale	0.777
1553	95% t UCL (assumes normality of ROS data)	0.614	95% Percentile Bootstrap UCL	0.605
1554	95% BCA Bootstrap UCL 95% H-UCL (Log ROS)	0.617 0.787	95% Bootstrap t UCL	0.653
1555	95% H-UCL (LOG ROS)	0.787		
1556	Statistics using KM estimates	on Logaed I	Data and Assuming Lognormal Distribution	
1557 1558	KM Mean (logged)	-2.158	KM Geo Mean	0.116
1559	KM SD (logged)	2.028	95% Critical H Value (KM-Log)	4.618
1560	KM Standard Error of Mean (logged)	0.555	95% H-UCL (KM -Log)	11.03
1561	KM SD (logged)	2.028	95% Critical H Value (KM-Log)	4.618
1562	KM Standard Error of Mean (logged)	0.555		
1563		B1 /6 *	Madiation	
1564	DL/2 Normal	DL/2 S	DL/2 Log-Transformed	
1565	Mean in Original Scale	0.393	DL/2 Log-Transformed Mean in Log Scale	-2.436
1566	SD in Original Scale	0.403	SD in Log Scale	2.446
1567 1568	95% t UCL (Assumes normality)	0.576	95% H-Stat UCL	61.41
1569			ded for comparisons and historical reasons	
1570				
	Nonparame	etric Distribu	tion Free UCL Statistics	
1571				
	<u>-</u>	ar Normal Di	stributed at 5% Significance Level	
1571	<u>-</u>			
1571 1572	<u>-</u>		UCL to Use	

	A B C D E	F	G H I J K	L
1576	N . 0			
1577			ovided to help the user to select the most appropriate 95% UCL.	•
1578		•	ta size, data distribution, and skewness.	
1579	<u>'</u>		nulation studies summarized in Singh, Maichle, and Lee (2006).	
1580	nowever, simulations results will not cover all near w	vonu uata se	ts; for additional insight the user may want to consult a statisticia	111.
1581	Naphthalene			
1582	парпинаюно			
1583		General	Statistics	
1584	Total Number of Observations	15	Number of Distinct Observations	4
1585	Number of Detects	4	Number of Non-Detects	11
1586	Number of Distinct Detects	3	Number of Distinct Non-Detects	1
1587	Minimum Detect	0.02	Minimum Non-Detect	0.01
1588 1589	Maximum Detect	0.62	Maximum Non-Detect	0.01
1590	Variance Detects	0.06	Percent Non-Detects	73.33%
1591	Mean Detects	0.32	SD Detects	0.245
1592	Median Detects	0.32	CV Detects	0.765
1593	Skewness Detects	0	Kurtosis Detects	1.5
1594	Mean of Logged Detects	-1.667	SD of Logged Detects	1.529
1595				
1596	Nom	nal GOF Tes	t on Detects Only	
1597	Shapiro Wilk Test Statistic	0.944	Shapiro Wilk GOF Test	
1598	5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Lev	/el
1599	Lilliefors Test Statistic	0.25	Lilliefors GOF Test	
1600	5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Lev	/el
1601	Detected Data	appear Norn	nal at 5% Significance Level	
1602				
1603			ritical Values and other Nonparametric UCLs	
1604	KM Mean	0.0927	KM Standard Error of Mean	0.0523
1605	KM SD	0.175	95% KM (BCA) UCL	N/A
1606	95% KM (t) UCL	0.185	95% KM (Percentile Bootstrap) UCL	N/A
1607	95% KM (z) UCL	0.179	95% KM Bootstrap t UCL	N/A
1608	90% KM Chebyshev UCL	0.25	95% KM Chebyshev UCL	0.321
1609	97.5% KM Chebyshev UCL	0.419	99% KM Chebyshev UCL	0.613
1610	Gamma GOE	Teete on De	etected Observations Only	
1611	A-D Test Statistic	0.499	Anderson-Darling GOF Test	
1612	5% A-D Critical Value	0.666	Detected data appear Gamma Distributed at 5% Significance	ce Level
1613	K-S Test Statistic	0.377	Kolmogorov-Smirnov GOF	
1614 1615	5% K-S Critical Value	0.402	Detected data appear Gamma Distributed at 5% Significance	ce Level
1616	Detected data appear	r Gamma Di	stributed at 5% Significance Level	
1617				
1618	Gamma	Statistics or	Detected Data Only	
1619	k hat (MLE)	1.084	k star (bias corrected MLE)	0.438
1620	Theta hat (MLE)	0.295	Theta star (bias corrected MLE)	0.731
1621	nu hat (MLE)	8.669	nu star (bias corrected)	3.501
1622	Mean (detects)	0.32		
1623				
1624			sing Imputed Non-Detects	
1625			6 NDs with many tied observations at multiple DLs	
1626			s <1.0, especially when the sample size is small (e.g., <15-20)	
1627			yield incorrect values of UCLs and BTVs	
1628			en the sample size is small.	
1629			by be computed using gamma distribution on KM estimates	0.000=
1630	Minimum	0.01	Mean	0.0927
1631	Maximum	0.62	Median	0.01
1632	SD k bot (MLE)	0.182	CV	1.96 0.403
1633	k hat (MLE) Theta hat (MLE)	0.448	k star (bias corrected MLE) Theta star (bias corrected MLE)	0.403
1634	nu hat (MLE)	13.44	nu star (bias corrected MLE)	12.08
1635	Adjusted Level of Significance (β)	0.0324	nu stat (bias corrected)	12.00
1636	Adjusted Level of Significance (ρ) Approximate Chi Square Value (12.08, α)	5.281	Adjusted Chi Square Value (12.08, β)	4.738
1637	95% Gamma Approximate UCL (use when n>=50)	0.212	95% Gamma Adjusted UCL (use when n<50)	N/A
1638		J 12	22.12 Samma , tajastica d'OE (aud mitori il 100)	
1639				

40.00	A B C D E	F	G H I J K	L				
1640		0.0927	meters using KM Estimates	0.175				
1641	Mean (KM) Variance (KM)	0.0927	SD (KM) SE of Mean (KM)	0.0523				
1642	k hat (KM)	0.0308	k star (KM)	0.0523				
1643	nu hat (KM)	8.366	nu star (KM)	8.026				
1644	theta hat (KM)	0.332	theta star (KM)	0.346				
1645	80% gamma percentile (KM)	0.332	90% gamma percentile (KM)	0.340				
1646	95% gamma percentile (KM)	0.439	99% gamma percentile (KM)	0.869				
1647	35 % gamma percentile (KW)	0.400	33 % gamma percentale (KW)	0.003				
1648	Gamm	a Kanlan-M	eier (KM) Statistics					
1649	Approximate Chi Square Value (8.03, α)	2.75	Adjusted Chi Square Value (8.03, β)	2.384				
1650	95% Gamma Approximate KM-UCL (use when n>=50)	0.27	95% Gamma Adjusted KM-UCL (use when n<50)	0.312				
1651 1652	Pro 11 (11 11 11 11 11 11 11 11 11 11 11 11		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
1653	Lognormal GO	F Test on D	etected Observations Only					
1654	Shapiro Wilk Test Statistic	0.794	Shapiro Wilk GOF Test					
1655	5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Le	evel				
1656	Lilliefors Test Statistic	0.385	Lilliefors GOF Test					
1657	5% Lilliefors Critical Value	0.375	Detected Data Not Lognormal at 5% Significance Leve	el				
1658	Detected Data appear A	pproximate	Lognormal at 5% Significance Level					
1659								
1660	Lognormal ROS	Statistics	Using Imputed Non-Detects					
1661	Mean in Original Scale	0.0877	Mean in Log Scale	-5.73				
1662	SD in Original Scale	0.184	SD in Log Scale	3.222				
1663	95% t UCL (assumes normality of ROS data)	0.171	95% Percentile Bootstrap UCL	0.171				
1664	95% BCA Bootstrap UCL	0.208	95% Bootstrap t UCL	0.23				
1665	95% H-UCL (Log ROS)	245.8						
1666								
1667	Statistics using KM estimates	on Logged I	Data and Assuming Lognormal Distribution					
1668	KM Mean (logged)	-3.822	KM Geo Mean	0.0219				
1669	KM SD (logged)	1.468	95% Critical H Value (KM-Log)	3.553				
1670	KM Standard Error of Mean (logged)	0.438	95% H-UCL (KM -Log)	0.259				
1671	KM SD (logged)	1.468	95% Critical H Value (KM-Log)	3.553				
1672	KM Standard Error of Mean (logged)	0.438						
1673		DI 10 0	A. Made					
1674	DI /O Normani	DL/2 S						
1675	DL/2 Normal Mean in Original Scale	0.089	DL/2 Log-Transformed Mean in Log Scale -4.33					
1676	SD in Original Scale	0.089	Mean in Log Scale SD in Log Scale	1.806				
1677	95% t UCL (Assumes normality)	0.172	95% H-Stat UCL	0.509				
1678	DI /O is not a recommended m		ded for comparisons and historical reasons	0.000				
1679	552 io not a 1000mmonada me	salou, provi	and incompanionic and motionical reasons					
1680 1681	Nonparame							
1682	Nonparametric Distribution Free UCL Statistics							
	<u> </u>		tion Free UCL Statistics stributed at 5% Significance Level					
	<u> </u>							
1683	Detected Data appea	r Normal Di						
1683 1684	Detected Data appea	r Normal Di	stributed at 5% Significance Level					
1683 1684 1685	Detected Data appea	r Normal Di	stributed at 5% Significance Level					
1683 1684	Detected Data appea	Normal Dis Suggested 0.185	stributed at 5% Significance Level					
1683 1684 1685 1686	Detected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95%	Suggested 0.185 UCL are pro	ucl to Use					
1683 1684 1685 1686 1687	Petected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base	Suggested 0.185 UCL are protected upon date	UCL to Use ovided to help the user to select the most appropriate 95% UCL.					
1683 1684 1685 1686 1687 1688	Petected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu	Suggested 0.185 UCL are proceed upon datalts of the sim	UCL to Use ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness.	n.				
1683 1684 1685 1686 1687 1688 1689	Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu However, simulations results will not cover all Real W	Suggested 0.185 UCL are proceed upon datalts of the sim	UCL to Use ovided to help the user to select the most appropriate 95% UCL. ta size, data distribution, and skewness. nulation studies summarized in Singh, Maichle, and Lee (2006).	n.				
1683 1684 1685 1686 1687 1688 1689	Petected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu	Suggested 0.185 UCL are proceed upon datalts of the sim	UCL to Use ovided to help the user to select the most appropriate 95% UCL. ta size, data distribution, and skewness. nulation studies summarized in Singh, Maichle, and Lee (2006).	n.				
1683 1684 1685 1686 1687 1688 1689 1690	Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu However, simulations results will not cover all Real W	Suggested 0.185 UCL are proceed upon datalts of the simple or datalts of the simple or datalts or	UCL to Use ovided to help the user to select the most appropriate 95% UCL. to a size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). ts; for additional insight the user may want to consult a statistician	n.				
1683 1684 1685 1686 1687 1688 1699 1691 1692 1693 1694	Perylene P5% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu However, simulations results will not cover all Real W	Suggested 0.185 UCL are proceed upon datalts of the similar ordid data se	UCL to Use ovided to help the user to select the most appropriate 95% UCL. to use to size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). ts; for additional insight the user may want to consult a statisticiant.					
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695	Perylene Detected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu However, simulations results will not cover all Real W	Suggested 0.185 UCL are project upon data lits of the simple orld data see	UCL to Use ovided to help the user to select the most appropriate 95% UCL. to use a size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). ts; for additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006).	10				
1683 1684 1685 1686 1687 1688 1699 1691 1692 1693 1694 1695 1696	Perylene Detected Data appea 95% KM (t) UCL Note: Suggestions regarding the selection of a 95% Recommendations are base These recommendations are based upon the resu However, simulations results will not cover all Real W Parylene Total Number of Observations Number of Detects	Suggested 0.185 UCL are properties of the simple of the s	UCL to Use ovided to help the user to select the most appropriate 95% UCL. to ta size, data distribution, and skewness. Intulation studies summarized in Singh, Maichle, and Lee (2006). Its; for additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). Its; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Non-Detects	10 5				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1697	Perylene Total Number of Observations Number of Distinct Detects Number of Distinct Detects Number of Distinct Detects	Suggested 0.185 UCL are project upon data lits of the sim orld data se General 15 10 9	ucl to Use Ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness. In additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). Its; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects	10 5 1				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1697 1698	Perylene Total Number of Observations Number of Distinct Detects Number of Distinct Detects Minimum Detect	Suggested 0.185 UCL are project upon datalits of the simple orld data see General 15 10 9 0.11	ucl to Use ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness. additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). ts; for additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). ts; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect	10 5 1 0.05				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1697 1698	Perylene Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Various Potests	Suggested 0.185 UCL are prized upon datalts of the simple orld data see General 15 10 9 0.11 0.41	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). Its; for additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). Its; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect	10 5 1 0.05 0.05				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1698 1699 1700	Perylene Total Number of Observations Number of Detects Number of Distinct Detects Minimum Detect Maximum Detect Variance Detects Variance Detects	Suggested 0.185 UCL are project upon data lits of the sim orld data se General 15 10 9 0.11 0.41 0.0106	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. to use a size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). tts; for additional insight the user may want to consult a statistician studies are made in the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects	10 5 1 0.05 0.05 33.33%				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1697 1700 1701	Perylene Total Number of Detects Number of Detects Number of Distinct Detects Maximum Detect Variance Detects Mean Detects Mean Detects Mean Detects	Suggested 0.185 UCL are project upon datalits of the simple of the simp	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. to use a size, data distribution, and skewness. Inulation studies summarized in Singh, Maichle, and Lee (2006). tts; for additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). The statistics of the statistic	10 5 1 0.05 0.05 33.33% 0.103				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1700 1701 1702	Perylene Total Number of Observations Number of Detects Number of Distinct Detects Maximum Detect Maximum Detect Variance Detects Median Detects Median Detects Median Detects Median Detects Median Detects	Suggested 0.185 UCL are project upon datalits of the simple of the simp	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness. For additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). as; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects	10 5 1 0.05 0.05 33.33% 0.103 0.485				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1700 1701 1702 1703	Perylene Total Number of Observations Number of Detects Number of Distinct Detects Number of Detects Maximum Detect Variance Detects Median Detects Median Detects Skewness Detects Skewness Detects	Suggested 0.185 UCL are project upon datalits of the simple of the simp	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. to use a size, data distribution, and skewness. For additional insight the user may want to consult a statisticial statistics. Statistics Number of Distinct Observations Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects Kurtosis Detects Kurtosis Detects	10 5 1 0.05 0.05 33.33% 0.103				
1683 1684 1685 1686 1687 1688 1690 1691 1692 1693 1694 1695 1696 1697 1700 1701 1702	Perylene Total Number of Observations Number of Detects Number of Distinct Detects Maximum Detect Maximum Detect Maximum Detects Median Detects Median Detects Mean of Logged Detects Mean of Logged Detects	Suggested	UCL to Use Ovided to help the user to select the most appropriate 95% UCL. as size, data distribution, and skewness. For additional insight the user may want to consult a statistician studies summarized in Singh, Maichle, and Lee (2006). as; for additional insight the user may want to consult a statistician studies. Statistics Number of Distinct Observations Number of Distinct Non-Detects Number of Distinct Non-Detects Minimum Non-Detect Maximum Non-Detect Percent Non-Detects SD Detects CV Detects	10 5 1 0.05 0.05 33.33% 0.103 0.485 -0.368				

1715		A B C D E	F	G H I J K	L
1700	1706				
Utilities Total	1707	<u>'</u>		•	-1
1710		<u> </u>			el
					اد
Triple					
1715 Kaplan-Moir (RM) Statistics using Normal Critical Values and other Nonparametric UCLs		Dolosica Data	appour mon	indi di 0 /0 Giginindano 2010i	
Number 1988		Kaplan-Meier (KM) Statistics usi	na Normal C	ritical Values and other Nonparametric UCLs	
1715				<u>-</u>	0.03
		KMSD	0.11	95% KM (BCA) UCL	0.209
		95% KM (t) UCL	0.211	95% KM (Percentile Bootstrap) UCL	0.205
1718		95% KM (z) UCL	0.207	95% KM Bootstrap t UCL	0.219
Gamma GOF Tests on Detected Observations Only		90% KM Chebyshev UCL	0.248	95% KM Chebyshev UCL	0.289
	1719	97.5% KM Chebyshev UCL	0.345	99% KM Chebyshev UCL	0.457
1722	1720				
1722	1721			·	
1724 K.S. Test Statistic 0.225	1722				
1725	1723			11	e Level
	1724				a Laval
1727 Gamma Statistics on Detected Data Only					e Levei
1728		регестел пата арреа	. Gamilia Di	annuted at 0 /8 Olymineance Level	
1729		Gamma	Statistics or	Detected Data Only	
The table The					3.716
1731		<u> </u>	0.0407	Theta star (bias corrected MLE)	0.057
1732 Mean (detects) 0.212		nu hat (MLE)	104.3	nu star (bias corrected)	74.33
1733 Gamma ROS Statistics using Imputed Non-Detects		Mean (detects)	0.212		
1734 Gamma ROS Statistics using Imputed Non-Detects					
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)		Gamma ROS	Statistics u	sing Imputed Non-Detects	
1737 For such situations, GROS method may yield incorrect values of UCLs and BTVS 1738	1735				
This is especially true when the sample size is small. 1739	1736	<u> </u>			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates	1737				
1740	1738	<u> </u>		· · · · · · · · · · · · · · · · · · ·	
			,		0.140
1742					0.148
1742					0.13
1744 Theta hat (MLE) 0.143 Theta star (bias corrected MLE) 0 1745 nu hat (MLE) 31.07 nu star (bias corrected MLE) 26 1746 Adjusted Level of Significance (β) 0.0324 1747 Approximate Chi Square Value (26.19, α) 15.53 Adjusted Chi Square Value (26.19, β) 14 1748 95% Gamma Approximate UCL (use when n>=50) 0.25 95% Gamma Adjusted UCL (use when n<50) 0 1749 1750 Estimates of Gamma Parameters using KM Estimates 1751 Mean (KM) 0.158 SD (KM) 0 1752 Variance (KM) 0.0122 SE of Mean (KM) 0.1753 k hat (KM) 2.053 k hat (KM) 1 1754 nu hat (KM) 61.58 nu star (KM) 1 1755 theta hat (KM) 0.077 theta star (KM) 5.1756 80% gamma percentile (KM) 0.077 theta star (KM) 0.1756 80% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 1759 Gamma Kaplan-Meler (KM) Statistics 1759 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 3.1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0.1762 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1766 Lilliefors Test Statistic 0.922 Shapiro Wilk GOF Test 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Da					0.873
1745					0.17
1746		<u> </u>	31.07	,	26.19
1747		Adjusted Level of Significance (β)	0.0324	, ,	
1748 95% Gamma Approximate UCL (use when n>=50) 0.25 95% Gamma Adjusted UCL (use when n<50) 0 1749 1750 Estimates of Gamma Parameters using KM Estimates 1751 Mean (KM) 0.158 SD (KM) 0 1752 Variance (KM) 0.0122 SE of Mean (KM) 0.158 K star (KM) 1 1753 K star (KM) 2.053 K star (KM) 1 1754 Nu hat (KM) 61.58 Nu ustar (KM) 50 1755 Mean (KM) 0.077 Second that at (KM) 0.1756 80% gamma percentile (KM) 0.241 90% gamma percentile (KM) 0.1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1757 1758 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1757 1759 Gamma Kaplan-Meler (KM) Statistics 1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 3761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n>=50 0.227 95% Gamma A		Approximate Chi Square Value (26.19, α)	15.53	Adjusted Chi Square Value (26.19, β)	14.52
1749 1750 Estimates of Gamma Parameters using KM Estimates 1751 Mean (KM) 0.158 SD (KM) 0 1752 Variance (KM) 0.0122 SE of Mean (KM) 0.153 k star (KM) 1.153 k hat (KM) 2.053 k star (KM) 1.154 nu hat (KM) 61.58 nu star (KM) 50 1.155 theta hat (KM) 0.077 theta star (KM) 0.1756 80% gamma percentile (KM) 0.241 90% gamma percentile (KM) 0.1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 1.159 Camma Kaplan-Meler (KM) Statistics 1.159 Camma Kaplan-Meler (KM) Statistics 1.159 1.159 1.159 Camma Kaplan-Meler (KM) Statistics 1.159		95% Gamma Approximate UCL (use when n>=50)	0.25	95% Gamma Adjusted UCL (use when n<50)	0.268
1750 Mean (KM) 0.158 SD (KM) 0					
Variance (KM) 0.0122 SE of Mean (KM) 0.1753 k star (KM) 1.1753 k star (KM) 2.053 k star (KM) 1.1754 nu hat (KM) 61.58 nu star (KM) 50.1755 theta hat (KM) 0.077 theta star (KM) 0.1756 80% gamma percentile (KM) 0.241 90% gamma percentile (KM) 0.1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 95% Gamma Kaplan-Meler (KM) Statistics 1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 33.1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0.1762 1763 Lognormal GOF Test on Detected Observations Only 1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal	1750			· · · · · · · · · · · · · · · · · · ·	
R hat (KM) 2.053 R k star (KM) 1	1751	<u> </u>		1 1	0.11
1754	1752	<u> </u>		. ,	0.03
theta hat (KM) 0.077 theta star (KM) 0.1755 theta hat (KM) 0.241 90% gamma percentile (KM) 0.241 90% gamma percentile (KM) 0.1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0.1758 Gamma Kaplan-Meier (KM) Statistics 1759 Gamma Kaplan-Meier (KM) Statistics 1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 33.1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0.1762 The statistic 0.922 Shapiro Wilk GOF Test 1.765 Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1.766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1.767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1.768 Detected Data appear Lognormal at 5%					1.686
1756 80% gamma percentile (KM) 0.241 90% gamma percentile (KM) 0 1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0 1758 1759 Gamma Kaplan-Meier (KM) Statistics 1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 33 1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0 1762 1763 Lognormal GOF Test on Detected Observations Only 1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level				` '	50.59 0.0937
1757 95% gamma percentile (KM) 0.396 99% gamma percentile (KM) 0 1758 1759 Gamma Kaplan-Meier (KM) Statistics 1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 33 1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0 1762 1763 Lognormal GOF Test on Detected Observations Only 1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level				` '	0.0937
Total Common C		9 1 ()			0.566
Comparison Co		3aa po. 3aa (1441)		34 po. 35 (1111)	
1760 Approximate Chi Square Value (50.59, α) 35.26 Adjusted Chi Square Value (50.59, β) 35.26 Adjusted Chi Square Value (50.59, β) 35.26 Adjusted Chi Square Value (50.59, β) 35.26 P5% Gamma Adjusted KM-UCL (use when n<50) 0.227 P5% Gamma Adjusted KM-UCL (use when n<50) 0.227 P5% Gamma Adjusted KM-UCL (use when n<50) 0.227 P5% Gamma Adjusted KM-UCL (use when n<50) 0.228 P5% Gamma Adjusted KM-UCL (use view not		Gamm	na Kaplan-M	eler (KM) Statistics	
1761 95% Gamma Approximate KM-UCL (use when n>=50) 0.227 95% Gamma Adjusted KM-UCL (use when n<50) 0					33.69
1762 1763 Lognormal GOF Test on Detected Observations Only 1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level		95% Gamma Approximate KM-UCL (use when n>=50)	0.227		0.237
Lognormal GOF Test on Detected Observations Only 1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level			1	·	
1764 Shapiro Wilk Test Statistic 0.922 Shapiro Wilk GOF Test 1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level		Lognormal GC	F Test on D	etected Observations Only	
1765 5% Shapiro Wilk Critical Value 0.842 Detected Data appear Lognormal at 5% Significance Level 1766 Lilliefors Test Statistic 0.204 Lilliefors GOF Test 1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level		-		<u>-</u>	
1767 5% Lilliefors Critical Value 0.262 Detected Data appear Lognormal at 5% Significance Level 1768 Detected Data appear Lognormal at 5% Significance Level		•			vel
1768 Detected Data appear Lognormal at 5% Significance Level	1766				
1700	1767				vel
11769	1768	Detected Data ap	pear Logno	rmal at 5% Significance Level	
1100	1769				

ı L	A B C D E	F	G H I J K	L
1770	Lognormal ROS	Statistics	Using Imputed Non-Detects	
1771	Mean in Original Scale	0.161	Mean in Log Scale	-2.049
1772	SD in Original Scale	0.111	SD in Log Scale	0.711
1773	95% t UCL (assumes normality of ROS data)	0.212	95% Percentile Bootstrap UCL	0.21
1774	95% BCA Bootstrap UCL	0.213	95% Bootstrap t UCL	0.228
1775	95% H-UCL (Log ROS)	0.258		
1776				
1777	_		Data and Assuming Lognormal Distribution	0.100
1778	KM Mean (logged)	-2.099	KM Geo Mean	0.123
1779	KM SD (logged) KM Standard Error of Mean (logged)	0.728	95% Critical H Value (KM-Log) 95% H-UCL (KM -Log)	2.343 0.252
1780	KM Standard Error of Mean (logged) KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.343
1781	KM Standard Error of Mean (logged)	0.198	33% Officer 11 Value (KW-Log)	2.040
1782	Tan Garlagia Error of moun (loggoss)	000		
1783 1784		DL/2 S	tatistics	
1785	DL/2 Normal		DL/2 Log-Transformed	
1786	Mean in Original Scale	0.15	Mean in Log Scale	-2.33
1787	SD in Original Scale	0.123	SD in Log Scale	1.061
1788	95% t UCL (Assumes normality)	0.206	95% H-Stat UCL	0.383
1789	DL/2 is not a recommended me	ethod, provi	ded for comparisons and historical reasons	
1790				
1791	Nonparame	tric Distribu	tion Free UCL Statistics	
1792	Detected Data appear	Normal Di	stributed at 5% Significance Level	
1793				
1794			UCL to Use	
1795	95% KM (t) UCL	0.211		
1796				
1797			ovided to help the user to select the most appropriate 95% UCL.	
1798		•	ta size, data distribution, and skewness.	
1799			nulation studies summarized in Singh, Maichle, and Lee (2006).	
1800	However, simulations results will not cover all Real W	orid data se	ts; for additional insight the user may want to consult a statistician.	•
1801				
1802	Phenanthrene			
1603	riidianundid			
1804				
		General	Statistics	
1805	Total Number of Observations	General 15	Statistics Number of Distinct Observations	15
1806	Total Number of Observations			15 0
1806 1807	Total Number of Observations Minimum		Number of Distinct Observations	
1806 1807 1808		15	Number of Distinct Observations Number of Missing Observations	0
1806 1807 1808 1809	Minimum	0.22	Number of Distinct Observations Number of Missing Observations Mean	0 1.424
1806 1807 1808	Minimum Maximum	0.22 4.05	Number of Distinct Observations Number of Missing Observations Mean Median	0 1.424 1.26
1806 1807 1808 1809 1810 1811	Minimum Maximum SD	15 0.22 4.05 1.02	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean	0 1.424 1.26 0.263
1806 1807 1808 1809 1810	Minimum Maximum SD	0.22 4.05 1.02 0.717	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic	0.22 4.05 1.02 0.717 Normal 0	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level E5% Significance Level	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness 30F Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t5% Significance Level	0 1.424 1.26 0.263
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level ### Company of Co	0 1.424 1.26 0.263 1.333
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level t 5% Significance Level mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995)	1.424 1.26 0.263 1.333
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level ### Company of Co	0 1.424 1.26 0.263 1.333
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1822 1823 1824	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	15 0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at 1.888	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level appear Normal at 5% Significance Level t 5% Significance Level ### Distribution ### GOF Test ### Data appear Normal at 5% Significance Level ### Data appear Normal at 5% Significance Level ### Distribution ### GOF Test ### Data appear Normal at 5% Significance Level ### Data appear N	1.424 1.26 0.263 1.333
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1822 1823 1824 1825	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	15 0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at 1.888	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t5% Significance Level ### Distribution ### GOF Test ### GOF	1.424 1.26 0.263 1.333
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1822 1823 1824 1825 1826	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL	15 0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma 0	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level appear Normal at 5% Significance Level t 5% Significance Level ### Distribution ### GOF Test ### Data appear Normal at 5% Significance Level ### Data appear Normal at 5% Significance Level ### Distribution ### GOF Test ### Data appear Normal at 5% Significance Level ### Data appear N	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1822 1823 1824 1825 1826 1827	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL	15 0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma 0 0.207	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level E5% Significance Level ### Distribution ### GOF Test ### Distribution ### GOF Test ### Distribution ### GOF Test ### GOF Test ### Anderson-Darling Gamma GOF Test ### Anderson-Darling Gamma GOF Test	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1820 1821 1823 1824 1825 1826 1827 1828	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value	15 0.22 4.05 1.02 0.717 Normal 0 0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma 0 0.207 0.747	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level E5% Significance Level ### Distribution ### GOF Test ### Distribution ### GOF Test ### Distribution ### GOF Test ### Adjusted for Skewness) ### GOF Test ### Adderson-Darling Gamma GOF Test ### Detected data appear Gamma Distributed at 5% Significance #### Detected data appear Gamma Distributed at 5% Significance ###################################	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1820 1821 1822 1823 1824 1825 1826 1827 1828 1828	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t5% Significance Level ### Distribution ### GOF Test ### Distribution ### GOF Test ### Distribution ### GOF Test ### Anderson-Darling Gamma GOF Test ### Detected data appear Gamma Distributed at 5% Significance ### Kolmogorov-Smirnov Gamma GOF Test	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1822 1823 1824 1825 1826 1827 1828 1829 1830	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t5% Significance Level mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1821 1820 1821 1823 1824 1825 1826 1827 1828 1829 1830 1831	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t5% Significance Level mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1823 1824 1825 1826 1827 1828 1829 1830 1831 1832	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t \$\$\forall \text{Distribution}\$ 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level	1.424 1.26 0.263 1.333 1.954 1.903
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1818 1820 1821 1823 1824 1825 1828 1829 1830 1831 1832 1833	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di Gamma	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level ### Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics	1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1823 1824 1825 1826 1827 1828 1829 1830 1831 1832 1833 1834	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di Gamma 2.096	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level Mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE)	1.954 1.903
1806 1807 1808 1810 1811 1812 1813 1814 1815 1816 1817 1818 1819 1820 1821 1823 1824 1825 1826 1827 1828 1828 1829 1830 1831 1832 1833 1834 1833	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear k hat (MLE) Theta hat (MLE)	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di Gamma 2.096 0.679	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level Mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smimov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE) Theta star (bias corrected MLE)	1.954 1.903 1.721 0.827
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1817 1820 1821 1822 1823 1824 1825 1826 1827 1828 1828 1830 1831 1832 1833 1834 1835 1834 1835 1836	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear k hat (MLE) Theta hat (MLE) nu hat (MLE)	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di Gamma 2.096 0.679 62.89	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level ### Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smimov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE) Theta star (bias corrected MLE) nu star (bias corrected)	1.954 1.903 1.721 0.827 1.721
1806 1807 1808 1809 1810 1811 1812 1813 1814 1815 1816 1820 1821 1822 1823 1824 1825 1826 1827 1828 1829 1830 1831 1832 1833 1834 1833 1834	Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Ass 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value Detected data appear k hat (MLE) Theta hat (MLE) nu hat (MLE)	15 0.22 4.05 1.02 0.717 Normal (0.89 0.881 0.205 0.22 ar Normal at 1.888 Gamma (0.207 0.747 0.121 0.224 Gamma Di Gamma 2.096 0.679 62.89	Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness GOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level t 5% Significance Level Mal Distribution 95% UCLs (Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance stributed at 5% Significance Level Statistics k star (bias corrected MLE) Theta star (bias corrected MLE) nu star (bias corrected) MLE Sd (bias corrected)	1.954 1.721 1.903 1.333 1.333 1.333 1.333 1.333 1.954 1.903 1.903 1.903 1.903

1839	A B C D E	F	G H I J K	L
-				
1840			ma Distribution	0.100
1841	95% Approximate Gamma UCL (use when n>=50))	2.035	95% Adjusted Gamma UCL (use when n<50)	2.129
1842		Lognormo	GOF Test	
1843	Shapiro Wilk Test Statistic	0.961	Shapiro Wilk Lognormal GOF Test	
1844	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
1845	Lilliefors Test Statistic	0.138	Lilliefors Lognormal GOF Test	
1846 1847	5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level	
1848	Data appear	r Lognormal	at 5% Significance Level	
1849				
1850		Lognorma	I Statistics	
1851	Minimum of Logged Data	-1.514	Mean of logged Data	0.0964
1852	Maximum of Logged Data	1.399	SD of logged Data	0.793
1853				
1854			rmal Distribution	
1855	95% H-UCL	2.525	90% Chebyshev (MVUE) UCL	2.431
1856	95% Chebyshev (MVUE) UCL	2.866	97.5% Chebyshev (MVUE) UCL	3.471
1857	99% Chebyshev (MVUE) UCL	4.658		
1858	Nonneram	atric Dietribur	tion Free UCL Statistics	
1859	•		Distribution at 5% Significance Level	
1860	Bata appear to follow a	Diocombio	South at 0 % Organica noo 20101	
1861 1862	Nonpa	rametric Dist	ribution Free UCLs	
1863	95% CLT UCL	1.857	95% Jackknife UCL	1.888
1864	95% Standard Bootstrap UCL	1.836	95% Bootstrap-t UCL	2.099
1865	95% Hall's Bootstrap UCL	2.248	95% Percentile Bootstrap UCL	1.885
1866	95% BCA Bootstrap UCL	1.945		
1867	90% Chebyshev(Mean, Sd) UCL	2.214	95% Chebyshev(Mean, Sd) UCL	2.572
1868	97.5% Chebyshev(Mean, Sd) UCL	3.069	99% Chebyshev(Mean, Sd) UCL	4.046
1869				
1870		Suggested	UCL to Use	
1871	95% Student's-t UCL	1.888		
1872	N. 0			
1873	** * *		ovided to help the user to select the most appropriate 95% UCL. a size, data distribution, and skewness.	
1874		•	a size, data distribution, and skewness.	
1875	I hese recommendations are based upon the resu	ılts of the sim	ulation studies summarized in Singh, Maichle, and Lee (2006).	
1076	· · · · · · · · · · · · · · · · · · ·		ulation studies summarized in Singh, Maichle, and Lee (2006). s; for additional insight the user may want to consult a statistician	ı.
1876 1877	· · · · · · · · · · · · · · · · · · ·			l.
1876 1877 1878	However, simulations results will not cover all Real V			l.
1877	However, simulations results will not cover all Real V			
1877 1878	However, simulations results will not cover all Real V			i.
1877 1878 1879	However, simulations results will not cover all Real V Pyrene	Vorld data set	s; for additional insight the user may want to consult a statistician	
1877 1878 1879 1880	However, simulations results will not cover all Real V Pyrene	Vorld data set	s; for additional insight the user may want to consult a statistician statistician statistician statistician statistician statistics Number of Distinct Observations	15
1877 1878 1879 1880 1881	However, simulations results will not cover all Real V Pyrene Total Number of Observations	General	s; for additional insight the user may want to consult a statistician Statistics Number of Distinct Observations Number of Missing Observations	15 0
1877 1878 1879 1880 1881 1882 1883	However, simulations results will not cover all Real V Pyrene Total Number of Observations Minimum	General 15 0.24	s; for additional insight the user may want to consult a statistician Statistics Number of Distinct Observations Number of Missing Observations Mean	15 0 1.307
1877 1878 1879 1880 1881 1882 1883 1884 1885	Pyrene Total Number of Observations Minimum Maximum	General 15 0.24 2.98	s; for additional insight the user may want to consult a statistician Statistics Number of Distinct Observations Number of Missing Observations Mean Median	15 0 1.307 1.13
1877 1878 1879 1880 1881 1882 1883 1884 1885	Pyrene Total Number of Observations Minimum Maximum SD	General 15 0.24 2.98 0.833	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886	Pyrene Total Number of Observations Minimum Maximum	General 15 0.24 2.98	s; for additional insight the user may want to consult a statistician Statistics Number of Distinct Observations Number of Missing Observations Mean Median	15 0 1.307 1.13
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887	Pyrene Total Number of Observations Minimum Maximum SD	General 15 0.24 2.98 0.833 0.637	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation	General 15 0.24 2.98 0.833 0.637	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation	General 15 0.24 2.98 0.833 0.637 Normal C	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic	General 15 0.24 2.98 0.833 0.637 Normal C 0.918	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.881	Statistics Number of Distinct Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1890 1891	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness 3OF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level 15% Significance Level	15 0 1.307 1.13 0.215
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894 1895	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level 15% Significance Level	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1890 1891 1893 1894 1895 1896 1897 1898	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level 15% Significance Level 15% Significance Level 15% Significance Level 15% Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995)	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1890 1891 1892 1893 1894 1895 1896 1897 1898	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level 15% Significance Level	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL	General 15 0.24 2.98 0.833 0.637 Normal C 0.918 0.881 0.184 0.22 ar Normal at	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level 15% Significance Level 15% Significance Level 15% Significance Level 15% Modified-t UCL (Chen-1995) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL	General 15	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data Appear Normal at 5% Significance Level S% Significance Level 15% Significance Level 15% Significance Level 15% Modified-t UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL	General 15	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data Appear Normal at 5% Significance Level S% Significance Level 1.5% Significance Level 1.5% Significance Level 1.5% Modified-t UCL (Chen-1995) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) GOF Test Anderson-Darling Gamma GOF Test	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894 1895 1896 1897 1990 1901 1902 1903	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL	General 15	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data Appear Normal at 5% Significance Level S% Significance Level 15% Significance Level 15% Significance Level 15% Modified-t UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978)	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894 1899 1900 1901 1902 1903 1904	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic	General 15	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness AOF Test Shapiro Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level S% Significance Level 1.5% Significance Level 1.5% Significance Level 3.5% Adjusted-CLT UCL (Chen-1995) 95% Adjusted-CLT UCL (Johnson-1978) 3.60F Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance	15 0 1.307 1.13 0.215 0.778
1877 1878 1879 1880 1881 1882 1883 1884 1885 1886 1887 1890 1891 1892 1893 1894 1895 1896 1897 1990 1901 1902 1903	Pyrene Total Number of Observations Minimum Maximum SD Coefficient of Variation Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appe As 95% Normal UCL 95% Student's-t UCL A-D Test Statistic 5% A-D Critical Value K-S Test Statistic 5% K-S Critical Value	General 15	Statistics Number of Distinct Observations Number of Missing Observations Number of Missing Observations Mean Median Std. Error of Mean Skewness Applied Wilk GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Lilliefors GOF Test Data appear Normal at 5% Significance Level Applied Test Data appear Normal at 5% Significance Level S% Significance Level 1.5% Significance Level 1.5% Significance Level 3.5% Adjusted for Skewness) 95% Adjusted-CLT UCL (Chen-1995) 95% Modified-t UCL (Johnson-1978) 3.0F Test Anderson-Darling Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Kolmogorov-Smirnov Gamma GOF Test	15 0 1.307 1.13 0.215 0.778

П	A B C D E	F	G H I J K	L
1908		Gamma	Statistics	
1909	k hat (MLE)	2.519	k star (bias corrected MLE)	2.059
1910	Theta hat (MLE)	0.519	Theta star (bias corrected MLE)	0.635
1911	nu hat (MLE)	75.56	nu star (bias corrected)	61.78
1912	MLE Mean (bias corrected)	1.307	MLE Sd (bias corrected)	0.911
1913			Approximate Chi Square Value (0.05)	44.7
1914	Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	42.91
1915				
1916			ima Distribution	
1917	95% Approximate Gamma UCL (use when n>=50))	1.806	95% Adjusted Gamma UCL (use when n<50)	1.881
1918			LOOF Total	
1919	Shapiro Wilk Test Statistic	0.967	GOF Test Shapiro Wilk Lognormal GOF Test	
1920	5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
1921	Lilliefors Test Statistic	0.121	Lilliefors Lognormal GOF Test	
1922	5% Lilliefors Critical Value	0.121	Data appear Lognormal at 5% Significance Level	
1923			at 5% Significance Level	
1924 1925	22.2 277			
1926		Lognorma	I Statistics	
1927	Minimum of Logged Data	-1.427	Mean of logged Data	0.056
1928	Maximum of Logged Data	1.092	SD of logged Data	0.71
1929	-		1	
1930	Assu	ıming Logno	ormal Distribution	
1931	95% H-UCL	2.114	90% Chebyshev (MVUE) UCL	2.109
1932	95% Chebyshev (MVUE) UCL	2.46	97.5% Chebyshev (MVUE) UCL	2.947
1933	99% Chebyshev (MVUE) UCL	3.903		
1934				
1935	_		tion Free UCL Statistics	
1936	Data appear to follow a	Discernible	Distribution at 5% Significance Level	
1937				
1938	-		tribution Free UCLs	1.005
1939	95% CLT UCL 95% Standard Bootstrap UCL	1.66	95% Jackknife UCL 95% Bootstrap-t UCL	1.685
1940	95% Hall's Bootstrap UCL	1.695	95% Percentile Bootstrap UCL	1.649
1941	95% BCA Bootstrap UCL	1.679	33701 electruic Bootstap CCE	1.043
1942	90% Chebyshev(Mean, Sd) UCL	1.952	95% Chebyshev(Mean, Sd) UCL	2.244
1943 1944	97.5% Chebyshev(Mean, Sd) UCL	2.649	99% Chebyshev(Mean, Sd) UCL	3.446
1945				
1946		Suggested	UCL to Use	
1947	95% Student's-t UCL	1.685		
1948			1	
1949	Note: Suggestions regarding the selection of a 95%	UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
1950		•	a size, data distribution, and skewness.	
1951	<u> </u>		nulation studies summarized in Singh, Maichle, and Lee (2006).	
1952	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statisticial	n.
1953	Outralling			
1954	Quinoline			
1955		Comerci	Statistics	
1956	Total Number of Observations	General 15	Statistics Number of Distinct Observations	1
1957	Number of Detects	0	Number of Distinct Observations Number of Non-Detects	15
1958	Number of Distinct Detects	0	Number of Distinct Non-Detects	1
1959			Table 5. 51 District Not Detects	•
1960 1961	Warning: All observations are Non-Detect	ts (NDs), the	refore all statistics and estimates should also be NDs!	
1962	-		stics are also NDs lying below the largest detection limit!	
1963			ralues to estimate environmental parameters (e.g., EPC, BTV)	
1964				
1965	The data set fo	r variable Q	uinoline was not processed!	
1966				
1967				

	ВСВ	UCL Statis	tics for Date	Sets with Non-Detects	L
3	User Selected Options				
4		5.111/14/2018 4 eet b.xls	4:02:11 PM		
6	Full Precision OFF				
Numb	Confidence Coefficient 95% ber of Bootstrap Operations 2000				
) F2					
1 FZ					
2	Total Number	of Observations	General 14	Statistics Number of Distinct Observations	11
4	Nu	mber of Detects	10	Number of Non-Detects	4
5		Distinct Detects Minimum Detect	10 0.06	Number of Distinct Non-Detects Minimum Non-Detect	0.05
		Maximum Detect	230 5228	Maximum Non-Detect Percent Non-Detects	0.05 28.57
3	v	Mean Detects	24.28	SD Detects	72.31
)		Median Detects ewness Detects	0.86 3.158	CV Detects Kurtosis Detects	2.978 9.98
2		Logged Detects	0.0369	SD of Logged Detects	2.387
3		Norm	nal GOF Tas	t on Detects Only	
5		ilk Test Statistic	0.385	Shapiro Wilk GOF Test	
,	5% Shapiro Wi Lilliefo	lk Critical Value rs Test Statistic	0.842	Detected Data Not Normal at 5% Significance Level Lilliefors GOF Test	
	5% Lilliefor	rs Critical Value	0.262	Detected Data Not Normal at 5% Significance Level	
)		Detected Data	NOT NOTHB	il at 5% Significance Level	
	Kaplan-Meler (KM	i) Statistics usli KM Mean	ng Normal C 17.36	Artical Values and other Nonparametric UCLs KM Standard Error of Mean	16.62
		KM SD	59	95% KM (BCA) UCL	50.02
		5% KM (t) UCL 5% KM (z) UCL	46.79 44.7	95% KM (Percentile Bootstrap) UCL 95% KM Bootstrap t UCL	49.73 1482
	90% KM (Chebyshev UCL	67.22	95% KM Chebyshev UCL	89.81
1	97.5% KM (Chebyshev UCL	121.2	99% KM Chebyshev UCL	182.7
				stected Observations Only	
+		D Test Statistic D Critical Value	1.492 0.843	Anderson-Darling GOF Test Detected Data Not Gamma Distributed at 5% Significance	Level
		-S Test Statistic	0.359	Kolmogorov-Smirnov GOF	
		S Critical Value cted Data Not (0.293 Gamma Disti	Detected Data Not Gamma Distributed at 5% Significance ributed at 5% Significance Level	Level
				n Detected Data Only	
		k hat (MLE)	0.229	k star (bias corrected MLE)	0.227
1		nu hat (MLE)	106.2 4.571	Theta star (bias corrected MLE) nu star (bias corrected)	107.1 4.533
		Mean (detects)	24.28		
+		Gamma ROS	Statistics us	sing imputed Non-Detects	
		sed when data s	set has > 50%	6 NDs with many tied observations at multiple DLs	
1				s <1.0, especially when the sample size is small (e.g., <15-20) yield incorrect values of UCLs and BTVs	
		This is espec	ially true whe	en the sample size is small.	
1	i oi gariina distributed detec	ted data, BTVs a Minimum	0.01	by be computed using gamma distribution on KM estimates Mean	17.35
		Maximum	230 61.23	Median CV	0.28
		k hat (MLE)	0.18	k star (bias corrected MLE)	0.189
1	1	Theta hat (MLE) nu hat (MLE)	96.12 5.053	Theta star (bias corrected MLE) nu star (bias corrected)	91.58 5.304
	Adjusted Level of	Significance (β)	0.0312		
1	Approximate Chi Square 95% Gamma Approximate UCL (us		1.295 71.05	Adjusted Chi Square Value (5.30, β) 95% Gamma Adjusted UCL (use when n<50)	1.054 87.33
			ı	1	
3		Mean (KM)		meters using KM Estimates SD (KM)	59
		Variance (KM)	3481 0.0866	SE of Mean (KM)	16.62
\pm		nu hat (KM)	0.0866 2.424	k star (KM) nu star (KM)	0.116 3.238
	909/	theta hat (KM)	200.5 14.58	theta star (KM) 90% gamma percentile (KM)	150.1 48.66
		percentile (KM)	99.5	90% gamma percentile (KM) 99% gamma percentile (KM)	256.1
		Gamm	a Kaplan-M	eler (KM) Statistics	
	Approximate Chi Square	Value (3.24, α)	0.446	Adjusted Chi Square Value (3.24, β)	0.337
1	95% Gamma Approximate KM-UCL (us	se when n>=50)	126	95% Gamma Adjusted KM-UCL (use when n<50)	166.7
				elected Observations Only	
1	Shapiro W 5% Shapiro Wi	ilk Test Statistic lk Critical Value	0.907 0.842	Shapiro Wilk GOF Test Detected Data appear Lognormal at 5% Significance Le	vel
		rs Test Statistic	0.192 0.262	Lilliefors GOF Test	
				Detected Data appear Lognormal at 5% Significance Le rmal at 5% Significance Level	*01
		Lognormal DO	S Statistice 1	Using Imputed Non-Detects	
	Mean i	n Original Scale	17.35	Mean in Log Scale	-1.645
1	SD is 95% t UCL (assumes normali	n Original Scale ty of ROS data)	61.23 46.33	SD in Log Scale 95% Percentile Bootstrap UCL	3.463 50.06
	95% BCA	Bootstrap UCL	66.55	95% Bootstrap t UCL	1488
1	95% H-I	JCL (Log ROS)	128575		
				Data and Assuming Lognormal Distribution	
1		Mean (logged) (M SD (logged)	-0.83 2.354	KM Geo Mean 95% Critical H Value (KM-Log)	0.436 5.395
	KM Standard Error of	Mean (logged)	0.663	95% H-UCL (KM -Log)	235.6
0	KM Standard Error of	(M SD (logged) Mean (logged)	2.354 0.663	95% Critical H Value (KM-Log)	5.395
			DL/2 S	tatistica	
3	DL/2 Normal			DL/2 Log-Transformed	
		n Original Scale n Original Scale	17.35 61.23	Mean in Log Scale SD in Log Scale	-1.028 2.645
6	95% t UCL (Assi	umes normality)	46.33	95% H-Stat UCL	963.1
7	DL/2 is not a re	commended me	ethod, provid	ded for comparisons and historical reasons	
8				tion Free UCL Statistics	
9	Detecte	u nana appear i		Distributed at 5% Significance Level	
9			Suggested	UCL to Use	
1	000/1/22	hohushanana	1007		
1		hebyshev) UCL	182.7		
B 9 1 1 2 2 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	Note: Suggestions regarding the s	election of a 95%	% UCL are pr	ovided to help the user to select the most appropriate 95% UCL. a size. data distribution, and skewness.	
B	Note: Suggestions regarding the s Recomme These recommendations are base	election of a 95% indations are based upon the resu	6 UCL are pr sed upon dat ults of the sim	ovided to help the user to select the most appropriate 95% UCL. a size, data distribution, and skewness. ulation studies summarized in Singh, Maichle, and Lee (2006). Sr, for additional insight the user may want to consult a statisticia	

120 121 122	A B C D E	F	G H I J K	L
121	F3			
		General	Statistics	
123	Total Number of Observations	14	Number of Distinct Observations	11
124	Number of Detects Number of Distinct Detects	10	Number of Non-Detects Number of Distinct Non-Detects	1
125	Minimum Detect	0.02	Minimum Non-Detect	0.1
127	Maximum Detect	216	Maximum Non-Detect	0.1
128	Variance Detects Mean Detects	4588 23.31	Percent Non-Detects SD Detects	28.57% 67.73
129	Median Detects	1.355	CV Detects	2.906
131	Skewness Detects	3.158	Kurtosis Detects	9.978
132	Mean of Logged Detects	0.294	SD of Logged Detects	2.473
133	Nom	nal GOF Tes	t on Detects Only	
135	Shapiro Wilk Test Statistic	0.39	Shapiro Wilk GOF Test	
136	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.842 0.503	Detected Data Not Normal at 5% Significance Level Lilliefors QOF Test	
138	5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level	
139	Detected Date	Not Norma	il at 5% Significance Level	
140 141	Kaplan-Meler (KM) Statistics using	ng Normal C	critical Values and other Nonparametric UCLs	
142	KM Mean	16.66	KM Standard Error of Mean	15.58
143	KM SD 95% KM (t) UCL	55.32 44.25	95% KM (BCA) UCL 95% KM (Percentile Bootstrap) UCL	47.61 47.13
144 145	95% KM (z) UCL	42.29	95% KM Bootstrap t UCL	669
146	90% KM Chebyshev UCL	63.41	95% KM Chebyshev UCL	84.58
147	97.5% KM Chebyshev UCL	114	99% KM Chebyshev UCL	171.7
148	Gamma GOF	Tests on De	etected Observations Only	
150	A-D Test Statistic	1.2	Anderson-Darling GOF Test	
151	5% A-D Critical Value K-S Test Statistic	0.835	Detected Data Not Gamma Distributed at 5% Significance Kolmogorov-Smlrnov GOF	Level
153	5% K-S Critical Value	0.291	Detected Data Not Gamma Distributed at 5% Significance	Level
154	Detected Data Not (Gemma Disti	ributed at 5% Significance Level	
155	Camma	Statistice or	n Detected Data Only	
156 157	k hat (MLE)	0.249	k star (bias corrected MLE)	0.241
158	Theta hat (MLE)	93.63	Theta star (bias corrected MLE)	96.75
159	nu hat (MLE) Mean (detects)	4.979 23.31	nu star (bias corrected)	4.819
160 161	weari (detects)	ا د.د.	1	
162			sing imputed Non-Detects	
163			6 NDs with many tied observations at multiple DLs s <1.0, especially when the sample size is small (e.g., <15-20)	
164			yield incorrect values of UCLs and BTVs	
166			en the sample size is small.	
167	For gamma distributed detected data, BTVs a Minimum	and UCLs ma 0.01	by be computed using gamma distribution on KM estimates Mean	16.65
168	Maximum	216	Median	0.505
170	SD	57.4	CV	3.447
171	k hat (MLE) Theta hat (MLE)	0.189 87.92	k star (bias corrected MLE)	0.196 84.77
172	nu hat (MLE)	5.303	Theta star (bias corrected MLE) nu star (bias corrected)	5.5
174	Adjusted Level of Significance (β)	0.0312		
175	Approximate Chi Square Value (5.50, α)	1.39	Adjusted Chi Square Value (5.50, β)	1.137 80.57
176	95% Gamma Approximate UCL (use when n>=50)	65.89	95% Gamma Adjusted UCL (use when n<50)	80.57
178			meters using KM Estimates	
179	Mean (KM) Variance (KM)	16.66 3060	SD (KM) SE of Mean (KM)	55.32 15.58
180	k hat (KM)	0.0907	k star (KM)	0.119
182			nu star (KM)	
183	nu hat (KM)	2.539	- 1	3.328
	theta hat (KM)	183.7	theta star (KM)	140.1
184			- 1	
184 185 186	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM)	183.7 14.45 95.16	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM)	140.1 47.06
184 185 186 187	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM)	183.7 14.45 95.16	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) sleft (KM) Statistics	140.1 47.06 242.3
188	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM)	183.7 14.45 95.16	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM)	140.1 47.06
184 185 186 187 188 189	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50)	183.7 14.45 95.16 E Keplen-M 0.476 116.5	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) eler (KM) Statletics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n<50)	140.1 47.06 242.3
188 189 190 191	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC	183.7 14.45 95.16 Kaplan-M 0.476 116.5	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) eler (KM) Statistics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n<50) elected Observations Only	140.1 47.06 242.3
188 189 190	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50)	183.7 14.45 95.16 E Keplen-M 0.476 116.5	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) see (KM) Statistics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n-50) selected Observations Only Shapiro Wilk GOF Teet	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognomal GC Shapiro Wilk Test Satistic 55% Shapiro Wilk Test Satistic Lilliefors Test Satistic	183.7 14.45 95.16 EXEMPLAN 0.476 116.5 DF Test on D 0.96 0.842 0.183	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) eler (KM) Statistics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n<50) Netected Observations Only Shaplo Wilk GOF Test Detected Data appear Lognard at 5% Significance Le Lilliefors GOF Test	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194 195	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gentil Approximate Chi Square Value (3.33. o) 95% Gamma Approximate KM-UCL (use when n>-50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Chrical Value	183.7 14.45 95.16 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) sider (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) estacted Observations Only Shapiro Wilk QOF Teet Detected Data appear Lognomal at 5% Significance Le Lilliafors QOF Teet Detected Data appear Lognomal at 5% Significance Le	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genm Approximate Chi Square Value (3.33. o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal QC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Shapiro Wilk Cricical Value Lilliefors Test Statistic 5% Lilliefors Cricical Value	183.7 14.45 95.16 16 Kaplan-Mi 0.476 116.5 16 O.96 0.842 0.183 0.262 0.282	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) ster (RM) Statistics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n<50) vetacted Observations Only Shaptor Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Teet Detected Data appear Lognormal at 5% Significance Le mail at 5% Significance Level	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194 195 196	theta hat (6M) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Slatistic Stillistors Critical Value Lillisfors Test Statistic 5% Lillisfors Critical Value Lillisfors Test Statistic 5% Lillisfors Critical Value Lillisfors Test Statistic	183.7 14.45 95.16 10.476 116.5 116.5 10.96 0.842 0.183 0.262 0.262 0.262 0.263 0.263	theia star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) seer (KM) Statistica Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) setsched Observations Chi Descriptions Chi Descript	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194 195 196 197 198	theta hat (AM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when no=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Deta ag Lognormal RO Mean in Original Scale	183.7 14.45 95.16 16 Kaplan-Mi 0.476 116.5 16 O.96 0.842 0.183 0.262 0.282	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) eler (KM) Statistice Adjusted Chi Square Value (3.33, §) 95% Gamma Adjusted KM-UCL (use when n<50) elected Observations Only Shaplro Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lillistors GOF Teet 15% Significance Leval using Imputed Non-Detectis Mean in Log Scale	140.1 47.06 242.3 0.361 153.7
188 189 190 191 192 193 194 195 196	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genom Approximate Chi Square Value (3.33, a) 95% Gamma Approximate KM-UCL (use when n>=50) Lognomal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Statistic 5% Shapiro Wilk Critical Statistic 5% Shapiro Wilk Critical Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 95% Lillefors Ortical State Detected Data ap Lognomal RO Mean in Original Scale 95% t UCL (assume normality of ROS data)	183.7 14.45 95.16 Exercise 16. 0.476 116.5 OF Test on D 0.96 0.842 0.183 0.262 Opear Lognor S Statistics 16.66 57.4 43.83	Heat star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) elev (KM) Statistics Adjusted Chi Square Value (3.33, B) 95% Gamma Adjusted KM-UCL (use when n-50) elected Observations Only Betected Observations Only Detected Observations Only Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Test Desected Observations Devel Desected Observations Devel Using Imputed Non-Detects Mean in Log Scale SD in Log Scale 95% Percentile Bootstrap UCL 95% Percentile Bootstrap UCL	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11
188 189 190 191 192 193 194 195 196 197 198 199 200 201 202	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when no=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Detocted Data ag Lognormal RCC Mean in Original Scale SD in Original Scale 95% LUCL (assumes normality of RCS data) 95% BCA Bootstrap UCL	183.7 14.45 95.16 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262 0.29peer Lognoi 16.66 57.4 43.83 63.27	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) siter (RM) Statistics Adjusted Chi Square Value (3.33, β) 95% Gamma Adjusted KM-UCL (use when n<50) wetscled Observations Only Shaptor Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Teet Detected Data appear Lognormal at 5% Significance Le meal at 5% Significance Level Using Imputed Non-Detects Mean in Log Scale SD in Log Scale	140.1 47.06 242.3 0.361 153.7 vvel vvel -1.034 3.063
188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genom Approximate Chi Square Value (3.33, a) 95% Gamma Approximate KM-UCL (use when n>=50) Lognomal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Statistic 5% Shapiro Wilk Critical Statistic 5% Shapiro Wilk Critical Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 95% Lillefors Ortical State Detected Data ap Lognomal RO Mean in Original Scale 95% t UCL (assume normality of ROS data)	183.7 14.45 95.16 Exercise 16. 0.476 116.5 OF Test on D 0.96 0.842 0.183 0.262 Opear Lognor S Statistics 16.66 57.4 43.83	Heat star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) elev (KM) Statistics Adjusted Chi Square Value (3.33, B) 95% Gamma Adjusted KM-UCL (use when n-50) elected Observations Only Betected Observations Only Detected Observations Only Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Test Desected Observations Devel Desected Observations Devel Using Imputed Non-Detects Mean in Log Scale SD in Log Scale 95% Percentile Bootstrap UCL 95% Percentile Bootstrap UCL	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11
188 189 190 191 192 193 194 195 196 197 198 199 200 201 202	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when no=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Deta ap Lognormal RC Mean in Original Scale SD in Original Scale 95% t UCL (assumes normality of ROS data) 95% BCA Bootstrap UCL 95% HUCL (Log RCS) Statistics using KM estimates	183.7 14.45 95.16 In Kaplen-Mi 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262 opear Lognor S Statistics I 16.66 57.4 43.83 63.27 13376 on Logged I	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) startistice Adjusted Chi Square Value (3.33, B) 95% Gamma Adjusted KM-UCL (use when n-50) setected Observations Only Shaplro Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lillistors GOF Teet Detected Data appear Lognormal at 5% Significance Le unal et 5% Significance Level Using Imputed Non-Detects Mean in Log Scale SD in Log Scale 95% Percentile Bootstrap UCL 95% Bootstrap t UCL	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204	theta hat (MM) 80% gamma percentile (KM) 95% Gamma Approximate KM-UCL (use when n>=50) 95% Gamma Approximate KM-UCL (use when n>=50) 10 pormal KC Shapiro Wilk Critical Value 1 Lillefors Test Statistic 5% Shapiro Wilk Critical Value 1 Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Critical Value 1 Lillefors Test Statistic 5% Lillefors Critical Value 1 Statistical Value 1 Value Value 1 Value Value 1 Value Value Value 1 Value Value Value 1 Value Value Value 1 Value Value Value Value 1 Value Value Value Value 1 Value Value Value 1 Value Value Value Value 1 Value Value Value Value 1 Value Value Value Value Value Value 1 Value Value Value Value Value Value 1 Value 1 Value Valu	183.7 14.45 95.16 95.16 16.66 0.476 0.476 0.842 0.183 0.262 ppear Lognov 16.66 57.4 43.83 63.27 13376 on Logged I -0.908	Mean in Log Scale Detected Data appear Lognormal at 5% Significance Level Using Imputed Non-Detects Mean in Log Scale SD in Log Scale 95% Bootstrap UCL Dete and Assuming Lognormal Distribution KM Geo Mean	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 199 200 201 201 202 203 204 205	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when no=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Detected Deta ap Lognormal RC Mean in Original Scale SD in Original Scale 95% t UCL (assumes normality of ROS data) 95% BCA Bootstrap UCL 95% HUCL (Log RCS) Statistics using KM estimates	183.7 14.45 95.16 In Kaplen-Mi 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262 opear Lognor S Statistics I 16.66 57.4 43.83 63.27 13376 on Logged I	theta star (KM) 90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) startistice Adjusted Chi Square Value (3.33, B) 95% Gamma Adjusted KM-UCL (use when n-50) setected Observations Only Shaplro Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lillistors GOF Teet Detected Data appear Lognormal at 5% Significance Le unal et 5% Significance Level Using Imputed Non-Detects Mean in Log Scale SD in Log Scale 95% Percentile Bootstrap UCL 95% Bootstrap t UCL	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11 684.2
188 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genna Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Company Lillifeors Test Statistic 5% Shapiro Wilk Critical Company Detected Data ap Lognormal ROC Mean in Original Scale 95% t UCL (assume normality of ROS data) 95% BCA Bootstrap UCL 95% t UCL (Log ROS) Statistics using KM estimate KM Mean (logged) KM Statistics using KM	183.7 14.45 95.16 95.16 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262 0.183 0.262 9ear Logno S Statistics 57.4 43.83 6.377 13376 on Logged I -0.908 2.746 0.774	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) elect (KM) Statistice Adjusted Chi Square Value (3.33, §) 95% Gamma Adjusted KM-UCL (use when n<50) elected Deservations Chly Shapiro Wilk GOF Teet Desected Data appear Lognormal at 5% Significance Le Lilliefors GOF Teet Desected Data appear Lognormal at 5% Significance Le mail at 5% Significance Level Using Imputed Non-Detects Mean in Log Scale 95% Percentile Bootstrap UCL 95% Bootstrap UCL Dete and Assuming Lognormal Distribution KM Geo Mean 95% Criccal H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 vel vel -1.034 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 200 201 202 203 204 205 206 207 208 209 210	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when no=50) 95% Gamma Approximate KM-UCL (use when no=50) Lapnormal CK Shapiro Wilk Test Sutistic 5% Shapiro Wilk Critical Value Lillateors Test Statistic 5% Shapiro Wilk Critical Value Lillateors Test Statistic 5% Lilla	183.7 14.45 95.16 95.16 0.476 116.5 F Test on D 0.96 0.842 0.262 0.262 0.262 0.33 63.27 13376 on Logged I -0.908 2.746 0.774	90% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 89% gamma percentile (RA) 86% Gamma Adjusted KN-UCL (use when n-50) 86% Close OF Test Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Test Detected Data appear Lognormal at 5% Significance Le mail at 5% Significance Level Using Imputed Non-Detects Mean in Log Scale 95% Percentile Bootstap UCL 95% Bootstrap t UCL 95% Bootstrap t UCL 95% Bootstrap t UCL 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 95% F-L/ICL (KM-Log) 95% F-L/ICL (KM-Log)	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 200 201 202 203 204 205 206 207 208 209 210 211	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genna Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Company Lillifeors Test Statistic 5% Shapiro Wilk Critical Company Detected Data ap Lognormal ROC Mean in Original Scale 95% t UCL (assume normality of ROS data) 95% BCA Bootstrap UCL 95% t UCL (Log ROS) Statistics using KM estimate KM Mean (logged) KM Statistics using KM	183.7 14.45 95.16 95.16 0.476 116.5 F Test on D 0.96 0.842 0.183 0.262 0.183 0.262 9ear Logno S Statistics 57.4 43.83 6.377 13376 on Logged I -0.908 2.746 0.774	theis atar (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 86° (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Aquated KM-UCL (use when n<50) 95% Gamma Aquated KM-UCL (use when n<50) 95% Gamma Aquated KM-UCL (use when n<50) 95% Significance Le Lilliefors QOF Test Detected Data appear Lognormal at 5% Significance Le Lilliefors QOF Test Detected Data appear Lognormal at 5% Significance Le mal at 5% Significance Level Mean in Log Scale Significance Level 95% Percentile Bootstrap UCL 95% Bootstrap UCL 95% Bootstrap UCL 95% Critical HValue (KM-Log) 95% Critical H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 200 201 202 203 204 205 206 207 208 209 210	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when no=50) 95% Gamma Approximate KM-UCL (use when no=50) Lapnomal CK Shapiro Wilk Test Sutistice 5% Shapiro Wilk Critical Value Lillateors Test Statistice 5% Shapiro Wilk Critical Value Lillateors Test Statistice 5% Lillat	183.7 14.45 55.16 Na Kaplan-M 0,476 116.5 0.96 0.842 0.883 0.262 0.2746 0.0774 0.2746 0.774 0.774 0.774	90% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 89% gamma percentile (RA) 86% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 100 PTest Detected Data appear Lognormal at 5% Significance Le 100 Limitedon GOF Test Detected Data appear Lognormal at 5% Significance Le 101 Limitedon GOF Test 102 Detected Data appear Lognormal at 5% Significance Le 103 Limitedon GOF Test 104 Detected Data appear Lognormal at 5% Significance Le 105% Significance Loval 105% Significance Loval 105% Bootstrap UCL 105% Bootstrap UCL 105% Bootstrap UCL 105% Bootstrap UCL 105% Critical H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 200 201 202 203 204 205 206 207 208 209 210 211 212	theta hat (KM) 80% gamma percentile (KM) 95% Gamma Approximate KM-UCL (use when n>=50) 100	183.7 14.45 95.16 0.476 0.476 116.5 0.96 0.842 0.183 0.262 0.292 peer Logno 0.163 6.327 13.63 63.27 0.100 0.	Mean in Log Scale Spik Bootstrap UCL William In Log Scale Spik Bootstrap UCL William In Log Scale Spik Bootstrap UCL Spik Bootstrap UCL Spik Bootstrap UCL Dete and Assuming Lognormal Distribution KM Geo Mean Spik HUCL (M.M. Log) Spik HUCL (M.M. Log) Spik Bootstrap UCL Detected Data appear Lognormal at 5% Significance Le Wean in Log Scale Spik Bootstrap UCL Spik Bootstrap UCL Detected Data Spik HUCL (M.M. Log) Spik HUCL (M.M. Log) Spik HUCL (M.M. Log) Spik Critical H Value (M.M. Log) Spik Critical H Value (M.M. Log) Spik Critical H Value (M.M. Log)	140.1 47.06 242.3 0.361 153.7 vvel vvel -1.034 3.063 47.11 684.2 0.403 6.21 1987 6.21
188 189 190 191 192 193 194 195 196 197 200 201 202 203 204 205 206 207 208 209 211 212 213 214 215	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when no=50) 95% Gamma Approximate KM-UCL (use when no=50) Lapnomal CK Shapiro Wilk Test Sutistice 5% Shapiro Wilk Critical Value Lillateors Test Statistice 5% Shapiro Wilk Critical Value Lillateors Test Statistice 5% Lillat	183.7 14.45 55.16 Na Kaplan-M 0,476 116.5 0.96 0.842 0.883 0.262 0.2746 0.0774 0.2746 0.774 0.774 0.774	90% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 99% gamma percentile (RA) 89% gamma percentile (RA) 86% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 95% Gamma Adjusted KN-UCL (use when n<50) 100 PTest Detected Data appear Lognormal at 5% Significance Le 100 Limitedon GOF Test Detected Data appear Lognormal at 5% Significance Le 101 Limitedon GOF Test 102 Detected Data appear Lognormal at 5% Significance Le 103 Limitedon GOF Test 104 Detected Data appear Lognormal at 5% Significance Le 105% Significance Loval 105% Significance Loval 105% Bootstrap UCL 105% Bootstrap UCL 105% Bootstrap UCL 105% Bootstrap UCL 105% Critical H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 3.063 47.11 684.2
188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 207 208 209 210 211 212 213	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal CK Shapiro Wilk Test Sultistic 5% Shapiro Wilk Test Sultistic 5% Shapiro Wilk Critical Value Lilliefors Test Sultistic 5% Lilliefors Test Sult	183.7 14.45 195.16 14.45 195.16 14.45 195.16 14.45 195.16 14.45 116.5 197.16 198.16 19	theta star (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 95% Gamma Adjusted KM-UCL (use when n<50) elected Observations Only Shapiro Wilk GOF Teet Detected Date appear Lognormal at 5% Significance Le Lilliefors GOF Teet Detected Data appear Lognormal at 5% Significance Le mail at 5% Significance Level 1 Significance Level 95% Percentile Bootstrap UCL 95% Bootstrap UCL 95% Bootstrap UCL 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 1 Statetice 1 DLZ Log-Transformed Mean in Log Scale SD in Log Scale	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 3.063 3.063 6.21 1987 6.21
188 189 190 191 192 193 194 195 196 197 200 201 202 203 204 205 206 207 208 209 211 212 213 214 215	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Gamma Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when no-50) 85% Gamma Approximate KM-UCL (use when no-50) 85% Gamma Approximate KM-UCL (Lagnosmal CG Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillateror Test Statistic 95% Shapiro Wilk Critical Value Detocted Data ap Lognormal RO Mean in Original Scale 95% t UCL (assumes normality of ROS data) 95% BCA Bootstary UCL 95% H-UCL (Log ROS) Statistics using KM estimates KM Mean (logged) KM Standard Error of Mean (logged) Statistics Statist	183.7 14.45 55.16 Na Kaplan-M 0.476 118.5 F Teet on D 0.98 0.842 0.183 0.98 0.842 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.86 0.87 1.83 0.87 1.83 0.87 1.83 0.87 1.83 0.87 1.83 0.87 1.83 0.83 0.83 0.83 0.83 0.83 0.83 0.83 0	gother (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 89% gamma percentile (KM) Adjusted Chi Square Value (3.33, β) 95% Gamma Aquised KM-UCL (use when n<50) **Setacted Observations Only **Shaplor Wilk GOF Teet Detected Data appear Lognormal at 5% Significance Le Lilliefors GOF Teet Detected Data papear Lognormal at 5% Significance Le ### Command of the Command	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 3.063 3.063 6.21 1987 6.21
188 189 190 191 192 193 196 197 198 199 200 201 202 203 204 205 206 207 208 211 212 213 214 215 216 217 218	theta hat (MM) 80% gamma percentile (KM) 95% gamma Approximate KM-UCL (use when n >= 50) 100	183.7 14.45 16.56 18.40 14.67 16.55 16.60 18.40 18.60	90% gamma percentile (RM) 99% gamma percentile (RM) Neer (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) ***setsched Observations Chiy Detected Obsta appear Lognormal at 5% Significance Le Lilliefors QOF Test Detected Data appear Lognormal at 5% Significance Le Lilliefors QOF Test Using Imputed Non-Detects Mean in Log Scale 95% Percentile Bootstrap UCL 95% Bootstrap t UCL 95% Bootstrap t UCL 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 1885% H-UCL (KM-Log) 95% Critical H Value (KM-Log) 1885 Log Scale 95% H-UCL (KM-Log) 95% Log Scale 95% H-UCL (Scale) 95% H-Stat UCL	140.1 47.06 242.3 0.361 153.7 -1.034 3.063 3.063 3.063 6.21 1987 6.21
188 189 190 191 192 193 194 195 196 197 200 201 202 203 204 205 206 207 208 209 211 212 213 214 215	theta hat (MM) 80% gamma percentile (KM) 95% gamma Approximate KM-UCL (use when n >= 50) 100	1837 1445 15516 1656 1656 1656 1656 1656 165	90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) Mer (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) **statistics** Description of the Common of the Co	140.1 47.06 242.3 0.361 153.7 153.7 vvel vvel -1.034 3.063 3.063 6.21 1987 6.21
188 189 190 191 192 193 196 197 198 199 200 201 202 203 204 205 206 207 208 211 212 213 214 215 216 217 218	theta hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 100	183.7 14.45 195.16 14.65 16.57 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5 17.67 116.5	90% gamma percentile (RM) 99% gamma percentile (RM) Neer (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) ***setsched Observations Chiy Detected Obsta appear Lognormal at 5% Significance Le Lilliefors QOF Test Detected Data appear Lognormal at 5% Significance Le Lilliefors QOF Test Using Imputed Non-Detects Mean in Log Scale 95% Percentile Bootstrap UCL 95% Bootstrap t UCL 95% Bootstrap t UCL 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 95% Critical H Value (KM-Log) 1885% H-UCL (KM-Log) 95% Critical H Value (KM-Log) 1885 Log Scale 95% H-UCL (KM-Log) 95% Log Scale 95% H-UCL (Scale) 95% H-Stat UCL	140.1 47.06 242.3 0.361 153.7 153.7 vvel vvel -1.034 3.063 3.063 6.21 1987 6.21
188 189 190 191 192 193 194 195 196 199 200 201 201 202 203 204 205 206 207 208 209 210 211 211 211 211 211 211 211 211 211	theta hat (MM) 80% gamma percentile (KM) 95% gamma Approximate KM-UCL (use when n >= 50) 100	1837 1445 15516 1656 1656 1656 1656 1656 165	90% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) 99% gamma percentile (RM) Mer (KM) Statistics Adjusted Chi Square Value (3.33, p) 95% Gamma Adjusted KM-UCL (use when n<50) **statistics** Description of the Common of the Co	140.1 47.06 242.3 0.361 153.7 vel vel vel 47.11 684.2 0.403 6.21 1987 6.21 -0.646 2.572
188 189 190 191 192 193 194 195 196 197 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 219 210 211 212 213 214 215 216 217 218 219 219 210 211 212 213 214 215 216 217 218 219 219 210 211 211 212 213 214 215 216 217 218 219 219 210 210 211 211 212 213 214 215 216 217 218 219 219 219 210 210 211 211 212 213 214 215 216 217 218 218 219 219 210 210 211 211 212 213 214 215 216 217 218 219 219 210 210 211 212 213 214 215 216 217 218 219 219 210 210 211 212 213 214 215 216 217 218 219 219 210 210 211 212 213 214 215 216 217 218 219 219 219 210 210 211 212 213 214 215 216 217 218 219 220 220 220 220 220 220 220 22	these hat (KM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Genom Approximate Chi Square Value (3.33, a) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Critical (use when n>=50) Lognormal GC Shapiro Wilk Critical (use when n>=50) Lillifeors Test Statistic 5% Lillifeors Test Statistic 5% Lillifeors Test Statistic 9% Decended Data ap Lognormal RO Mean in Original Scale 10% Mean (logged) 10% Statistics using KM estimate 10% KM Standard Error of Mean (logged) 10% L/2 Normal 10% Mean in Original Scale 10% 10% 10% 10% 10% 10% 10% 10% 10% 10%	183.7 14.45 15.5 16.5 16.5 17.7 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5	Mean in Log Scale Spis Bootstrap UCL Spis Critical H Value (KM-Log) 95% Critical H Value (KM-Log) Spis Critical H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 vel vel vel 47.11 684.2 0.403 6.21 1987 6.21 -0.646 2.572
188 189 190 191 192 193 194 195 196 199 200 201 201 202 203 204 205 206 207 208 209 210 211 211 211 211 211 211 211 211 211	theta hat (SM) 80% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) 95% gamma percentile (KM) Approximate Chi Square Value (3.33, c) 95% Gamma Approximate KM-UCL (use when no-950) Lognomal GC Shapiro Wilk Test Satistice 55% Shapiro Wilk Test Satistice 55% Shapiro Wilk Critical Value Lilliefors Test Statistice 55% Lilliefors Test Statistice 55% Lilliefors Test Statistice 55% Lilliefors Test Statistice 55% Lilliefors Critical Value Detected Data ap Lognormal RO Mass in Original Scale 95% LUCL (assumes normality of ROS data) 95% BCA Bootstrap UCL 95% HUCL (cg ROS) Statistics using KM setfmatee KM Mean (logged) KM SSD (logged) KM SSD (logged) KM Standard Error of Mean (logged) LILLIE Normal Mean in Original Scale 95% LUCL (Assumes normality) DLZ hormal Mean in Original Scale 95% LUCL (Assumes normality) DLZ la not a recommanded m Detected Data appear in 99% KM (Chebyshev) UCL Note: Suggestions regarding the selection of a 95% Recommendations are bar	183.7 14.45 16.56 16.60 16.56 16.60 16.56 16.56 16.56 16.56 16.56 16.56 16.56 16.56 16.56 16.57 133.76 16.57 133.76 16.57 133.76 16.56 16.57 133.76 16.57 133.76 16.57 133.76 16.57 133.76 16.57 133.76 16.57 133.76 16.57 133.76 16.58 16	Peter and (KM) 90% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 99% gamma percentile (KM) 89% gamma percentile (KM) 89% gamma percentile (KM) 80% gamma percentile (KM) 80% gamma percentile (KM) 95% Gamma Adjusted KM-UCL (use when n<50) 95% Gamma Adjusted KM-UCL (use when n<50) 100 gested Description (KM) 100 gested Si in Log Scale 100 ge	140.1 47.06 242.3 0.361 153.7 vel vel vel 47.11 684.2 0.403 6.21 1987 6.21 -0.646 2.572
188 189 190 191 192 193 194 195 196 199 200 201 201 202 203 204 205 206 207 208 209 210 211 211 211 211 211 211 211 211 211	theta hat (MM) 80% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 94% Lilliefors Test Statistic 95% HOR Mean in Original Scale 95% LUCL (assumes normality of ROS data) 95% BOR Bootstrap UCL 95% HJCL (Log ROS Statistic using KM estimate KM Mean (logged) KM Standard Error of	183.7 14.45 195.16 10.476 116.5 10.96 0.842 0.183 0.262 0.29pear Lognor 16.66 0.774 4.3.83 63.27 10.90 0.774 2.746 0.774	Mean in Log Scale Spis Bootstrap UCL Spis Critical H Value (KM-Log) 95% Critical H Value (KM-Log) Spis Critical H Value (KM-Log)	140.1 47.06 242.3 0.361 153.7 vvel vvel 153.7 3.063 47.11 684.2 1987 6.21 -0.646 2.572 926.1
188 189 190 191 192 193 194 195 196 197 200 201 202 203 203 205 206 207 208 209 211 212 213 214 215 216 217 218 219 220 221 221	theta hat (MM) 80% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) 95% gamma percentile (RM) Approximate Chi Square Value (3.33, o) 95% Gamma Approximate KM-UCL (use when n>=50) Lognormal GC Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Test Statistic 94% Lilliefors Test Statistic 95% HOR Mean in Original Scale 95% LUCL (assumes normality of ROS data) 95% BOR Bootstrap UCL 95% HJCL (Log ROS Statistic using KM estimate KM Mean (logged) KM Standard Error of	183.7 14.45 195.16 10.476 116.5 10.96 0.842 0.183 0.262 0.29pear Lognor 16.66 0.774 4.3.83 63.27 10.90 0.774 2.746 0.774	Mean in Log Scale Spis, Bootstrap LUCL Spis, Bootstrap LUCL Spis, Critical H Value (KM-Log) Bys, Critical H Value (KM-Log) Spis, H-LUCL (KM-Log) Spis, Log Scale Spis	140.1 47.06 242.3 0.361 153.7 vvel vvel 153.7 3.063 47.11 684.2 1987 6.21 -0.646 2.572 926.1

	A B C D E	F	G H I J K	L
230	MTPH			
232	<u> </u>		Statistics	45
233	Total Number of Observations Number of Detects	14 9	Number of Distinct Observations Number of Non-Detects	10 5
235	Number of Distinct Detects	9	Number of Distinct Non-Detects	1
236	Minimum Detect Maximum Detect	0.3	Minimum Non-Detect Maximum Non-Detect	0.1
237	Variance Detects	21838	Percent Non-Detects	35.71%
239	Mean Detects Median Detects	53.06 3.3	SD Detects CV Detects	147.8 2.785
240	Skewness Detects	2.996	Kurtosis Detects	8.983
242	Mean of Logged Detects	1.325	SD of Logged Detects	2.161
243 244	Norm	nal GOF Tea	t on Detects Only	
245	Shapiro Wilk Test Statistic	0.412	Shapiro Wilk GOF Test	
246	5% Shapiro Wilk Critical Value Lilliefors Test Statistic	0.829	Detected Data Not Normal at 5% Significance Level Lilliefors GOF Test	
247 248	5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	
249	Detected Date	Not Norma	il at 5% Significance Level	
250 251	Kaplan-Meler (KM) Statistics usli	ng Normal C	Critical Values and other Nonparametric UCLs	
252	KM Mean KM SD	34.14 114.6	KM Standard Error of Mean	32.47 97.91
253 254	95% KM (t) UCL	91.65	95% KM (BCA) UCL 95% KM (Percentile Bootstrap) UCL	97.91
255	95% KM (z) UCL	87.56	95% KM Bootstrap t UCL	1964
256	90% KM Chebyshev UCL 97.5% KM Chebyshev UCL	131.6 236.9	95% KM Chebyshev UCL 99% KM Chebyshev UCL	175.7 357.2
258	U.S. Tan Glasyana GC	200.5	35.5 km diesysier 662	007.2
259			etected Observations Only	
260	A-D Test Statistic 5% A-D Critical Value	1.365	Anderson-Darling GOF Test Detected Data Not Gamma Distributed at 5% Significance	l evel
261 262	K-S Test Statistic	0.368	Kolmogorov-Smirnov GOF	
263	5% K-S Critical Value	0.304	Detected Data Not Gamma Distributed at 5% Significance	Level
264 265	Detected Data Not (aduima Dist	ributed at 5% Significance Level	
266			Detected Data Only	
267	k hat (MLE) Theta hat (MLE)	0.266 199.6	k star (bias corrected MLE) Theta star (bias corrected MLE)	0.251
268 269	nu hat (MLE)	4.784	nu star (bias corrected)	4.522
270	Mean (detects)	53.06		
271	Gamma ROS	Statistics u	sing imputed Non-Detects	
273			6 NDs with many tied observations at multiple DLs	
274			s <1.0, especially when the sample size is small (e.g., <15-20)	
275			yield incorrect values of UCLs and BTVs on the sample size is small.	
277	For gamma distributed detected data, BTVs a	and UCLs ma	by be computed using gamma distribution on KM estimates	
278	Minimum Maximum	0.01 447	Mean Median	34.11 0.85
279	SD	118.9	CV	3.485
281	k hat (MLE)	0.174	k star (bias corrected MLE)	0.184
282	Theta hat (MLE) nu hat (MLE)	196.1 4.87	Theta star (bias corrected MLE) nu star (bias corrected)	185.1 5.16
283 284	Adjusted Level of Significance (β)	0.0312	,	
285	Approximate Chi Square Value (5.16, α)	1.227	Adjusted Chi Square Value (5.16, β)	0.994
286 287	95% Gamma Approximate UCL (use when n>=50)	143.5	95% Gamma Adjusted UCL (use when n<50)	177.1
288			meters using KM Estimates	
289	Mean (KM) Variance (KM)	34.14 13123	SD (KM) SE of Mean (KM)	114.6 32.47
290	k hat (KM)	0.0888	k star (KM)	0.117
292	nu hat (KM)	2.487	nu star (KM)	3.288
293 294	theta hat (KM) 80% gamma percentile (KM)	384.4 29.21	theta star (KM) 90% gamma percentile (KM)	290.8 96.14
295	95% gamma percentile (KM)	195.4	99% gamma percentile (KM)	499.8
296	Genne	e Kenlen M	eler (KM) Statistics	
297	Approximate Chi Square Value (3.29, α)		Adjusted Chi Square Value (3.29, β)	0.35
299	95% Gamma Approximate KM-UCL (use when n>=50)	242.7	95% Gamma Adjusted KM-UCL (use when n<50)	320.6
300	Lognormei GC	F Test on C	Netected Observations Only	
301 302	Shapiro Wilk Test Statistic	0.897	Shapiro Wilk GOF Test	
303	5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Le	vel
304	Lilliefors Test Statistic 5% Lilliefors Critical Value	0.192	Lilliefors GOF Test Detected Data appear Lognormal at 5% Significance Le	vel
306			rmal at 5% Significance Level	
307	Lognormal RO	R Statistics	Using Imputed Non-Detects	
308 309	Mean in Original Scale	34.12	Mean in Log Scale	-0.66
310	SD in Original Scale	118.9	SD in Log Scale	3.344 97.32
311 312	95% t UCL (assumes normality of ROS data) 95% BCA Bootstrap UCL	90.39	95% Percentile Bootstrap UCL 95% Bootstrap t UCL	97.32 1979
312	95% H-UCL (Log ROS)	141032		
314	Challettee union ICM entirentee	!	Date and Assumbs I assumed Distribution	
315 316	KM Mean (logged)	0.0294	Data and Assuming Lognormal Distribution KM Geo Mean	1.03
317	KM SD (logged)	2.385	95% Critical H Value (KM-Log)	5.46
318	KM Standard Error of Mean (logged) KM SD (logged)	0.676 2.385	95% H-UCL (KM -Log) 95% Critical H Value (KM-Log)	656.3 5.46
319 320	KM Standard Error of Mean (logged)	0.676	(un cog)	
321		DI 10 0	tatletje.	
322	DL/2 Normal	DL/2 8	tatistics DL/2 Log-Transformed	
324	Mean in Original Scale	34.13	Mean in Log Scale	-0.218
325	SD in Original Scale 95% t UCL (Assumes normality)	118.9 90.39	SD in Log Scale 95% H-Stat UCL	2.737 3733
326 327			ded for comparisons and historical reasons	5,00
328				
329			tion Free UCL Statistics Distributed at 5% Significance Level	
330	notation nerg appear	y.rviinai L	at one origination Later	
332			UCL to Use	
333	99% KM (Chebyshev) UCL	357.2		
335 335	Note: Suggestions regarding the selection of a 959	6 UCL are pr	ovided to help the user to select the most appropriate 95% UCL.	
_	Recommendations are bar		a size, data distribution, and skewness.	
336	Those recommendations			
336 337 338	These recommendations are based upon the result However, simulations results will not cover all Real V		ts; for additional insight the user may want to consult a statisticia	n.

	Α	В	С	D	E	F	G	Н	I	J	K	L	
1					UCL Statis	ics for Data	Sets with N	on-Detects					
2		Hear Cala	cted Options										
3	Dat	e/Time of Co	•	ProUCL 5.11	/30/2010 3:3	10.26 PM							
4						00.201 W							
5	Full Drapinian OFF												
6	Confidence Coefficient OFO/												
7		of Bootstrap		2000									
8													
10													
-	As												
12													
13						General	Statistics						
14			Total	Number of Ob	servations	12				r of Distinct O		3	
15									Number	of Missing O	bservations	0	
16					Minimum	2					Mean	3	
17					Maximum	4			·	·	Median	3	
18					SD	0.603				Std. Er	rror of Mean	0.174	
19				Coefficient	of Variation	0.201					Skewness	0	
20													
21							GOF Test						
22				hapiro Wilk Te		0.774		Shapiro Wilk GOF Test					
23			5% SI	napiro Wilk Cr		0.859		Data Not Normal at 5% Significance Level Lilliefors GOF Test					
24				Lilliefors Te		0.333		D-t- N-			11		
25			5	% Lilliefors Cr		0.243	5% Significar		ot Normai at t	5% Significan	ce Level		
26					Data Not	Normai at c	om Significat	ice revei					
27					Ass	sumina Nori	mal Distribut	ion					
28			95% No	rmal UCL	7.0.	Julining Hori			UCLs (Adiu	sted for Skev	wness)		
29 30					ent's-t UCL							3.286	
31									•	ed-t UCL (Joh	,	3.313	
32										•	,		
33						Gamma	GOF Test						
34				A-D Te	est Statistic	1.554		Ander	son-Darling	Gamma GO	F Test		
35				5% A-D Cr	itical Value	0.731	D	ata Not Gam	ıma Distribut	ed at 5% Sigr	nificance Lev	rel	
36				K-S Te	est Statistic	0.36		Kolmog	orov-Smirno	ov Gamma G	OF Test		
37				5% K-S Cr		0.245				ed at 5% Sigr	nificance Lev	rel	
38				Data	Not Gamr	na Distribut	ed at 5% Sig	nificance Le	evel				
39												-	
40							Statistics						
41					hat (MLE)	25.64				star (bias corr		19.28	
42					hat (MLE)	0.117			Theta	star (bias corr		0.156	
43					ı hat (MLE)	615.3					s corrected)	462.8	
44			ML	E Mean (bias	corrected)	3				MLE Sd (bia		0.683	
45			A -1:	20- الممد	::£:	0.000				Chi Square		413.9	
46			Adjus	ted Level of S	igniticance	0.029			Ac	djusted Chi S	quare Value	406.8	
47					A	umina Co	ma Distrib	ion					
48	0	E0/ Approxi	noto Commo	LICI (uso with			ma Distribut		liveted Corre	ma LICL /uss	whon acEO	2 410	
49	9	o	nate Gamma	UCL (use wh	en n>=50))	3.354		95% AC	ijusted Gamr	na UCL (use	wnen n<50)	3.412	
50													

П	Α	В	С	D		E	F	G	Н	I		J	T	K	L	
51		•	•	•			Lognorma	GOF Test					•			
52				Shapiro Wi	lk Test	Statistic	0.76		Sha	piro Wilk	Logn	ormal GC)F Tes	t		
53			5%	Shapiro Wil	k Critic	al Value	0.859		Data Not	Lognorm	nal at	5% Signifi	cance	Level		
54				Lilliefo	rs Test	Statistic	0.37		Li	lliefors L	ognor	mal GOF	Test			
55				5% Lilliefor	s Critic	al Value	0.243		Data Not	Lognorm	nal at	5% Signifi	cance	Level		
56					Da	ata Not L	ognormal a	5% Significa	ance Level							
57																
58							Lognorma	l Statistics								
59				Minimum	of Logg	ed Data	0.693					Mean	of logge	ed Data	1.079)
60				Maximum	of Logg	ed Data	1.386					SD	of logge	ed Data	0.211	1
61																
62						Assu	ıming Logno	ormal Distribu	ıtion							
63						H-UCL	3.384					hebyshev	-			
64				6 Chebyshe			3.803			97.	.5% C	hebyshev	(MVU	E) UCL	4.149	}
65			99%	6 Chebyshe	v (MVL	JE) UCL	4.83									
66																
67						•		tion Free UC								
68					Data	do not fo	ollow a Disc	ernible Distri	bution (0.0	5)						
69																
70								tribution Free	UCLs							
71						LT UCL	3.286							ife UCL	3.313	3
72			959	% Standard		•	N/A					95% Bo		•	N/A	
73				95% Hall's		•	N/A			9	5% P	ercentile E	Bootstr	ap UCL	N/A	
74			200/ 6	95% BCA		•	N/A			250					0.75	
75				hebyshev(3.522					ebyshev(M			3.759	
76			97.5% (hebyshev(Mean, S	Sd) UCL	4.087			99%	% Che	ebyshev(M	lean, S	id) UCL	4.732	<u>-</u>
77																
78				050/ /	S. 1			UCL to Use				050/ 1		1.1101	0.044	
79				95% 8	stuaent	's-t UCL	3.313					or 95% N	/loaitle	a-t UCL	3.313	
80		Note: Cuasa	otiono rogo	rding the or	lootion	of a OE9/	LICI oro nr	avidad ta balı	the weer to	a a la at th		ot opprop	rioto Ol	E0/ LICI		
81		Note. Sugge	siions rega					ovided to help a size, data c					nate 9	5% UCL	-	
82		These reco	mmendatio					ulation studie					nd I aa	(2006)		
83	H							ts; for addition								
84					0010. u			to, for addition	- Idi iiloigiit ii	10 4001 11			- Cuit a c	otation on		
85	В															
80																
87 88							General	Statistics								
89			Tota	al Number o	of Obse	rvations	12			Nur	mber	of Distinct	Obser	rvations	4	
90				Nur	nber of	Detects	9					Number o	f Non-	Detects	3	
91				Number of I	Distinct	Detects	3			Nu	ımber	of Distinc	t Non-	Detects	1	
92				N	linimun	n Detect	4					Minimu	m Non	-Detect	2	
93				М	aximun	n Detect	6					Maximu	m Non	-Detect	2	
94				Va	ariance	Detects	0.361					Percen	t Non-	Detects	25%	
95					Mean	Detects	4.889						SD	Detects	0.601	<u> </u>
96				1	Median	Detects	5						CV	Detects	0.123	3
97				Ske	ewness	Detects	-0.0183					Ku	ırtosis	Detects	1.126	<u>`</u>
98				Mean of I	ogged	Detects	1.58					SD of Lo	ogged	Detects	0.125	5
99								I								
55																

	Α	В	С	D	E	F	G	Н	<u> </u>	J	K	L
100					Norm	nal GOF Tes	t on Detects	Only				
101				Shapiro Wilk	Test Statistic	0.781			Shapiro Wi	ilk GOF Test		
102			5% S	hapiro Wilk C	Critical Value	0.829	I	Detected Da	ta Not Norma	al at 5% Sign	ificance Leve	I
103				Lilliefors	Test Statistic	0.351			Lilliefors	GOF Test		
104			5	5% Lilliefors C	Critical Value	0.274	[Detected Da	ta Not Norma	al at 5% Sign	ificance Leve	I
105				C	etected Data	a Not Norma	l at 5% Sign	ificance Lev	rel .			
106												
107			Kaplan-	Meier (KM)	Statistics usi	ng Normal C	ritical Value	s and other	Nonparamet	tric UCLs		
108					KM Mean	4.167			KN	M Standard E	rror of Mean	0.411
109					KM SD	1.344				95% KM	I (BCA) UCL	N/A
110				95%	KM (t) UCL	4.906			95% KM (F	Percentile Boo	otstrap) UCL	N/A
111				95%	KM (z) UCL	4.843				95% KM Boo	tstrap t UCL	N/A
112			!	90% KM Che	byshev UCL	5.401			,	95% KM Che	byshev UCL	5.96
113			97	'.5% KM Che	byshev UCL	6.736			9	99% KM Che	byshev UCL	8.26
114												
115				G	amma GOF	Tests on De	tected Obse	ervations Or	nly		-	
116				A-D	Test Statistic	1.221		A	nderson-Da	rling GOF Te	est .	
117				5% A-D C	Critical Value	0.72	Detect	ed Data Not	Gamma Dis	tributed at 5%	6 Significance	Level
118				K-S	Test Statistic	0.369		ı	Kolmogorov-	Smirnov GO	F	
119				5% K-S C	Critical Value	0.279	Detect	ed Data Not	Gamma Dis	tributed at 5%	6 Significance	Level
120				Detecte	ed Data Not (Gamma Dist	ributed at 59	6 Significan	ce Level		-	
121												
122					Gamma	Statistics on	Detected D	ata Only				
123					k hat (MLE)	73.09			k	star (bias cor	rected MLE)	48.8
124				The	ta hat (MLE)	0.0669			Theta	star (bias cor	rected MLE)	0.1
125				r	nu hat (MLE)	1316				nu star (bia	as corrected)	878.4
126				Me	an (detects)	4.889						
127												
128				(amma ROS	Statistics us	sing Imputed	Non-Detec	ts			
129			GROS may	y not be used	when data s	et has > 50%	NDs with m	any tied obs	ervations at	multiple DLs		
130		GROS ma	y not be use	d when kstar	of detects is	small such as	s <1.0, espec	cially when t	he sample si	ze is small (e	.g., <15-20)	
131			Fo	or such situat	ions, GROS i	method may	yield incorre	ct values of	UCLs and B1	ΓVs		
132				7	his is especi	ally true whe	n the sample	e size is sma	II.			
133		For ga	mma distribu	ted detected	data, BTVs a	nd UCLs ma	y be comput	ed using gar	mma distribu	tion on KM es	stimates	
134					Minimum	3.432					Mean	4.586
135					Maximum	6					Median	5
136					SD	0.757					CV	0.165
137					k hat (MLE)	39.47			k	star (bias cor	rected MLE)	29.66
138				The	ta hat (MLE)	0.116			Theta	star (bias cor	rected MLE)	0.155
139				r	nu hat (MLE)	947.3				nu star (bia	as corrected)	711.8
140			Adjusted	d Level of Sig	nificance (β)	0.029						
141		Appr	oximate Chi	Square Value	e (711.78, α)	650.9		A	Adjusted Chi	Square Value	e (711.78, β)	642
142	Ç	95% Gamma	a Approximat	e UCL (use v	vhen n>=50)	5.015		95% Ga	amma Adjust	ted UCL (use	when n<50)	5.085
143												
144				Es	timates of G	amma Parar	neters using	KM Estima	ites		-	
145					Mean (KM)	4.167					SD (KM)	1.344
146				Va	riance (KM)	1.806				SE o	f Mean (KM)	0.411
147					k hat (KM)	9.615					k star (KM)	7.267
148					nu hat (KM)	230.8					nu star (KM)	174.4
149				th	eta hat (KM)	0.433				the	eta star (KM)	0.573
150			809	% gamma per	centile (KM)	5.381			90%	% gamma per	centile (KM)	6.229
151			959	% gamma per	centile (KM)	6.991			999	% gamma per	centile (KM)	8.575
152												
153					Gamm	a Kaplan-M	eier (KM) Sta	atistics				
154		Appr	oximate Chi	Square Value		144.9	-		Adjusted Chi	Square Value	e (174.41, β)	140.8
155	95%	• • • • • • • • • • • • • • • • • • • •		M-UCL (use v	. ,	5.016			•	KM-UCL (use	,	5.163
156		•		•					-	•		
100												

	A B C D E	F	G H I J K	L
157	Lognormal GO	F Test on D	etected Observations Only	
158	Shapiro Wilk Test Statistic	0.774	Shapiro Wilk GOF Test	
159	5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Leve	A.
160	Lilliefors Test Statistic	0.371	Lilliefors GOF Test	
161	5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Leve	A .
162	Detected Data N	Not Lognorn	nal at 5% Significance Level	
163				
164	Lognormal ROS	S Statistics	Using Imputed Non-Detects	
165	Mean in Original Scale	4.598	Mean in Log Scale	1.514
166	SD in Original Scale	0.74	SD in Log Scale	0.163
167	95% t UCL (assumes normality of ROS data)	4.981	95% Percentile Bootstrap UCL	4.917
168	95% BCA Bootstrap UCL	4.918	95% Bootstrap t UCL	4.964
169	95% H-UCL (Log ROS)	5.032		
170				
171	Statistics using KM estimates		Data and Assuming Lognormal Distribution	
172	KM Mean (logged)	1.358	KM Geo Mean	3.89
173	KM SD (logged)	0.397	95% Critical H Value (KM-Log)	2.023
174	KM Standard Error of Mean (logged)	0.122	95% H-UCL (KM -Log)	5.364
175	KM SD (logged)	0.397	95% Critical H Value (KM-Log)	2.023
176	KM Standard Error of Mean (logged)	0.122		
177				
178		DL/2 S	tatistics	
179	DL/2 Normal		DL/2 Log-Transformed	
180	Mean in Original Scale	3.917	Mean in Log Scale	1.185
181	SD in Original Scale	1.832	SD in Log Scale	0.723
182	95% t UCL (Assumes normality)	4.866	95% H-Stat UCL	7.239
183	DL/2 is not a recommended me	ethod, provi	ded for comparisons and historical reasons	
184				
185	-		tion Free UCL Statistics	
186	Data do not follow a Di	scernible D	istribution at 5% Significance Level	
187				
188			UCL to Use	
189	95% KM (t) UCL	4.906	KM H-UCL	5.364
190	95% KM (BCA) UCL	N/A		
191	Warning: One or n	nore Recom	mended UCL(s) not available!	
192	N . O	1101		
193		•	ovided to help the user to select the most appropriate 95% UCL.	
194		•	a size, data distribution, and skewness.	
195	•		nulation studies summarized in Singh, Maichle, and Lee (2006).	
196	However, simulations results will not cover all Real W	orld data se	ts; for additional insight the user may want to consult a statistician	1.
197				
198				

Common C	100		В	С	D		E	F	G	Н	I	J	K	L
Total Number of Observations 12	155													
Total Number of Disservations 12								General	Statistics					
Number of Missing Observations 6.267				Tota	al Number o	of Obser	vations	12			Numb	er of Distinct	t Observations	12
Minimum 17.8 Media 6.28											Numb	er of Missing	Observations	0
Maximum 17.8						Mi	nimum	1.3					Mean	6.267
Stock Stoc						Ма	ximum	17.8					Median	5.8
							SD	4.489				Std.	Error of Mean	1.296
Normal GOF Test	207				Coeffici	ent of Va	ariation	0.716					Skewness	1.613
Shapiro Wilk Test Statistic 0.86	208													
	209								GOF Test					
Lilliefors Critical Value 0.22	210										•			
Data appear Normal at 5% Significance Level	211			5% 8	•					Data app				
Data appear Normal at 5% Significance Level	212									Data				
Assuming Normal Distribution					5% LIIIIeTor:				EV Cianifia		ear inormai	at 5% Signif	icance Level	
						Dai	а арре	ar Normai a	t 5% Signific	ance Levei				
217 95% Normal UCL 95% UCLs (Adjusted for Skewness) 9.0.43							Δο	suming Nor	mal Dietribut	ion				
218 95% Student's-t UCL 8.594 95% Adjusted-CLT UCL (Chen-1995) 9.043 219				95% N	lormal UCL		7.0	Sulling Non	iliai Distribut		UCLs (Ad	iusted for Sk	(ewness)	
September Sep							-t UCL	8.594			-			9.043
Camma GOF Test														8.694
Camma GOF Test												`		
A-D Test Statistic								Gamma	GOF Test					
223 S% A-D Critical Value 0.741 Detected data appear Gamma Distributed at 5% Significance Level					A-I	D Test S	Statistic	0.224		Ande	rson-Darlin	g Gamma G	OF Test	
224 K-S Test Statistic 0.133 Kolmogorov-Smirnov Gamma GOF Test					5% A-0	O Critica	l Value	0.741	Detecte	d data appea	ar Gamma I	Distributed a	t 5% Significan	ce Level
Detected data appear Gamma Distributed at 5% Significance Level					K-	S Test S	Statistic	0.133		Kolmog	orov-Smir	nov Gamma	GOF Test	
227 228 Gamma Statistics 2.381 k star (bias corrected MLE) 1.841 2.30 Theta hat (MLE) 2.632 Theta star (bias corrected MLE) 3.404 2.31 nu hat (MLE) 5.7.13 nu star (bias corrected) 4.4.18 2.32 MLE Mean (bias corrected) 6.267 MLE Sd (bias corrected) 4.619 2.33 Adjusted Level of Significance 0.029 Adjusted Chi Square Value (0.05) 22.94 Adjusted Level of Significance 0.029 Adjusted Chi Square Value 2.8.16 2.35 2.35 2.36 Assuming Gamma Distribution 2.37 95% Approximate Gamma UCL (use when n≥50) 9.248 95% Adjusted Gamma UCL (use when n≤50) 9.833 2.39 Lognormal GOF Test 2.41 5% Shapiro Wilk Test Statistic 0.977 Shapiro Wilk Lognormal GOF Test 2.41 5% Shapiro Wilk Critical Value 0.859 Data appear Lognormal at 5% Significance Level 2.42 Lilliefors Test Statistic 0.145 Lilliefors Lognormal GOF Test 2.43 5% Lilliefors Critical Value 0.243 Data appear Lognormal at 5% Significance Level 2.44 Data appear Lognormal at 5% Significance Level 2.45 Data appear Lognormal at 5% Significance Level 2.46 Data appear Lognormal at 5% Significance Level 2.47 Minimum of Logged Data 0.262 Mean of logged Data 1.611 2.48 Maximum of Logged Data 2.879 SD of logged Data 0.72 2.	225				5% K-9	S Critica	l Value	0.248	Detecte	d data appea	ar Gamma I	Distributed a	t 5% Significan	ce Level
Gamma Statistics 229 k hat (MLE) 2.381 k star (bias corrected MLE) 1.841 230 Theta hat (MLE) 2.632 Theta star (bias corrected MLE) 3.404 231 nu hat (MLE) 57.13 nu star (bias corrected) 44.18 232 MLE Mean (bias corrected) 6.267 MLE Sd (bias corrected) 4.619 233 Approximate Chi Square Value (0.05) 29.94 234 Adjusted Level of Significance 0.029 Adjusted Chi Square Value (0.05) 29.94 235 Assuming Gamma Distribution 28.16 28.16 28.16 237 95% Approximate Gamma UCL (use when n>=50)) 9.248 95% Adjusted Gamma UCL (use when n<50)	226				Detect	ted data	appear	r Gamma Di	stributed at !	5% Significa	nce Level			
229	227													
Theta hat (MLE) 2.632 Theta star (bias corrected MLE) 3.404	228								Statistics					
231 nu hat (MLE) 57.13 nu star (bias corrected) 44.18 232 MLE Mean (bias corrected) 6.267 MLE Sd (bias corrected) 4.619 233 Approximate Chi Square Value (0.05) 29.94 234 Adjusted Level of Significance 0.029 Adjusted Chi Square Value 28.16 235 Assuming Gamma Distribution 237 95% Approximate Gamma UCL (use when n>=50)) 9.248 95% Adjusted Gamma UCL (use when n<50)	229											`	,	
MLE Mean (bias corrected) 6.267 MLE Sd (bias corrected) 4.619	230				ı		, ,				I heta		-	
Approximate Chi Square Value (0.05) 29.94	231			Λ.	ALE Moon /							,	,	_
Adjusted Level of Significance 0.029 Adjusted Chi Square Value 28.16 Assuming Gamma Distribution 37 95% Approximate Gamma UCL (use when n>=50)) 9.248 95% Adjusted Gamma UCL (use when n<50) 9.833 28 Lognormal GOF Test 240 Shapiro Wilk Test Statistic 0.977 Shapiro Wilk Lognormal GOF Test 241 5% Shapiro Wilk Critical Value 0.859 Data appear Lognormal at 5% Significance Level 242 Lilliefors Test Statistic 0.145 Lilliefors Lognormal GOF Test 243 5% Lilliefors Critical Value 0.243 Data appear Lognormal at 5% Significance Level 244 Data appear Lognormal at 5% Significance Level 245 Lognormal Statistics 246 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72				IV	ile Mean (Dias cor	rectea)	0.207			Annrovimo			
Assuming Gamma Distribution 237 95% Approximate Gamma UCL (use when n>=50)) 9.248 95% Adjusted Gamma UCL (use when n<50) 9.833 238 239 Lognormal GOF Test 240 Shapiro Wilk Test Statistic 0.977 Shapiro Wilk Lognormal GOF Test 241 5% Shapiro Wilk Critical Value 0.859 Data appear Lognormal at 5% Significance Level 242 Lilliefors Test Statistic 0.145 Lilliefors Lognormal GOF Test 243 5% Lilliefors Critical Value 0.243 Data appear Lognormal at 5% Significance Level 244 Data appear Lognormal at 5% Significance Level 245 Lognormal Statistics 246 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72				Λdiı	isted Level	of Signi	ficanco	0.020					` ′	
Assuming Gamma Distribution23795% Approximate Gamma UCL (use when n>=50))9.24895% Adjusted Gamma UCL (use when n<50)				Auju	usteu Level	or Signin	licarice	0.023				-ujusteu Cili	Square value	20.10
95% Approximate Gamma UCL (use when n>=50)) 9.248 95% Adjusted Gamma UCL (use when n<50) 9.833 238							Ass	suming Gam	ma Distribu	tion				
238 239		g	95% Approxir	nate Gamm	a UCL (use	when n					ljusted Gan	nma UCL (us	se when n<50)	9.833
Shapiro Wilk Test Statistic 0.977 Shapiro Wilk Lognormal GOF Test			•••				,,				<u>, </u>	`		
Shapiro Wilk Test Statistic 241 5% Shapiro Wilk Critical Value 242 Lilliefors Test Statistic 243 5% Lilliefors Critical Value 244 Data appear Lognormal at 5% Significance Level 245 Lilliefors Critical Value 246 Lognormal Statistics 247 Minimum of Logged Data 248 Maximum of Logged Data 249 Shapiro Wilk Lognormal at 5% Significance Level 250 Data appear Lognormal at 5% Significance Level 260 Lognormal Statistics 261 Mean of logged Data 262 Mean of logged Data 263 SD of logged Data 265 O.72								Lognorma	I GOF Test					
2415% Shapiro Wilk Critical Value0.859Data appear Lognormal at 5% Significance Level242Lilliefors Test Statistic0.145Lilliefors Lognormal GOF Test2435% Lilliefors Critical Value0.243Data appear Lognormal at 5% Significance Level244Data appear Lognormal at 5% Significance Level245Lognormal Statistics247Minimum of Logged Data0.262Mean of logged Data1.611248Maximum of Logged Data2.879SD of logged Data0.72					Shapiro Wil	lk Test S	Statistic	0.977		Shap	oiro Wilk Lo	ognormal GO	OF Test	
Lilliefors Test Statistic 0.145 Lilliefors Lognormal GOF Test 243 Data appear Lognormal at 5% Significance Level 244 Data appear Lognormal at 5% Significance Level 245 246 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72				5% 9	Shapiro Will	k Critica	l Value	0.859		Data appea	r Lognorma	al at 5% Sigr	nificance Level	
243 5% Lilliefors Critical Value 0.243 Data appear Lognormal at 5% Significance Level 244 Data appear Lognormal at 5% Significance Level 245 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72					Lilliefor	rs Test S	Statistic	0.145		Lil	liefors Log	normal GOF	Test	
244 Data appear Lognormal at 5% Significance Level 245 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72					5% Lilliefor	s Critica	l Value	0.243		Data appea	ar Lognorma	al at 5% Sigr	nificance Level	
245 246 Lognormal Statistics 247 Minimum of Logged Data 0.262 Mean of logged Data 1.611 248 Maximum of Logged Data 2.879 SD of logged Data 0.72						Data	appear	Lognormal	at 5% Signif	icance Leve	I			
Lognormal Statistics247Minimum of Logged Data0.262Mean of logged Data1.611248Maximum of Logged Data2.879SD of logged Data0.72														
247Minimum of Logged Data0.262Mean of logged Data1.611248Maximum of Logged Data2.879SD of logged Data0.72									I Statistics					
														1.611
[249]	248				Maximum o	of Logge	ed Data	2.879				SD	of logged Data	0.72
	249													

	Α	В	С	D	E	F	G	Н	I	J	K	L
250							ormal Distrib	ution				
251					95% H-UCL	11.03					(MVUE) UCL	10.44
252				Chebyshev (-	12.3			97.5%	Chebyshev ((MVUE) UCL	14.89
253			99%	Chebyshev (MVUE) UCL	19.97						
254												
255					•		tion Free UC					
256				Data appea	r to follow a	Discernible	Distribution	at 5% Signif	icance Level			
257												
258						ametric Dis	tribution Fre	e UCLs				
259					% CLT UCL	8.398					ackknife UCL	8.594
260				Standard Bo	•	8.369					otstrap-t UCL	9.823
261				95% Hall's Bo	="	19.27			95% I	Percentile Bo	ootstrap UCL	8.383
262				95% BCA Bo	•	8.95						
263				nebyshev(Me	•	10.15					ean, Sd) UCL	11.92
264			97.5% Ch	nebyshev(Me	an, Sd) UCL	14.36			99% Ch	ebyshev(Me	ean, Sd) UCL	19.16
265												
266							UCL to Use					
267				95% Stu	dent's-t UCL	8.594						
268												
269		Note: Sugge									ate 95% UCL.	
270				Recommenda		•						
271					•						d Lee (2006).	
272		However, simu	ılations resul	ts will not cov	er all Real W	orld data se	ts; for addition	onal insight th	ne user may v	want to cons	ult a statisticia	ın.
273												
2/4	Cu											
275						0	Statistics					
276			Total	Number of C)haan (ationa	12	Statistics		Numba	r of Distinct (Observations	5
277			TOLAI		er of Detects	4			Numbe		Non-Detects	8
278			N	umber of Dis		4			Numbe		Non-Detects	1
279					mum Detect	9			rvambe		n Non-Detect	2
280					mum Detect	20					n Non-Detect	2
281					nce Detects	23.58					Non-Detects	66.67%
282 283				M	ean Detects	15.25					SD Detects	4.856
					dian Detects	16					CV Detects	0.318
284 285					ess Detects	-0.688				Kur	tosis Detects	-0.946
286				Mean of Log		2.681				SD of Log	gged Detects	0.355
287											,,,	
288					Norm	al GOF Tes	t on Detects	Only				
289			S	Shapiro Wilk	Test Statistic	0.957		-	Shapiro Wi	lk GOF Test	1	
290			5% S	hapiro Wilk C	Critical Value	0.748	D	etected Data	appear Norr	nal at 5% Sig	gnificance Lev	/el
291				Lilliefors	Test Statistic	0.214			Lilliefors	GOF Test		
292			5	% Lilliefors C	Critical Value	0.375	D	etected Data	appear Norr	nal at 5% Sig	gnificance Lev	/el
293				De	tected Data	appear Norn	nal at 5% Sig	gnificance L	evel			
294												
295			Kaplan-	Meier (KM)	Statistics usi	ng Normal C	ritical Value	s and other	Nonparamet	ric UCLs		
296					KM Mean	6.417			ΚN	// Standard E	rror of Mean	2.234
297					KM SD	6.701				95% KN	Л (BCA) UCL	N/A
298				95%	KM (t) UCL	10.43			95% KM (P	ercentile Bo	otstrap) UCL	N/A
299				95%	KM (z) UCL	10.09			!	95% KM Boo	otstrap t UCL	N/A
300			(90% KM Che	byshev UCL	13.12			Ç	95% KM Che	ebyshev UCL	16.15
301			97	.5% KM Che	byshev UCL	20.37			Ç	99% KM Che	ebyshev UCL	28.64
302							I					
502											-	

303	A B C D E Gamma GOF	F Tests on De	G H I J K Letter Good of the control	L
304	A-D Test Statistic	0.299	Anderson-Darling GOF Test	
305	5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance	e Level
306	K-S Test Statistic	0.25	Kolmogorov-Smirnov GOF	
307	5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance	e Level
308	Detected data appear	Gamma Di	stributed at 5% Significance Level	
309				
310	Gamma	Statistics or	n Detected Data Only	
311	k hat (MLE)	11.53	k star (bias corrected MLE)	3.05
312	Theta hat (MLE)	1.322	Theta star (bias corrected MLE)	5
313	nu hat (MLE)	92.26	nu star (bias corrected)	24.4
314	Mean (detects)	15.25		
315			1	
316	Gamma ROS	Statistics u	sing Imputed Non-Detects	
317	GROS may not be used when data so	et has > 50%	6 NDs with many tied observations at multiple DLs	
318	GROS may not be used when kstar of detects is	small such a	s <1.0, especially when the sample size is small (e.g., <15-20)	
319	For such situations, GROS i	method may	yield incorrect values of UCLs and BTVs	
320	This is especi	ally true whe	en the sample size is small.	
321	For gamma distributed detected data, BTVs a	nd UCLs ma	ay be computed using gamma distribution on KM estimates	
322	Minimum	0.01	Mean	6.273
323	Maximum	20	Median	3.533
324	SD	7.364	CV	1.174
325	k hat (MLE)	0.319	k star (bias corrected MLE)	0.295
326	Theta hat (MLE)	19.64	Theta star (bias corrected MLE)	21.25
327	nu hat (MLE)	7.667	nu star (bias corrected)	7.084
328	Adjusted Level of Significance (β)	0.029		
329	Approximate Chi Square Value (7.08, α)	2.217	Adjusted Chi Square Value (7.08, β)	1.825
330	95% Gamma Approximate UCL (use when n>=50)	20.05	95% Gamma Adjusted UCL (use when n<50)	N/A
331				
332			meters using KM Estimates	
333	Mean (KM)	6.417	SD (KM)	6.701
334	Variance (KM)	44.91	SE of Mean (KM)	2.234
335	k hat (KM)	0.917	k star (KM)	0.743
336	nu hat (KM)	22	nu star (KM)	17.84
337	theta hat (KM)	6.999	theta star (KM)	8.634
338	80% gamma percentile (KM)	10.52	90% gamma percentile (KM)	15.88
339	95% gamma percentile (KM)	21.37	99% gamma percentile (KM)	34.43
340		a Marile - **	John (IVAI) Charlesia	
341		•	leier (KM) Statistics	0.045
342	Approximate Chi Square Value (17.84, α)	9.272	Adjusted Chi Square Value (17.84, β)	8.345
343	95% Gamma Approximate KM-UCL (use when n>=50)	12.34	95% Gamma Adjusted KM-UCL (use when n<50)	13.71
344	1	E Tost 5	Detected Observations Cally	
345	Lognormal GO Shapiro Wilk Test Statistic	0.922	Detected Observations Only Shapiro Wilk GOF Test	
346	•	0.922	-	wol
347	5% Shapiro Wilk Critical Value Lilliefors Test Statistic		Detected Data appear Lognormal at 5% Significance Le	vei
348	5% Lilliefors Critical Value	0.223	Detected Data appear Lognormal at 5% Significance Le	wol
349			predicted Data appear Lognormal at 5% Significance Legerated at 5% Significance Level	evel .
350	Detected Data ap	hear roalio	ninai at 5 /0 Signinicance Level	
351				

	A B C	I D I	E	l F	G	I н	т ,				K		
352	A B C			S Statistics			ects		J		K		
353		Mean in Origi	inal Scale	7.985					Me	an in L	og Scale	1.809)
354		SD in Origi	inal Scale	6.134					5	D in L	og Scale	0.776	;
355	95% t UCL (assu	mes normality of R	ROS data)	11.17				95% F	Percentile	Boots	trap UCL	10.99	
356		95% BCA Boots	strap UCL	11.42					95% E	Bootstr	ap t UCL	12.32	
357		95% H-UCL (L	og ROS)	14.9									
358													
359	Sta	atistics using KM e	estimates	on Logged I	Data and As	suming Log	normal	Distril	oution				
360		KM Mear	n (logged)	1.356						KM G	ieo Mean	3.879)
361		KM SE	(logged)	0.954			!	95% C	Critical H \	/alue ((KM-Log)	2.832	-
362	KM Stan-	dard Error of Mear	n (logged)	0.318					95% H-	UCL (KM -Log)	13.8	
363		KM SE	(logged)	0.954			!	95% C	Critical H \	/alue ((KM-Log)	2.832	-
364	KM Stand	dard Error of Mear	n (logged)	0.318									
365													
366				DL/2 S	tatistics								
367	DL/	/2 Normal		T			DL/2	Log-T	ransform				
368		Mean in Origi									og Scale	0.894	
369		SD in Origi									og Scale	1.333	
370		t UCL (Assumes r	• • • • • • • • • • • • • • • • • • • •							5% H-	Stat UCL	24.77	
371	DL	/2 is not a recomm	nended m	ethod, provi	ded for com	parisons an	d histori	ical re	asons				
372					F 11	01 01-11-11-1							
373			-	etric Distribu									
374		Detected Da	ata appea	ar Normal Di	stributed at	5% Significa	ance Le	vei					
375				Suggested	LICL to Lies								
376		95% K	M (t) UCL	10.43	OCL to Ose	,							
377		307010	(t) 00L	10.40									
378	Note: Suggestions reg	arding the selection	n of a 95%	6 UCL are pr	ovided to be	In the user to	select	the m	ost appro	oriate	95% UCI		
379	Troite: eaggestione ragi	Recommendatio		•		•						-	
380	These recommendation			•						and Le	e (2006).		
382	However, simulations res	-									, ,	an.	
383													
384	Pb												
385													
386				General	Statistics								
387	То	otal Number of Obs	ervations	12			N	umbei	of Disting	t Obs	ervations	2	
388		Number o	of Detects	1					Number	of Nor	n-Detects	11	
389		Number of Distinct	ct Detects	1			N	lumbe	r of Distin	ct Nor	n-Detects	1	
390													
391	Warning: Only one dis					· · ·							
392	It is suggested to use alternativ	e site specific valu	ues deter	mined by the	Project Tea	am to estima	ate envi	ronme	ental para	meter	s (e.g., E	PC, BTV).
393													
394		Th	ne data se	et for variable	e Pb was no	t processed	l						
334	i												
395													

	Α	В	С		D	E		F	G	Н	I	J	K	L
397	Sr													
398														
399									Statistics					
400			Tota	al Num	ber of C			12			Numbe		Observations	6
401						er of De		10					Non-Detects	2
402			N	Numbe	er of Dis			6			Numbe		Non-Detects	1
403						imum [5					n Non-Detect	
404						imum D		113 1201					n Non-Detect	-
405												Percent	Non-Detects	34.66
406						lean De		26.3					SD Detects CV Detects	1.318
407						ness De		2.033				Kur	tosis Detects	
408				Moa	n of Log			2.572					gged Detects	
409				IVICA	11 01 200	gged De	Siccis	2.572				OD OI LO	Jged Delects	1.211
410							Norm	nal GOF Tes	t on Detects	Only				
411				Shanir	ro Wilk	Test St		0.693	l on Detects	Cilly	Shaniro Wi	lk GOF Tes		
412					o Wilk (0.842		Detected Da	•		nificance Leve	اد
413				-	lliefors 7			0.321		20100104 24		GOF Test		-
414					liefors (0.262		Detected Da			nificance Leve	
415				0 70 2				a Not Norma				a. a. o /o o.g.		
416														
417 418			Kaplan	-Meie	r (KM)	Statisti	cs usii	ng Normal C	ritical Value	s and other	Nonparamet	tric UCLs		
419			•		• ,		Mean	22.75					Error of Mean	9.447
420						K	M SD	31.05				95% KN	M (BCA) UCL	41.08
421					95%	6 KM (t)) UCL	39.72			95% KM (F	Percentile Bo	otstrap) UCL	39.17
422					95%	KM (z)) UCL	38.29				95% KM Bo	otstrap t UCL	58.63
423				90% I	KM Che	ebyshev	/ UCL	51.09				95% KM Che	ebyshev UCL	63.93
424			97	7.5% I	KM Che	ebyshev	/ UCL	81.75			9	99% KM Che	ebyshev UCL	116.7
425							ļ							1
426					(Gamma	GOF	Tests on De	etected Obse	ervations Or	nly			
427					A-D	Test St	atistic	1.121		Α	nderson-Da	rling GOF T	est	
428				59	% A-D (Critical '	Value	0.754	Detect	ted Data Not	Gamma Dis	tributed at 5°	% Significance	e Level
429					K-S	Test St	atistic	0.358		ı	Kolmogorov-	Smirnov GC)F	
430				5'	% K-S (Critical '	Value	0.275	Detect	ted Data Not	Gamma Dis	tributed at 5°	% Significance	e Level
431					Detecte	ed Data	Not (Gamma Dist	ributed at 59	% Significan	ce Level			
432														
433								Statistics or	Detected D	ata Only				
434						k hat (0.845				`	rrected MLE)	0.658
435						eta hat (31.13			Theta	`	rrected MLE)	39.97
436						nu hat (16.9				nu star (bi	as corrected)	13.16
437					Me	ean (de	tects)	26.3						
438							- DOO	Otalistics	-!	I Nan Datas	4-			
439			CDOC					Statistics us						
440		CDOC		•							ervations at	•		
441		GRUS Ma									ne sample sizu CLs and B1		s.y., ≤15-20)	
442			F	UI SUC				ally true whe				1 V S		
443		Ear ar	mma distrik	וויין אין					•		ıı. nma distribu	tion on I/M -	etimotoc	
444		Fui yai	ากกล นเรแก้ป	ui c u ü	erecied.		imum	0.01	y ne comput	.eu using gar	าแาล นเอเเเมน	uon on Aivi e	Mean	21.92
445							imum	113					Median	5.5
446						IVIAX	SD	32.98					CV	1.505
447						k hat (0.387			k	star (hias co	rrected MLE)	0.346
448					The	eta hat (56.69				•	rrected MLE)	63.44
449						nu hat (9.279			. nota		as corrected)	8.292
450			Adjuste	d Lev				0.029				0.0.1 (0)		5.202
451		Ar	proximate C					2.905			Adjusted C	hi Square V	alue (8.29, β)	2.441
452		ے 95% Gamma						62.56		95% G			e when n<50)	74.46
453		CO /O GUITITIO		00	_ (436)		50)	02.00		33 /0 (36	u / lujuəl	.cu		, 4.40
454														

	Α	В	С		D E	E etimates o	f Gam	F ma Para	G meters usin	H a KM Estim	l	J		K	L
455						Mean (Kl		22.75	meters using	y Kivi Esuii	iales			SD (KM)	31.05
456					V	ariance (Kl		963.9				S		ean (KM)	9.447
457					•	k hat (Kl		0.537						star (KM)	0.458
458						nu hat (Kl		12.89						star (KM)	11
459 460					th	eta hat (Kl		42.37						star (KM)	49.64
461			80	% gan		rcentile (Kl		37.18			90	% gamma		` ′	62.64
462			95	% gan	nma pe	rcentile (Kl	M)	90.14			99	% gamma	percent	tile (KM)	158.3
463															
464						Gar	mma k	Kaplan-M	eier (KM) St	tatistics					
465		App	roximate Cl	hi Squ	are Val	ue (11.00,	α)	4.575			Adjusted C	hi Square \	Value (1	11.00, β)	3.962
466	95%	Gamma App	oroximate K	M-UC	L (use v	when n>=5	50)	54.69		95% Gam	ma Adjusted	KM-UCL (ι	use whe	en n<50)	63.15
467							Ш								
468					L	ognormal	GOF 1	Test on D	etected Obs	servations	Only		-		
469			;	Shapir	o Wilk	Test Statis	tic	0.774			Shapiro W	/ilk GOF T	est		
470			5% 5	Shapir	o Wilk (Critical Val	ue	0.842	D	etected Da	ta Not Logno	mal at 5%	Signific	ance Lev	el
471				Lil	lliefors	Test Statis	tic	0.34				GOF Tes			
472				5% Lil		Critical Val		0.262			ta Not Logno	rmal at 5%	Signific	ance Lev	el
473					De	etected Da	ta No	t Lognorn	nal at 5% Si	gnificance	Level				
474															
475								Statistics	Using Imput	ed Non-De	tects				
476						riginal Sca		22.06						og Scale	2.115
477						riginal Sca		32.87						og Scale	1.535
478		95% t L	JCL (assum				,	39.11			95%	Percentile		- 1	39.22
479						ootstrap U		43.31				95% I	Bootstra	ap t UCL	57.81
480				95%	6 H-UC	L (Log RO	S) 1	169.1							
481															
482			Stat	istics (-				Data and As	suming Lo	gnormal Dist	ribution			
483						ean (logge		2.412			250/	0		eo Mean	11.15
484			1410: 1			SD (logge	- 1	1.108			95%	Critical H	•		3.114
485			KM Standa	ard Err			-	0.337			050/			(M -Log)	58.32
486			I/M Chand	I		SD (logge		1.108 0.337			95%	Critical H	value (F	KIVI-LOG)	3.114
487			KM Standa	aru Err	OF OF IVI	ean (logge	ea)	0.337							
488								DI /2 S	tatistics						
489			DI <i>1</i> 2	Norm	al			0023	lausucs		DI /2 I og-	Transform	ned.		
490						riginal Sca	ale	22.33			DDZ LOg-			og Scale	2.296
491						Original Sca		32.69						og Scale	1.271
492			95% t			es normali		39.28						Stat UCL	82.86
493				`			• /		ded for com	parisons a	nd historical				
494								,							
495						Nonpara	metric	c Distribu	tion Free U	CL Statistic	:s				
496 497				Da	ta do n	•					icance Level				
498															
499							Sı	uggested	UCL to Use	1					
500			9	5% KI	И (Chel	byshev) U(63.93							
501									<u>I</u>						
502		Note: Sugge	stions regar	rding th	ne seled	ction of a 9	5% U	CL are pr	ovided to he	lp the user	to select the i	nost appro	priate 9	95% UCL.	
503				Recor	nmend	ations are	based	l upon dat	a size, data	distribution	, and skewne	SS.			
504		These recor	mmendatior	ns are	based (upon the re	esults	of the sim	ulation studi	ies summa	rized in Singh	, Maichle,	and Lee	e (2006).	
505	Но	owever, simu	lations resu	ılts will	not co	ver all Rea	l Worl	d data se	ts; for addition	onal insight	the user may	want to co	nsult a	statisticia	n.
506															
507															
557															

	Α	В	С	D	Е	F	G	Н		J	K	L
508	٧											
509						0	04-4-4					
510			Total	Number of C	haantatiana	12	Statistics		Niumak	or of Distinct	Observations	5
511			TOtal	Number of C	DServations	12					Observations	0
512					Minimum	2			Nullib	er or wissing	Mean	4.25
513					Maximum	6					Median	4.23
514					SD	1.215				Std	Error of Mean	0.351
515				Coefficient	t of Variation	0.286				Ota.	Skewness	-0.205
516					0	0.200						0.200
517 518						Normal (GOF Test					
519			S	Shapiro Wilk 1	Test Statistic	0.94			Shapiro V	Vilk GOF Tes	st	
520			5% S	hapiro Wilk C	Critical Value	0.859		Data app	ear Normal	at 5% Signifi	cance Level	
521				Lilliefors 7	Γest Statistic	0.169			Lilliefor	s GOF Test		
522			5	% Lilliefors C	ritical Value	0.243		Data app	ear Normal	at 5% Signifi	cance Level	
523					Data appe	ar Normal a	5% Signific	cance Level				
524												
525					As	suming Nor	mal Distribu					
526			95% No	ormal UCL				95%	UCLs (Ad	ljusted for Sk	ewness)	
527				95% Stu	dent's-t UCL	4.88					(Chen-1995)	4.805
528									95% Mod	ified-t UCL (J	ohnson-1978)	4.877
529												
530							GOF Test					
531					Test Statistic	0.443	Datasta			ng Gamma G		
532					Critical Value Fest Statistic	0.731	Detecte			nov Gamma	5% Significan	ce Levei
533					Critical Value	0.245	Detecto				:5% Significan	co Lovel
534					data appear					Distributed at	. 5 % Significan	ce Level
535				Doloolog	data appear	Gamma Di	ou ibaloa at	O 70 Olgrillo	IIIOO LOVOI			
536 537						Gamma	Statistics					
538					k hat (MLE)	11.8				k star (bias co	orrected MLE)	8.906
539				The	ta hat (MLE)	0.36			Theta	a star (bias co	orrected MLE)	0.477
540				r	nu hat (MLE)	283.2				nu star (b	ias corrected)	213.7
541			М	LE Mean (bia	s corrected)	4.25				MLE Sd (b	ias corrected)	1.424
542									Approxima	te Chi Squar	e Value (0.05)	180.9
543			Adju	sted Level of	Significance	0.029				Adjusted Chi	Square Value	176.3
544												
545						suming Gam	ıma Distribu					
546		95% Approxi	mate Gamma	UCL (use w	nen n>=50))	5.021		95% A	djusted Gar	mma UCL (us	e when n<50)	5.153
547												
548				N	F+ O+-+'-+'-		GOF Test	Oh -	! \A/!!!- I	1 00	F T•	
549				Shapiro Wilk T		0.907				ognormal GC		
550			5% S	hapiro Wilk C	Test Statistic	0.859 0.228				normal GOF	ificance Level	
551			5	% Lilliefors C		0.228					ificance Level	
552					Data appear		at 5% Signi			O/O OIGIT		
553 554									-			
554 555						Lognorma	l Statistics					
556				Minimum of L	ogged Data	0.693				Mean	of logged Data	1.404
557				Maximum of L		1.792					of logged Data	0.319
558							I.					
559					Assı	ıming Logno	rmal Distrib	oution				
560					95% H-UCL	5.166			909	% Chebyshev	(MVUE) UCL	5.456
561			95%	Chebyshev (MVUE) UCL	5.996			97.59	% Chebyshev	(MVUE) UCL	6.744
562			99%	Chebyshev (I	MVUE) UCL	8.215						
563												
564					•			CL Statistics				
565				Data appea	r to follow a	Discernible	Distribution	at 5% Signi	ficance Lev	rel		

	Α	В		С	D		E	F	G	Н	I	J	K	L
566							Nama	nometrie Die	tuibution Fuo	- 1101 -				
567						OE9/	CLT UCL		tribution Fre	e UCLS		0E9/ Ja	ackknife UCL	4.88
568				95%	Standar		strap UCL	4.827					otstrap-t UCL	4.88
569							strap UCL	4.838			95%		ootstrap UCL	4.833
570 571							strap UCL	4.667				. 0.00	70:0::: ap 0 0 2	
572							, Sd) UCL	5.303			95% CI	nebyshev(Me	ean, Sd) UCL	5.779
573				97.5% CI	nebyshev	(Mean	, Sd) UCL	6.441					ean, Sd) UCL	7.741
574														
575								Suggested	UCL to Use					
576					95%	Stude	nt's-t UCL	4.88						
577														
578		Note: Sug	gesti							•		• • • • • • • • • • • • • • • • • • • •	ate 95% UCL.	
579		Thoso ro	oomr						ta size, data				d Lee (2006).	
580	Ц												ult a statisticia	n e
581		owever, si	IIIuia	tions resu	LS WIII HOL	covei	all Neal V	voriu uata se	is, for addition	mai msigni u	le usei illay	want to cons	uit a StatiSticio	111.
582		Note: F	or hi	ahlv nega	tivelv-ske	ewed c	lata. conf	dence limits	(e.g., Chen.	Johnson, Lo	ognormal, a	nd Gamma)	may not be	
583 584									de adjustme					
585								•	•	•				
586														
587	Zn													
588														
589								General	Statistics					
590				Tota	l Number	of Obs	servations	12					Observations	8
591											Numbe	r of Missing (Observations	0
592							Minimum						Mean	22.33
593							Maximum	108				0.4.5	Median	11
594					Cooffic	signt of	SD f Variation	28.02 1.255				Sta. E	Error of Mean Skewness	8.088 3.042
595					Coemic	Jeni o	Variation	1.200					Skewiless	3.042
596								Normal (GOF Test					
597 598					Shapiro W	/ilk Tes	st Statistic				Shapiro W	ilk GOF Test	t	
599				5% S	hapiro W	ilk Crit	ical Value	0.859		Data No	ot Normal at	5% Significar	nce Level	
600					Lilliefo	ors Tes	st Statistic	0.337			Lilliefors	GOF Test		
601				Ę	5% Lilliefo	rs Crit	ical Value	0.243		Data No	ot Normal at	5% Significar	nce Level	
602							Data No	t Normal at	% Significa	nce Level				
603														
604							As	suming Nor	mal Distribut					
605				95% N	ormal UC							sted for Ske	<u> </u>	
606					95%	Stude	nt's-t UCL	36.86					(Chen-1995)	43.23
607											95% Modifi	ea-t UCL (Jo	hnson-1978)	38.04
608								Gamma	GOF Test					
609					A	-D Tes	st Statistic		1031	Ande	rson-Darling	Gamma GC)F Test	
610							ical Value		D				gnificance Lev	el
611 612							st Statistic					ov Gamma G	-	
613					5% K	-S Crit	ical Value	0.25	D				gnificance Lev	el
614						Data	Not Gam	ma Distribut	ed at 5% Sig			-		
615														
616									Statistics					
617							hat (MLE)					`	rrected MLE)	1.182
618			-				hat (MLE)				Theta	`	rrected MLE)	18.89
619							hat (MLE)						as corrected)	28.37
620				M	LE Mean	(bias	corrected)	22.33			Ammerica	-	as corrected)	20.54
621				۸ ـ۱:	otod I	1 44 0.		0.000					Value (0.05)	17.22
622				Adju	siea Leve	ot Sig	gnificance	0.029			A	ujusted Chi S	Square Value	15.9
623														

\sqcup	Α	В	С	D	E	F	G	Н	I	J	K	L
624							ma Distribut					
625		95% Approxi	mate Gamma	UCL (use w	hen n>=50))	36.8		95% Ad	djusted Gam	ma UCL (use	when n<50)	39.84
626												
627							GOF Test					
628				Shapiro Wilk T		0.799			·	gnormal GOF		
629			5% S	hapiro Wilk C		0.859			-	t 5% Significa		
630			_		Test Statistic	0.296			_	ormal GOF To		
631			5	% Lilliefors C		0.243	F0/ Ol16-		Lognormai a	t 5% Significa	ince Level	
632					Data Not L	ognormal at	5% Signific	ance Level				
633							l Canalination					
634				M::::	anned Data	1.946	l Statistics			Maanafi	arrad Data	2.738
635				Minimum of L Maximum of L		4.682					ogged Data	0.768
636			·	viaxiiiiuiii 0i L	Logged Data	4.002				30 011	ogged Data	0.706
637					Assi	ımina Loana	rmal Distrib	ution				
638					95% H-UCL	37.15	טווומו טופעוטי	uuon	Ω0%	Chebyshev (N	W/HE) HCI	34.17
639			05%	Chebyshev (I		40.52				Chebyshev (N		49.34
640				Chebyshev (I	-	66.67			37.370	Chebyshev (i	WIVOL) OCL	43.54
641			3370	Chebyshev (i	WIVOL) OCL							
642					Nonnarame	atric Dietribu	tion Free UC	'l Statistics				
643				ſ	Data do not f							
644					Juliu uo not i	onow a bloc	CITIBIO DIGU	ibadon (o.o.	-)			
645					Nonnai	rametric Dis	tribution Fre	e UCLs				
646				95	% CLT UCL	35.64		0 0020		95% Jac	ckknife UCL	36.86
647			95%	Standard Bo		34.93					strap-t UCL	66.94
648				5% Hall's Bo	•	79.54			95%	Percentile Boo	-	37.67
649				95% BCA Bo	="	45.17					0.0ap 0.02	
650 651				ebyshev(Me	•	46.6			95% CI	nebyshev(Mea	an. Sd) UCL	57.59
651 652				ebyshev(Me	· ·	72.84				nebyshev(Mea		102.8
653					, ,						,,	
654						Suggested	UCL to Use					
655			95% Ch	ebyshev (Me	an, Sd) UCL	57.59						
656					,							
657		Note: Sugge	estions regard	ling the selec	tion of a 95%	UCL are pr	ovided to hel	p the user to	select the m	nost appropria	te 95% UCL.	
658			F	Recommenda	ations are bas	sed upon dat	a size, data	distribution,	and skewnes	SS.		
659		These reco	mmendation	s are based u	pon the resu	Its of the sim	ulation studi	es summariz	zed in Singh,	Maichle, and	Lee (2006).	
660	H	However, simu	ulations resul	ts will not cov	er all Real W	orld data se	ts; for additio	nal insight th	ne user may	want to consu	lt a statisticia	n.
661												
662												
	HMW											
664												
665						General	Statistics					
666			Total	Number of C	bservations	12			Numbe	er of Distinct O	bservations	12
667									Numbe	r of Missing O	bservations	0
668					Minimum	3.8					Mean	22.26
669					Maximum	58.1					Median	21.55
670					SD	15.54				Std. Er	ror of Mean	4.487
671				Coefficient	of Variation	0.698					Skewness	1.059
672												
673							GOF Test					
674				hapiro Wilk 1		0.914				ilk GOF Test		
675			5% S	hapiro Wilk C		0.859		Data app		nt 5% Significa	ince Level	
676					Test Statistic	0.183				GOF Test		
677			5	% Lilliefors C		0.243		• • • • • • • • • • • • • • • • • • • •	ear Normal a	nt 5% Significa	ince Level	
678					Data appe	ar Normal at	5% Signific	ance Level				
679												

	Α	В	С	D	E	F	G	Н		J	K	L
680			000/ 11		Ass	suming Nor	mal Distribut					
681			95% No	ormal UCL		22.22		95%	• •	usted for Skewne	· .	
682				95% Stu	dent's-t UCL	30.32			-	ed-CLT UCL (Che		31.1
683									95% Modifi	ed-t UCL (Johns	on-1978)	30.55
684												
685							GOF Test					
686					Test Statistic	0.26				Gamma GOF T		
687					Critical Value	0.741	Detecte			istributed at 5% S	_	e Level
688					Test Statistic	0.158			·	ov Gamma GOF		
689					Critical Value	0.249		• • • • • • • • • • • • • • • • • • • •		istributed at 5% S	Significand	e Level
690				Detected	l data appear	Gamma Di	stributed at {	5% Significa	nce Level			
691												
692							Statistics					4.570
693					k hat (MLE)	2.027				star (bias correct	′	1.576
694					ta hat (MLE)	10.98			Theta	star (bias correct	′	14.13
695					nu hat (MLE)	48.64				nu star (bias co		37.81
696			MI	LE Mean (bia	as corrected)	22.26				MLE Sd (bias co		17.73
697										e Chi Square Val	, ,	24.73
698			Adjus	sted Level of	Significance	0.029			Α	djusted Chi Squa	re Value	23.13
699												
700							ıma Distribut					
701		95% Approxii	mate Gamma	UCL (use w	rhen n>=50))	34.03		95% Ad	djusted Gam	ma UCL (use wh	en n<50)	36.39
702												
703							GOF Test					
704				-	Test Statistic	0.928				gnormal GOF Te		
705			5% S		Critical Value	0.859				l at 5% Significan		
706					Test Statistic	0.193				ormal GOF Test		
707			5	% Lilliefors (Critical Value	0.243				l at 5% Significan	ice Level	
708					Data appear	Lognormal	at 5% Signif	icance Leve	l			
709												
710							l Statistics					
711					Logged Data	1.335				Mean of log		2.836
712			N	Maximum of	Logged Data	4.062				SD of log	ged Data	0.832
713												
714							rmal Distrib	ution				
715					95% H-UCL	46.57				Chebyshev (MVI		40.93
716					MVUE) UCL	48.93			97.5%	Chebyshev (MVI	UE) UCL	60.04
717			99%	Chebyshev (MVUE) UCL	81.87						
718												
719							tion Free UC					
720				Data appea	r to follow a	Discernible	Distribution a	at 5% Signif	icance Leve	·I		
721												
722					<u> </u>		tribution Fre	e UCLs				
723					% CLT UCL	29.64				95% Jackk		30.32
724					otstrap UCL	29.4				95% Bootstra	•	32.77
725					ootstrap UCL	34.44			95%	Percentile Bootst	trap UCL	29.56
726					otstrap UCL	30.71						
727				• •	an, Sd) UCL	35.72				hebyshev(Mean,		41.82
728			97.5% Ch	ebyshev(Me	an, Sd) UCL	50.28			99% CI	hebyshev(Mean,	Sd) UCL	66.91
729												
730							UCL to Use					
731				95% Stu	dent's-t UCL	30.32						
732												
733		Note: Sugge	estions regard	ling the selec	ction of a 95%	UCL are pr	ovided to hel	p the user to	select the n	nost appropriate (95% UCL.	
734					ations are bas							
735		These reco	mmendations	s are based i	upon the resu	Its of the sim	ulation studi	es summariz	zed in Singh,	Maichle, and Le	e (2006).	
736	H	owever, simu	ulations resul	ts will not co	ver all Real W	orld data se	ts; for additio	nal insight tl	ne user may	want to consult a	statisticia	n.
737												
												-

	Α	В	С		D	E	F	G	Н	I	J	K	L
738													
755	1												
740 741							General	Statistics					
741			Tota	al Nun	nber of C	bservations	12			Numbe	er of Distinct	Observations	12
743										Numbe	r of Missing	Observations	0
744						Minimum	64.3					Mean	96.83
745						Maximum	155.2					Median	92.65
746						SD					Std. E	Error of Mean	7.614
747				Co	pefficient	of Variation	0.272					Skewness	0.931
748							Normal	GOF Test					
749				Shani	ro Wilk 1	Test Statistic		GOF TEST		Shaniro W	ilk GOF Tes	•	
750				•		Critical Value			Data app	·	at 5% Signific		
751 752				-		Test Statistic					GOF Test		
753				5% Li	Iliefors C	ritical Value	0.243		Data app	ear Normal a	at 5% Signific	ance Level	
754						Data appe	ar Normal a	t 5% Signific	ance Level				
755													
756						As	suming Nor	mal Distribu					
757			95% N				110.5		95%		sted for Ske		444.5
758					95% Stu	dent's-t UCL	110.5					(Chen-1995)	111.5
759										95% IVIOUITI	ea-t UCL (Jo	hnson-1978)	110.8
760							Gamma	GOF Test					
761 762					A-D 1	Test Statistic			Ande	rson-Darling	Gamma GC	OF Test	
763				5	% A-D C	ritical Value	0.731	Detecte	d data appe	ar Gamma D	istributed at	5% Significan	ce Level
764					K-S T	Test Statistic	0.124		Kolmog	gorov-Smirn	ov Gamma C	GOF Test	
765				5	% K-S C	Critical Value	0.245	Detecte	ed data appe	ar Gamma D	istributed at	5% Significan	ce Level
766					Detected	data appea	r Gamma D	Detected data appear Gamma Distributed at 5% Significan stributed at 5% Significance Level					
767								0					
768						k bot (MLE)		Statistics		le.	atar (biaa aa	rrected MLE)	11.93
769					The	k hat (MLE) ta hat (MLE)					`	rrected MLE)	8.116
770 771						u hat (MLE)				Tileta	`	as corrected)	286.3
771			N	/ILE M		s corrected)	96.83					as corrected)	28.03
773										Approximate	e Chi Square	Value (0.05)	248.1
774			Adju	usted	Level of	Significance	0.029			Α	djusted Chi S	Square Value	242.7
775													
776								nma Distribu					
777	!	95% Approxir	mate Gamm	ia UCI	L (use w	hen n>=50))	111.7		95% A	djusted Gam	ma UCL (use	e when n<50)	114.2
778							Lognorma	I GOF Test					
779				Shani	ro Wilk 1	Test Statistic		Tuoi rest	Sha	piro Wilk Loc	gnormal GOI	F Test	
780 781				•		Critical Value						ficance Level	
782						Test Statistic			Li	lliefors Logn	ormal GOF	Test	
783			,	5% Li	lliefors C	Critical Value	0.243		Data appea	ar Lognorma	l at 5% Signif	ficance Level	
784						Data appea	r Lognormal	at 5% Signi	ficance Leve	el			
785													
786								al Statistics					
787						ogged Data						f logged Data	4.541
788				iviaxir	rium of L	ogged Data	5.045				SD of	f logged Data	0.261
789						Δοο	umina Loan	ormal Distrib	ution				
790						95% H-UCL	112.6			90%	Chebyshev	(MVUE) UCL	118.7
791 792			95%	Cheb		MVUE) UCL	128.7					(MVUE) UCL	142.5
793						MVUE) UCL	169.7				<u> </u>	,	
794					<u>-</u>		ı	ı					
, 57													

	Α	В	С	D	Е	F	G	Н	I	J	K	L
795					Nonparame	etric Distribu	tion Free UC	L Statistics				
796				Data appea	r to follow a	Discernible	Distribution a	at 5% Signifi	cance Level			
797												
798					Nonpa	rametric Dis	tribution Fre	e UCLs				
799				95	% CLT UCL	109.4				95% Ja	ckknife UCL	110.5
800			95%	Standard Bo	otstrap UCL	108.6				95% Boo	tstrap-t UCL	114.1
801			9	5% Hall's Bo	otstrap UCL	116.6			95% I	Percentile Bo	otstrap UCL	109.5
802				95% BCA Bo	otstrap UCL	110.6						
803			90% Ch	ebyshev(Me	an, Sd) UCL	119.7			95% Ch	ebyshev(Me	an, Sd) UCL	130
804			97.5% Ch	ebyshev(Me	an, Sd) UCL	144.4			99% Ch	ebyshev(Me	an, Sd) UCL	172.6
805												
806						Suggested	UCL to Use					
807				95% Stu	dent's-t UCL	110.5						
808												
809		Note: Sugge	stions regard	ling the selec	ction of a 95%	6 UCL are pr	ovided to hel	p the user to	select the m	ost appropria	ate 95% UCL	==
810			F	Recommenda	ations are ba	sed upon dat	ta size, data d	distribution, a	and skewnes	S.		
811		These recor	mmendation	s are based u	ipon the resu	Its of the sim	nulation studio	es summariz	ed in Singh,	Maichle, and	Lee (2006).	
812	Но	wever, simu	ılations resul	s will not cov	er all Real W	orld data se	ts; for additio	nal insight th	e user may v	want to consi	ult a statistici	an.
813												

	A B C D	l E	F	G	Н	I	J	K	\top	L
1	Wilcoxon-Mann-Whitney Sar					or Full Data				
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	12:59:44 PM							
5	From File WorkSheet	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	lean/Median	= Sample 2	Mean/Mediar	n (Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	an					
11	-									
12										
13	Sample 1 Data: Arsenic-Site									
14	Sample 2 Data: Arsenic-Back									
15									1	
16	Raw Statistic	cs								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	12	3							
20	Minimum	17	9							
21	Maximum	78	13							
22	Mean	31.13	11							
23	Median	24	11							
24	SD	17.76	2							
25	SE of Mean	4.586	1.155							
26		1	1							
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.00753								
40										
41	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2									
43										
44										

	A B C D	E	F	G	Н	l ı	J	K	T
1	Wilcoxon-Mann-Whitney Sai					or Full Data	Ŭ		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:06:30 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 N	lean/Mediar	n = Sample 2	Mean/Mediar	n (Two Sided	Alternative))		
10	Alternative Hypothesis Sample 1 N	1ean/Mediar	n <> Sample 2	2 Mean/Media	an				
11									
12									
13	Sample 1 Data: Chromium-Site								
14	Sample 2 Data: Chromium-Back								
15									
16	Raw Statistic								
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	13	3						
20	Minimum	11	11						
21	Maximum	98	22						
22	Mean	34.4	16.33						
23	Median	31	16						
24	SD	22.64	5.508						
25	SE of Mean	5.846	3.18						
26	NATI								
27	Wilcoxon-Mann-Whitney	(WMW) IE	est						
28									
29	H0: Mean/Median of Sample 1 = Mean/Median of	of Comple 2							
30	no. Mean/Median of Sample 1 - Mean/Median of	oi Sample 2							
31	Sample 1 Rank Sum W-Stat	158.5							
32	WMW U-Stat								
33	Mean (U)								
34	SD(U) - Adj ties								
35	Lower U-Stat Critical Value (0.025)								
36	Upper U-Stat Critical Value (0.975)								+
37	Standardized WMW U-Stat								
38	Approximate P-Value								
39				1					
40	Conclusion with Alpha = 0.05								
41	Do Not Reject H0, Conclude Sample 1 = Sam	ple 2							
43		-							+
44									+
44							1		

	A B C D	l E	l F	G	Н	ı	J	K	Т
1	Wilcoxon-Mann-Whitney Sai					or Full Data	·		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:41:07 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								-
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 N	lean/Median	= Sample 2	Mean/Mediar	(Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	n				
11									
12									
13	Sample 1 Data: Chry-Site								
14	Sample 2 Data: Chry-Back								
15									
16	Raw Statistic	cs							
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	15	2						
20	Minimum	0.14	0.01						
21	Maximum	1.7	0.03						
22	Mean	0.769	0.0233						
23	Median	0.66	0.03						
24	SD	0.482	0.0115						
25	SE of Mean	0.124	0.00667						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	st						
28									
29									
30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31		105							
32	Sample 1 Rank Sum W-Stat								
33	WMW U-Stat								
34	Mean (U)								
35	SD(U) - Adj ties Lower U-Stat Critical Value (0.025)								
36	Upper U-Stat Critical Value (0.025)								
37	Standardized WMW U-Stat								
38	Approximate P-Value		1						
39	Approximate P-value	0.00765	1						
40	Conclusion with Alpha = 0.05								
41	Reject H0, Conclude Sample 1 <> Sample 2								
42	reject no, Conclude Sample 1 >> Sample 2								
43									
44									

	A B C D	l E	F	G	Н	l 1	J	K	T 1
1	Wilcoxon-Mann-Whitney Sar					or Full Data	-		_
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:08:29 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 M	lean/Mediar	n = Sample 2	Mean/Mediar	n (Two Sided	Alternative)		
10	Alternative Hypothesis Sample 1 M	lean/Mediar	n <> Sample 2	2 Mean/Media	an				
11	1								
12									
13	Sample 1 Data: Cobalt-Site								
14	Sample 2 Data: Cobalt-Back								
15									
16	Raw Statistic	cs							
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	10	3						
20	Minimum	8	7						
21	Maximum	22	10						
22	Mean	13.53	8.333						
23	Median	13	8						
24	SD	3.739	1.528						
25	SE of Mean	0.965	0.882						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	est						
28									
29									
30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31									
32	Sample 1 Rank Sum W-Stat								
33	WMW U-Stat								
34	Mean (U)								
35	SD(U) - Adj ties								
36	Lower U-Stat Critical Value (0.025)								
37	Upper U-Stat Critical Value (0.975)								
38	Standardized WMW U-Stat								
39	Approximate P-Value	0.0198							
40	One short an arith Alaba 2005								
41	Conclusion with Alpha = 0.05								
42	Reject H0, Conclude Sample 1 <> Sample 2								
43									
44									

	A B C D	l E	F	G	Н	ı	J	K	\top	L
1	Wilcoxon-Mann-Whitney Sar					or Full Data				
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	111/16/2018	1:10:42 PM							
5	From File WorkSheet	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 N	lean/Median	= Sample 2	Mean/Mediar	(Two Sided	Alternative)			-
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	n					
11										
12										
13	Sample 1 Data: Copper-Site									
14	Sample 2 Data: Copper-Back									
15									1	
16	Raw Statistic	cs								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	14	3							
20	Minimum	63	6							
21	Maximum	260	14							-
22	Mean	145.3	9.333							
23	Median	147	8							
24	SD	50.21	4.163							
25	SE of Mean	12.96	2.404							
26				,						
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat	t 45								
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.00765								
40										
41	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2									_
43										
44										

	A B C D	l E	l F	G	Н			K	
1	Wilcoxon-Mann-Whitney Sar					or Full Data	Sets without		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:37:59 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 M	lean/Mediar	n = Sample 2	Mean/Media	n (Two Sided	l Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Mediar	<> Sample 2	2 Mean/Medi	an				
11									
12									T
	Sample 1 Data: F3-Site								
14	Sample 2 Data: F3-Back								
15									
16	Raw Statistic	cs							
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	15	2						
20	Minimum	38	15						
21	Maximum	419	22						
22	Mean	187.9	17.33						
23	Median	200	15						
24	SD	112.2	4.041						
25	SE of Mean	28.96	2.333						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	st						
28									
29									
30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31									
32	Sample 1 Rank Sum W-Stat								
33	WMW U-Stat								
34	Mean (U)								
35	SD(U) - Adj ties								
36	Lower U-Stat Critical Value (0.025)								
37	Upper U-Stat Critical Value (0.975)								
38	Standardized WMW U-Stat								
39	Approximate P-Value	0.00765							
40	Conclusion with Alaba - 0.05								
41	Conclusion with Alpha = 0.05								
42	Reject H0, Conclude Sample 1 <> Sample 2								
43									
44									

	A B C D	E	F	G	Н	I	T J	K	\top	L
1	Wilcoxon-Mann-Whitney San					or Full Data	_			
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:46:10 PM							
5	From File WorkSheet_	a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	ean/Median	= Sample 2 l	Mean/Median	(Two Sided	Alternative)		-	
10	Alternative Hypothesis Sample 1 M	ean/Median	<> Sample 2	Mean/Media	n					
11	-									-
12										
13	Sample 1 Data: Fluoranthene-Site									
14	Sample 2 Data: Fluoranthene-Back									
15										
16	Raw Statistic	s								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	14	2							
20	Minimum	0.3	0.05							
21	Maximum	3.93	0.07							
22	Mean	1.669	0.0633							
23	Median	1.37	0.07							
24	SD	1.137	0.0115							
25	SE of Mean	0.294	0.00667							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	f Sample 2								
31										
32	Sample 1 Rank Sum W-Stat	165								
33	WMW U-Stat	45								
34	Mean (U)	22.5								
35	SD(U) - Adj ties	8.437								
36	Lower U-Stat Critical Value (0.025)	6								
37	Upper U-Stat Critical Value (0.975)	39								
38	Standardized WMW U-Stat	2.668								
39	Approximate P-Value	0.00762								
40										
41	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2									
43										
44										

	A B C D	E	F	G	Н	Ιı	J	K	T
1	Wilcoxon-Mann-Whitney Sar					or Full Data	-		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:14:46 PM						
5	From File WorkSheet_	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9			n = Sample 2			Alternative))		
10	Alternative Hypothesis Sample 1 M	lean/Mediar	n <> Sample 2	2 Mean/Media	an				
11					1	T.	- T		
12									
13	Sample 1 Data: Lead-Site								
14	Sample 2 Data: Lead-Back								
15									
16	Raw Statistic								
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	13	3						
20	Minimum	54.4	5.9						
21	Maximum	728	7.4						
22	Media	286.9 252	6.6 6.5						
23	Median								
24	SD SE of Mean	165.1 42.62	0.755 0.436						
25	SE OI Wealt	42.02	0.430						
26	Wilcoxon-Mann-Whitney	/\/\M\\/\ To	et						
27	Wilcoxon-Maini-Willuley	(*******) 16							
28									
29 30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31									
32	Sample 1 Rank Sum W-Stat	165							
33	WMW U-Stat	45							
34	Mean (U)	22.5							
35	SD(U) - Adj ties	8.437							
36	Lower U-Stat Critical Value (0.025)	6							
37	Upper U-Stat Critical Value (0.975)	39							
38	Standardized WMW U-Stat	2.668							
39	Approximate P-Value	0.00762							
40		*							
	Conclusion with Alpha = 0.05								
42	Reject H0, Conclude Sample 1 <> Sample 2								
43									
44									

П	A B C D	ΙE	F	G	Н	I	J	K	\top	L
1	Wilcoxon-Mann-Whitney San					or Full Data				
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:22:27 PM							
5	From File WorkSheet_	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	ean/Median	= Sample 2	Mean/Mediar	n (Two Sided	Alternative)			-
10	Alternative Hypothesis Sample 1 M	ean/Median	<> Sample 2	Mean/Media	an					
11	,									
12										
13	Sample 1 Data: Molybdenum-Site									
14	Sample 2 Data: Molybdenum-Back									
15										
16	Raw Statistic	s								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	6	2							
20	Minimum	2	2							
21	Maximum	9	3							-
22	Mean	4.933	2.333							
23	Median	4	2							
24	SD	2.463	0.577							
25	SE of Mean	0.636	0.333							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Tes	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.0533								
40										
41	Conclusion with Alpha = 0.05									
42	Do Not Reject H0, Conclude Sample 1 = Sam	ple 2								
43										
44										

	A B C D	l E	l F	G	Н	ı	J	K	$\overline{\mathbf{T}}$	L
1	Wilcoxon-Mann-Whitney Sar					or Full Data				
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/19/2018	3:01:08 PM							
5	From File WorkSheet.	xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	ean/Median	= Sample 2	Mean/Mediar	(Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	ean/Median	<> Sample 2	Mean/Media	n					
11	,									-
12										
13	Sample 1 Data: mTPH-Site									
14	Sample 2 Data: mTPH-Back									
15										
16	Raw Statistic	s								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	15	2							
20	Minimum									
21	Maximum	Maximum 419 22								
22	Mean	189.2	20.67							
23	Median	200	20							
24	SD	113.1	1.155							
25	SE of Mean	29.2	0.667							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.00765								
40										
41	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2									
43										
44										

	A B C D	l E	l F	G	Н	I	l J	K	T	T
1	Wilcoxon-Mann-Whitney Sar					or Full Data	_			
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:25:19 PM							
5	From File WorkSheet	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	lean/Median	= Sample 2	Mean/Mediar	(Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	n					
11	-									-
12										
13	Sample 1 Data: Nickel-Site									
14	Sample 2 Data: Nickel-Back									
15										
16	Raw Statistic	cs								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	10	3							
20	Minimum	Minimum 9 11								
21	Maximum	Maximum 45 18								
22	Mean	21.73	14							
23	Median	22	13							
24	SD	8.102	3.606							
25	SE of Mean	2.092	2.082							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.0844								
40										
41	Conclusion with Alpha = 0.05									
42	Do Not Reject H0, Conclude Sample 1 = Sam	ple 2								
43										
44										

	A B C D	l E	l F	G	Н	Ιı	J	K	
1	Wilcoxon-Mann-Whitney Sar					or Full Data	Sets without		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:49:50 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 N	lean/Median	ı = Sample 2 I	Mean/Mediar	n (Two Sideo	Alternative))		
10	Alternative Hypothesis Sample 1 M	lean/Median	Mean/Media	an					
11									
12									
13	Sample 1 Data: Phenanthrene-Site								
14	Sample 2 Data: Phenanthrene-Back								
15									
16	Raw Statistic	cs							
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	15	3						
20	Minimum	0.22	0.03						
21	Maximum	4.05	0.06						
22	Mean	1.424	0.0433						
23	Median	1.26	0.04						
24	SD	1.02	0.0153						
25	SE of Mean	0.263	0.00882						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	st						
28									
29									
30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31		T	1	I					
32	Sample 1 Rank Sum W-Stat								
33	WMW U-Stat								
34	Mean (U)								
35	SD(U) - Adj ties								
36	Lower U-Stat Critical Value (0.025)								
37	Upper U-Stat Critical Value (0.975)								
38	Standardized WMW U-Stat								
39	Approximate P-Value	0.00915							
40	Oppolysion with Alpha a COS								
71	Conclusion with Alpha = 0.05								
42	Reject H0, Conclude Sample 1 <> Sample 2								
43									
44									

	A B C D	l E	l F	G	Н	I	J	K	\top	L
1	Wilcoxon-Mann-Whitney Sar					or Full Data	_			
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:50:59 PM							
5	From File WorkSheet_	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 M	lean/Median	= Sample 2 l	Mean/Median	ı (Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	n					
11										
12										
10	Sample 1 Data: Pyrene-Site									
14	Sample 2 Data: Pyrene-Back									
15										
16	Raw Statistic									
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	15	2							
20	Minimum	Minimum 0.24 0.05								
21	Maximum	2.98	0.06							
22	Mean	1.307	0.0533							
23	Median	1.13	0.05							
24	SD	0.833	0.00577							
25	SE of Mean	0.215	0.00333							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31		T	T	I						
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)								_	
38	Standardized WMW U-Stat						1			
39	Approximate P-Value	0.00765							_	
40	Opensiusian with Alpha - 2.25									
71	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2						1			
43										
44										

	A B C D	E	F	G	Н	l I	J	K	Т
1	Wilcoxon-Mann-Whitney Sai					or Full Data	-		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:31:46 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								-
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 N	lean/Mediar	n = Sample 2	Mean/Mediar	n (Two Sided	Alternative))		
10	Alternative Hypothesis Sample 1 N	lean/Mediar	2 Mean/Media	an					
11									
12									
13	Sample 1 Data: Tin-Site								
14	Sample 2 Data: Tin-Back								
15									
16	Raw Statistic								
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	11	2						
20	Minimum	7	3						
21	Maximum	28	4						
22	Mean	14.73	3.333						
23	Median	13	3						
24	SD	6.617	0.577						
25	SE of Mean	1.708	0.333						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	est						
28									
29	H0: Mean/Median of Sample 1 = Mean/Median of	of Comple 2							
30	no: Mean/Median of Sample 1 - Mean/Median of	or Sample 2							
31	Sample 1 Rank Sum W-Stat	165							
32	WMW U-Stati								
33	Mean (U)								
34	SD(U) - Adj ties								
35	Lower U-Stat Critical Value (0.025)								
36	Upper U-Stat Critical Value (0.975)								
37	Standardized WMW U-Stat								+
38	Approximate P-Value								+
39	pp. oa.c i Valuo	1.30.11							
40	Conclusion with Alpha = 0.05								-
42	Reject H0, Conclude Sample 1 <> Sample 2								
43	. ,								
44							1		

	A B C D	l E	F	G	Н	ı	J	K	T
1	Wilcoxon-Mann-Whitney Sai					or Full Data	Ŭ		
2									
3	User Selected Options								
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:33:00 PM						
5	From File WorkSheet	_a.xls							
6	Full Precision OFF								
7	Confidence Coefficient 95%								
8	Substantial Difference 0.000								
9	Selected Null Hypothesis Sample 1 M	lean/Mediar	n = Sample 2	Mean/Mediar	(Two Sided	Alternative)			
10	Alternative Hypothesis Sample 1 M	lean/Mediar	2 Mean/Media	an					
11	-								
12									
13	Sample 1 Data: Uranium-Site								
14	Sample 2 Data: Uranium-Back								
15									
16	Raw Statistic	CS							
17		Sample 1	Sample 2						
18	Number of Valid Observations	15	3						
19	Number of Distinct Observations	11	2						
20	Minimum	0.7	1.1						
21	Maximum	2.5	1.4						
22	Mean	1.373	1.3						
23	Median	1.2	1.4						
24	SD	0.554	0.173						
25	SE of Mean	0.143	0.1						
26									
27	Wilcoxon-Mann-Whitney	(WMW) Te	est						
28									
29									
30	H0: Mean/Median of Sample 1 = Mean/Median of	of Sample 2							
31		T	T	T-					
32	Sample 1 Rank Sum W-Stat								
33	WMW U-Stat								
34	Mean (U)								
35	SD(U) - Adj ties								
36	Lower U-Stat Critical Value (0.025)								
37	Upper U-Stat Critical Value (0.975)								
38	Standardized WMW U-Stat								
39	Approximate P-Value	0.633							
40	Oppolysion with Alpha a COS								
41	Conclusion with Alpha = 0.05								
42	Do Not Reject H0, Conclude Sample 1 = Sam								
43									
44									

П	A B C D	E	F	G	Н	ı	l J	К	$\overline{}$	ī
1	Wilcoxon-Mann-Whitney San					or Full Data	_			
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:34:36 PM							
5	From File WorkSheet_	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9				Mean/Mediar		Alternative)			
10	Alternative Hypothesis Sample 1 M	ean/Median	<> Sample 2	2 Mean/Media	n					
11										
12										
13	Sample 1 Data: Vanadium-Site									
14	Sample 2 Data: Vandium-Back									
15										
16	Raw Statistic		T							
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	13	3							
20		Minimum 14 26								
21		Maximum 63 40								
22	Mean	40.93	33							
23	Median	45	33							
24	SD	13.61	7						\bot	
25	SE of Mean	3.514	4.041							
26	NAGI a com a NAGO MA NAGO MA COM A NAGO MA C	OADAD T-								
27	Wilcoxon-Mann-Whitney	(WMW) IE	SI							
28										
29	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
	110. Mean/Median of Sample 1 – Mean/Median o	n Sample 2							+	
31	Sample 1 Rank Sum W-Stat	154.5							_	
32	WMW U-Stat								+	
33	Mean (U)								+	
34	SD(U) - Adj ties								+	
35	Lower U-Stat Critical Value (0.025)						1		_	
36	Upper U-Stat Critical Value (0.975)								_	
37 38	Standardized WMW U-Stat						1		_	
39	Approximate P-Value									
40	••		1	1			+		+	
	Conclusion with Alpha = 0.05								+	
42	Do Not Reject H0, Conclude Sample 1 = Sam	ple 2					+		-	
43	· ·	=								
44										
44										

	A B C D	E	l F	G	Н	I	J	K	\top	L
1	Wilcoxon-Mann-Whitney Sar					or Full Data				
2										
3	User Selected Options									
4	Date/Time of Computation ProUCL 5.1	11/16/2018	1:36:12 PM							
5	From File WorkSheet	_a.xls								
6	Full Precision OFF									
7	Confidence Coefficient 95%									
8	Substantial Difference 0.000									
9	Selected Null Hypothesis Sample 1 N	lean/Median	= Sample 2	Mean/Median	(Two Sided	Alternative)		-	
10	Alternative Hypothesis Sample 1 M	lean/Median	<> Sample 2	Mean/Media	n					
11										
12										
13	Sample 1 Data: Zinc-Site									
14	Sample 2 Data: Zinc-Back									
15									1	
16	Raw Statistic	cs								
17		Sample 1	Sample 2							
18	Number of Valid Observations	15	3							
19	Number of Distinct Observations	15	3							
20	Minimum	267	30							
21	Maximum									
22	Mean	1026	34							
23	Median	629	34							
24	SD	1210	4							
25	SE of Mean	312.5	2.309							
26										
27	Wilcoxon-Mann-Whitney	(WMW) Te	st							
28										
29										
30	H0: Mean/Median of Sample 1 = Mean/Median o	of Sample 2								
31										
32	Sample 1 Rank Sum W-Stat									
33	WMW U-Stat									
34	Mean (U)									
35	SD(U) - Adj ties									
36	Lower U-Stat Critical Value (0.025)									
37	Upper U-Stat Critical Value (0.975)									
38	Standardized WMW U-Stat									
39	Approximate P-Value	0.00915								
40										
41	Conclusion with Alpha = 0.05									
42	Reject H0, Conclude Sample 1 <> Sample 2									
43										
44										

Appendix E HHRA Supporting Information

Site-Specific Target Levels for Human Health (Non-Threshold Substances) - Commercial Adult at Marystown Shipyard, Marystown, Newfoundland and Labrador

Site Name: Marystown Shipyard, Marystown, Newfoundland and Labrador

Receptor: Adult

Dust Levels: Default

Exposure Scenario: Commercial

 Time on site:
 Default

 Hours per day (inhalation)
 8

 Days per Week
 5

 Weeks per Year
 48

 Years Exposed
 35

 Life Expectancy
 80

SSTL =	TR x BW x LE	+ BSC
	$ED \times [(AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o)]$	

Default Scenario? Yes

Compound	SF。	SFi	BSC	AF _{gut}	AF _{lung}	AF _{skin}	SSTL
	(mg/kg-d) ⁻¹	(mg/kg-d) ⁻¹	(mg/kg)				(mg/kg)
Arsenic	1.8	27	11	1	1	0.03	69

<u>Parameter</u>	<u>Definition (units)</u>	Default Value	Reference
SF _o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010b)
SF _i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010b)
TR =	target risk	0.00001	Health Canada (2010a)
BSC =	background sediment concentration	chemical specific	Site-specific - mean concentration
BW =	body weight (kg)	70.7	Health Canada (2010a) - Adult
AF _{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1.
AF _{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed 1.
AF skin =	absorption factor skin (unitless)	chemical specific	Health Canada (2010b)
SIR =	soil ingestion rate (kg/day)	0.00002	Health Canada (2010a) - Adult
IR soil =	soil inhalation rate (kg/day) = CRP (kg/m³) x IR _{air} (m³/day)	1.2616E-08	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA _{hands} x M _{hands}) + (SA _{body} x M _{body}) x 1E-6 (kg/mg)	0.000114	Calculated
ET ing =	exposure term for soil ingestion pathway (unitless)	0.659	Site Specific [24 Hours per Day, 5 Days per Week, 48 Weeks per Year]
ET _{inh} =	exposure term for soil inhalation pathway (unitless)	0.220	Site Specific [8 Hours per Day, 5 Days per Week, 48 Weeks per Year]
ET _{derm} =	exposure term for soil dermal contact pathway (unitless)	0.659	Site Specific [24 Hours per Day, 5 Days per Week, 48 Weeks per Year]
CRP =	concentration of respirable particles (kg/m³)	7.60E-10	Health Canada (2010a) - Default
IR _{air} =	daily inhalation rate (m³ air/day)	16.6	Health Canada (2010a) - Adult
SA _{hands} =	skin surface area - hands (cm²/day)	890	Health Canada (2010a) - Adult
SA _{body} =	skin surface area - arms (cm²/day)	2500	Health Canada (2010a) - Adult
M _{hands} =	soil to skin adherence factor - hands (mg/cm²)	0.1	Health Canada (2010a) - Adult
M _{body} =	soil to skin adherence factor - rest of body (mg/cm²)	0.01	Health Canada (2010a) - Adult

Site Specific Target Levels for Human Health (Non-carcinogenic Substances) - Adult at Marystown Shipyard, Marystown, Newfoundland and Labrador

Site Name: Marystown Shipyard, Marystown, Newfoundland and Labrador

exposure term for soil ir exposure term for soil ingestion pathway (unitless)

exposure term for soil ir exposure term for soil inhalation pathway (unitless)

exposure term for soil ingestion pathway (unitless) - developmental toxicant

exposure term for soil inhalation pathway (unitless) - developmental toxicant

concentration of respirable particles (kg/m3)

skin surface area - rest of body (cm2/day)

soil to skin adherence factor - hands (mg/cm2)

soil to skin adherence factor - rest of body (mg/cm2)

daily inhalation rate (m3/day)

skin surface area - hands (cm²/day)

exposure term for soil d exposure term for soil dermal contact pathway (unitless)

exposure term for soil dermal contact pathway (unitless) - developmental toxicant

Receptor: Adult **Dust Levels:** Default

Exposure Scenario: Commercial

Time on site:

Hours per day (inhalation) 8 Days per Week 5

ET ing =

ET inh =

ET derm =

ET ing =

ET inh =

ET derm =

CRP =

IR air =

SA hands =

SA _{body} =

M _{hands} =

M $_{\rm body}$ =

Weeks per Year 52

SSTL =	HQ x BW	+ BSC
((1/($TDI - EDI) \times AF_{gut} \times SIR \times ET_{ing}) + ((1/(TDI - EDI)) \times AF_{lung} \times IR_{soil} \times ET_{inh}) + ((1/(TDI - EDI)) \times AF_{skin} \times SDR \times ET_{del} \times ET_{soil} \times ET_$)

Site Specific [8 Hours per Day, 5 Days per Week, 52 Weeks per Year]

Site Specific [8 Hours per Day, 5 Days per Week, 52 Weeks per Year] Site Specific [8 Hours per Day, 5 Days per Week, 52 Weeks per Year]

Site Specific [24 Hours per Day, 5 Days per Week]

Site Specific [8 Hours per Day, 5 Days per Week]

Site Specific [24 Hours per Day, 5 Days per Week]

Health Canada (2012) - Default

Health Canada (2012) - Adult

Health Canada (2012) - Adult - arms

Compound	TDI	TDI	EDI	THQ	BSC	AF _{gut}	AF _{lung}	AF _{skin}	SSTL	Comments
	(oral)	(inhalation)							(mg/kg)	
Lead	0.0011	0.0011		1	6.6	0.6	1	0.006	8,588	Developmental Toxicant. No Amortization.
<u>Parameter</u>	Definition (units)							Default Value		Reference
TDI =	reference dose (mg/kg bw-day)							chemical specific		Lead - AFWEI (2015)
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)							chemical specific		Not available.
THQ =	target hazard quotient (unitless)							chemical specific		Health Canada (2012)
BW =	body weight (kg)							70.7		Health Canada (2012) - Adult
BSC =	background sediment concentration (mg/kg)							chemical specific		Site-specific - mean concentration
AF _{gut} =	absorption factor for gut (unitless)							chemical specific		Assumed 1.
AF _{lung} =	absorption factor for lung (unitless)							chemical specific		Assumed 1.
AF skin =	absorption factor skin (unitless)							chemical specific		Antimony - Ontario MOECC (2016); Iron - USEPA RSL (2018); Lead - AFWEI (2015)
SIR =	soil ingestion rate (kg/day)							0.00002		Health Canada (2012) - Adult
IR soil =	soil inhalation rate (kg/day) = CRP (kg/m³) x IR _{air} (m³/day)							1.3E-08		Calculated
SDR =	soil dermal contact rate (kg/day) = (SA _{hands} x M _{hands}) + (SA _{body} x M _{body}) x 1E-6 (kg/mg)							0.000114		Calculated

0.7143

0.2381

0.7143

0.7143

0.2381

0.7143

16.6

890

2500

0.1

0.01

7.60E-10

Site-Specific Target Levels for Human Health (Non-Carcinogenic Substances) - Recreational/Commercial Fisher Consumption of Shellfish Toddler at Marystown Shipyard, Marystown, Newfoundland and Labrador

Site Name: Marystown Shipyard, Marystown, Newfoundland and Labrador

Receptor: Toddler

Exposure Scenario: Recreational/Commercial Fisher

Exposure Pathway: Consumption of Shellfish

SSTL =	TDI x THQ x BW	+ BC
AF_{c}	gut x IR fish x EF1 x EF	2

Compound	TDI	AF _{gut}	ВС	SSTL	EPC
	(mg/kg-d)		(mg/kg)	(mg/kg)	(mg/kg)
Cadmium	0.001	1	4.9	5.9	8.6

<u>Parameter</u>	<u>Definition (units)</u>	Default Value	Reference
TDI =	reference dose (mg/kg bw-day)	chemical specific	Health Canada (2010)
THQ =	target hazard quotient (unitless)	0.2	Health Canada (2012)
AF _{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1.
IR _{fish} =	fish ingestion rate (kg/day)	0.009	Health Canada (2007)
EF1 =	exposure frequency (unitless)	0.71	Site-Specific; based on 2 days per week exposed/7 days
EF2 =	exposure frequency (unitless)	0.50	Site-Specific; based on 26 weeks per year exposed/52 weeks
BW =	body weight (kg)	16.5	Health Canada (2012)
BC =	background concentration (mg/kg)	chemical specific	For cadmium, background concentrations are based on site-specific maximum background shellfish concentrations as indicated in Table 7-5 of the main report.

Site-Specific Target Levels for Human Health (Non-Carcinogenic Substances) - Recreational/Commercial Fisher Consumption of Shellfish Adult at Marystown Shipyard, Marystown, Newfoundland and Labrador

Site Name: Marystown Shipyard, Marystown, Newfoundland and Labrador

Receptor: Adult

Exposure Scenario: Recreational/Commercial Fisher

Exposure Pathway: Consumption of Shellfish

SSTL =	TDI x THQ x BW	+ BC
	AF _{gut} x IR _{fish} x EF1 x EF	2

Compound	TDI	AF _{gut}	ВС	SSTL	EPC
	(mg/kg-d)		(mg/kg)	(mg/kg)	(mg/kg)
Cadmium	0.001	1	4.9	9.3	8.6

<u>Parameter</u>	Definition (units)	Default Value	Reference
TDI =	reference dose (mg/kg bw-day)	chemical specific	Health Canada (2010)
THQ =	target hazard quotient (unitless)	0.2	Health Canada (2012)
AF _{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1.
IR _{fish} =	fish ingestion rate (kg/day)	0.009	Health Canada (2007)
EF1 =	exposure frequency (unitless)	0.71	Site-Specific; based on 2 days per week exposed/7 days
EF2 =	exposure frequency (unitless)	0.50	Site-Specific; based on 26 weeks per year exposed/52 weeks
BW =	body weight (kg)	70.7	Health Canada (2012)
BC =	background concentration (mg/kg)	chemical specific	For cadmium, background concentrations are based on site-specific maximum background shellfish concentrations as indicated in Table 7-5 of the main report.

Site-Specific Target Levels for Human Health (Non-Carcinogenic Substances) - Recreational/Commercial Fisher - Site Specific Consumption of Shellfish Toddler at Marystown Shipyard, Marystown, Newfoundland and Labrac

Site Name: Marystown Shipyard, Marystown, Newfoundland and Labrador

Receptor: Toddler

Exposure Scenario: Recreational/Commercial Fisher - Site Specific

Exposure Pathway: Consumption of Shellfish

SSTL =	TDI x THQ x BW	+ BC
Al	F _{gut} x IR _{fish} x EF1 x EF	-2

Compound	TDI	AF_{gut}	ВС	SSTL	EPC
	(mg/kg-d)		(mg/kg)	(mg/kg)	(mg/kg)
Cadmium	0.001	1	4.9	10.1	8.6

<u>Parameter</u>	Definition (units)	Default Value	Reference
TDI =	reference dose (mg/kg bw-day)	chemical specific	Health Canada (2010)
THQ =	target hazard quotient (unitless)	0.2	Health Canada (2012)
AF _{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1.
IR _{fish} =	fish ingestion rate (kg/day)	0.009	Health Canada (2007)
EF1 =	exposure frequency (unitless)	0.14	Site-Specific; based on 2 days per week exposed/7 days
EF2 =	exposure frequency (unitless)	0.50	Site-Specific; based on 26 weeks per year exposed/52 weeks
BW =	body weight (kg)	16.5	Health Canada (2012)
BC =	background concentration (mg/kg)	chemical specific	For cadmium, background concentrations are based on site-specific maximum background shellfish concentrations as indicated in Table 7-5 of the main report.

TOXICITY PROFILE

Arsenic

Arsenic is a natural, ubiquitous element found in soils and minerals. Arsenic can occur in both organic and inorganic forms in the environment with substantially different toxicological effects. For the purposes of this assessment the total concentrations of arsenic are believed to be in the inorganic form.

Assessment of Carcinogenicity

Exposure to high levels of arsenic has been shown to cause both carcinogenic and non-carcinogenic effects in humans. There is sufficient convincing epidemiological evidences to show that inhalation exposure to inorganic arsenic can increase the risk of developing lung cancer and that the ingestion of inorganic arsenic increases the risk of developing skin cancer, therefore, inorganic arsenic is a known human carcinogen (Environment Canada and Health Canada, 1993; US EPA, 1998; US EPA, 2002). Arsenic is listed as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC, 1987).

Susceptible Populations

No studies were located regarding unusual susceptibility of any human subpopulation to arsenic; however, since the degree of arsenic toxicity may be influenced by the rate and extent of methylation in the liver, it is likely that members of the population with lower than normal methylating capacity might be more susceptible (ATSDR, 2000).

Selection of Toxicity Reference Values

A summary of the reviewed studies, and the rationale for the selection of the TRVs used in the HHRA, is outlined below.

Oral Exposure

Non-Carcinogenic Toxicity Reference Values

Chronic oral exposure to inorganic arsenic in humans has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage (ATSDR, 2000).

The United States Environmental Protection Agency (US EPA IRIS, 1988, last revised 1993) provides an oral RfD for non-carcinogenic effects from inorganic arsenic of 3 x 10⁻⁴ mg/kg-day (last revised 1993). This value is based on the extensive data set of both non-cancerous and carcinogenic health effects of Taiwan residents that were exposed to inorganic arsenic

(predominately as arsenate (As(V)) in their drinking water. Tseng (1977) studied the prevalence of skin cancer and blackfoot disease in 40,421 inhabitants of an area on the Southwest coast of Taiwan where well water with a high concentration of arsenic was used for over 60 years. The rates of blackfoot disease were recorded for three ranges of arsenic concentrations in well water. The low range (<0.3 ppm arsenic) from the Tseng (1977) study was taken as a LOAEL of 0.17 mg/L (converted to 0.014 mg/kg-day) (Tseng et al., 1968; US EPA 1993).

In an earlier study (Tseng et al., 1968), prevalence of hyperpigmentation, keratosis, skin cancer and blackfoot disease were observed. A control population of 7,500 individuals was also examined. In the control population, 4,978 persons used water with non-detectable levels of arsenic and 2,522 persons used water with 0.001 to 0.017 ppm of arsenic. Not a single case of keratosis, hyperpigmentation or skin cancer was observed in these populations. The US EPA (1993) adopted a NOAEL of 0.009 mg/L based on this study (converted to 0.0008 mg/kg-day).

The RfD was developed based on the NOAEL of 0.8 µg/kg-day of arsenic divided by an uncertainty factor of 3. The uncertainty factor of 3 was to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals; therefore, this RfD is appropriate for comparison to exposures averaged over an entire lifetime (US EPA, 2003). The US EPA weights the selected study as medium given the poor characterization of doses, the presence of other contaminants despite the large sample population (1993).

The World Health Organization (WHO, 1998) provide a provisional Tolerable Daily Intake (TDI) for the dietary ingestion of inorganic arsenic of 2.1 μ g/kg-day. The WHO value, however, was developed in the late 1980s and may not be representative of the current knowledge of the health effects related to arsenic exposure.

As arsenic is being assessed on its carcinogenic endpoints via oral exposure, a non-cancer value has not been selected for use in this assessment.

Cancer Oral Toxicity Reference Values

The US EPA (1998) provides an oral cancer SF of 1.5 (mg/kg-day)⁻¹. The slope factor was based on data provided by the US EPA (2002) from increased incidence of skin cancer in Taiwanese populations orally exposed to arsenic in drinking water (Tseng, 1977; Tseng et al., 1968). These studies did not examine rates of internal cancers (e.g., bladder and lung cancer) and are thus considered to underestimate total carcinogenic risks from arsenic. Arsenic is being reassessed under the Integrated Risk Information System (IRIS) program (US EPA, 1998).

Health Canada (2010) recommends a SF of 1.8 (mg/kg-day)⁻¹. The slope factor was based on an epidemiological study of increased incidence of cancers (bladder, liver, and lung) in Taiwanese populations orally exposed to arsenic in drinking water (Morales, 2000). The TRV was based on the upper end of range of mean unit risks.

The US EPA recently lowered its drinking water standard from 50 μ g/L to 10 μ g/L (US EPA 2001a; 2002) because of indications that the total carcinogenic risk from arsenic exposure was previously underestimated. New estimates were based solely on Taiwanese mortality data.

Risks presented by the National Research Council (NRC, 2001) indicate an excess lifetime risk of bladder cancer of $7.1x10^{-5}$ per μ g/L based on Taiwan data and $1.8x10^{-4}$ per μ g/L based on US data (see Table below).

Summary of NRC (2001) reported unit risks

Bladder Cancer Unit Risk (per µg/L)		Lung Cancer	Unit Risk (per µg/L)
US Background	Taiwan	US Background	Taiwan Background Rate
Rate	Background Rate	Rate	
1.7 x10 ⁻⁴	7.1 x 10 ⁻⁵	1.6 x 10 ⁻⁴	5.9 x 10 ⁻⁵

The NRC reviewed the four recent studies conducted since 1999 as cited above and concluded from their review that the risks from arsenic in drinking water are greater than those on which the previous arsenic standard of 50 μ g/L was based as well as the risks that the updated standard of 10 μ g/L is based on.

The Health Canada (2010) SF of 1.8 (mg/kg-day)⁻¹ has been adopted for use in this assessment.

Non-Cancer Inhalation Toxicity Reference Values

Chronic inhalation exposure to inorganic arsenic in humans is associated with irritation of the skin and mucous membranes (dermatitis, conjunctivitis, pharyngitis, and rhinitis) (ATSDR, 2000). The US EPA has not established a RfC for inorganic arsenic (US EPA, 2002).

A non-cancer inhalation TRV has not been selected for this assessment due to the lack of sufficient data and the fact that arsenic is being assessed as a carcinogen.

Cancer Inhalation Toxicity Reference Values

The US EPA has developed a unit risk of 4.3×10^{-3} per $\mu g/m_3$ (last revised April 1998) for carcinogenic risk from inhalation of inorganic arsenic. This is based on unit risk estimates derived for the Anaconda, Montana smelter cohort (3 studies yielding average unit risk of 2.6×10^{-3} per $\mu g/m^3$) and the ASARCO (Tacoma, Washington) smelter cohort (average of two estimates of 7.2×10^{-3} per $\mu g/m^3$) (US EPA, 1993). The midpoint of average unit risk estimated for the two cohorts was adopted by the US EPA for use in developing the unit risk.

Health Canada (2004) made TD₀₅ estimates for inhalation carcinogenic risk for the Anaconda, Tacoma and Ronnskar (Sweden) cohorts of 7.83, 10.2, and 50.5 μg/m³, respectively. These equate to unit risks of 6.4 x10⁻³ per μg/m³, of 4.9 x10⁻³ per μg/m³, and of 0.99 x 10⁻³ per μg/m³ for the Anaconda, Tacoma, and Ronnskar cohorts, respectively. The Health Canada TD₀₅ is based on only the Anaconda smelter data as being the most conservative. Recently, Health Canada

(2010) has recommended an inhalation SF of 2.7 x 10^1 (mg/kg-day)⁻¹. (which equates to an inhalation unit risk of 6.40 x 10^0) based on a TC_{05} of 7.8 μ g/m³ for arsenic and its inorganic compounds (Health Canada, 1996). This value has been adopted for the purposes of this assessment.

Bioavailability

For this HHRA, the relative oral and inhalation bioavailability factor for soil was conservatively assumed to be 1 (Health Canada, 2010); while the relative dermal absorption fraction (RAF) was set as 0.03 (Health Canada, 2010).

Conclusion

The following table presents arsenic TRVs selected for use in this risk assessment.

Table 1 Oral and Inhalation TRVs used in the HHRA

COPC	Toxicity Reference Value	Value ^a	Critical Effect	Reference Type	Source
	Non-carcinogenic TRV		NE		
Arsenic	Carcinogenic Slope Factor – oral	1.8	bladder, lung, liver	GCDWQ	Health Canada, 2010
	Carcinogenic Slope Factor - inhalation	27	lung cancer	PSL1	Health Canada, 2010

^a Units: Carcinogenic COPC (mg/kg/day⁻¹) , NE – Not Evaluated

References

ATSDR (Agency for Toxic Substances and Disease Registry), 2000. Toxicological Profile for Arsenic. September 2000.

Dutkiewicz T, 1977. Experimental studies on arsenic absorption routes in rats. Environmental Health Perspectives 19:173-177.

Environment Canada and Health Canada, 1993. Priority substances list assessment report, Arsenic and its compounds. Canadian Environmental Protection Act. Government of Canada, Ottawa, Ontario.

Health Canada. 2004. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). September, 2004.

Health Canada. 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs). May 2009.

Health Canada. 1996. Health based Tolerable daily intakes/concentrations and tumorigenic doses/concentrations for priority substances. Minister of Supply and Services Canada, Ottawa.

Hrudey SE, Chen W and Rousseaux CG. 1996. Bioavailability in Environmental Risk Assessment. CRC Press, Lewis Publishers, Boca Raton.

IARC (International Agency for Research on Cancer), 2004. Volume 87: Inorganic and organic lead compounds 10–17 February 2004.

Morales, K.H., Ryan, L., Kuo, T.L., Wu, M.M., and Chen, C.J. 2000. Risk of internal cancers from arsenic in drinking water. Environ. Health Perspect., 108: 655–661.

NRC (National Research Council). 2001. Arsenic in Drinking Water: 2001 Update. Committee on Toxicology, National Academy Press, Washington, D.C.

Tseng WP. 1977. Effects and dose-response relationships of skin cancer and Blackfoot disease with arsenic. Environmental Health Perspectives. 19:109-119.

Tseng WP, Chu HM, How SW, Fong JM, Lin CS and Yeh S. 1968. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. J. Natl. Cancer Inst. 40: 453-463.

US EPA (United States Environmental Protection Agency). 2003. Integrated Risk Information System (IRIS) Glossary. Revised September 2003. Available http://www.epa.gov/iris/ gloss8.htm

US EPA (United States Environmental Protection Agency). 2002. Implementation Guidance for the Arsenic Rule, Drinking Water Regulations for Arsenic and Clarification to Compliance and New Source Contaminants Monitoring. August 2002. United States Environmental Protection Agency.

US EPA. 2001a. "To Implement 10ppb Standard for Arsenic in Drinking Water." EPA 815-F-01-010, October. http://www.epa. gov/safewater/ars/ars-oct-factsheet.html. United States Environmental Protection Agency.

US EPA. 2001b. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Office of Emergency and Remedial Response, EPA/540/R/99/005, Interim, Review Draft, September. United States Environmental Protection Agency.

US EPA. 1998. Integrated Risk Information System (IRIS) Database: Arsenic, inorganic (Carcinogenicity Assessment). Last revised 04/10/1998. Available on-line at: http://www.epa.gov/iris/.

US EPA Region III. 1995. Preliminary Remediation Goals Database.

US EPA. 1988. Integrated Risk Information System (IRIS) Database: Arsenic, inorganic (Oral RfD Assessment). Last revised 02/01/1993. Available on-line at: http://www.epa.gov/iris/

Wester RC, Maibach HI, Sedik L, Melendres J, and Wade M. 1993. In vivo and in vitro percutaneous absorption and skin decontamination of arsenic from water and soil. Fundamental and Applied Toxicology 20: 336-340.

WHO (World Health Organization). 1998. Guidelines for drinking-water quality, 2nd edition. Addendum to Volume 2 Health Criteria and Other Supporting Information. Geneva.

TOXICITY PROFILE

Antimony

In humans and animals, the gastrointestinal tract appears to be the primary target for acute and long term oral exposure to antimony. Effects include vomiting and diarrhea. Oral exposure to antimony also may adversely affect the cardiovascular system, blood (for example, increased serum cholesterol levels and decreased glucose levels), and liver. The respiratory tract is the primary target for toxicity of inhaled antimony following acute, sub-chronic, and chronic exposures. Both human and animal data have demonstrated various forms of restrictive airway diseases including: bronchitis pneumoconiosis, emphysema, pulmonary edema, and varying degrees of irritation and inflammation. Inhalation exposure to antimony also may adversely affect the cardiovascular system, kidneys, and reproductive tract. Developmental toxicity is suggested by animal data showing that prenatal and postnatal exposure to antimony may affect cardiovascular functions (ATSDR, 1992).

Assessment of Carcinogenicity

Animal studies show that there is no evidence of carcinogenicity following oral, dermal or inhalation exposure to antimony.

Susceptible Populations

An increased incidence of spontaneous abortions, compared to a control group, were reported in women working at an antimony metallurgical plant. The women were exposed to a mixture of antimony trioxide, antimony pentasulphide, and metallic antimony. Women also reported disturbances in their menstrual cycles when exposed to the same antimony compounds (ATSDR, 1992).

Selection of Toxicity Reference Values

A summary of the reviewed studies, and the rationale for the selection of the TRVs used in the HHRA, is outlined below.

Oral Exposure

Non-Carcinogenic Toxicity Reference Values

The US EPA (2013) derived a tolerable daily intake (TDI) for antimony of 0.0004 mg/kg-day based on the Schroeder, et al., (1970) study as presented in the Integrated Risk Information System (IRIS) database. An experimental group of 50 male and 50 female rats was administered 5 parts per million (ppm) potassium antimony tartrate in water. Over the period of study, growth rates of treated animals were not affected, but male rats survived 106 and females 107 fewer days than did controls at median life spans. Because there was only one level of antimony administered, a NOEL was not established in

this study. Although not precisely stated, the concentration of 5-ppm antimony was expressed as an exposure of 0.35 mg/kg/day.

A UF of 1,000 was applied to the value, 10 for interspecies conversion, 10 to protect sensitive individuals, and 10 because the effect level was a LOAEL of 0.35 mg/kg/day and no NOEL was established.

The US EPA IRIS value of 0.0004 mg/kg-day was used as the exposure limit in this assessment.

Cancer Oral Toxicity Reference Values

The lack of suitable positive carcinogenic data precludes the derivation of an oral slope factor for antimony.

Inhalation Exposure

Non-Carcinogenic Toxicity Reference Values

The derived inhalation tolerable daily intake (TDI) for cobalt of 0.000057 mg/kg-day is based on the OMOE TRV of 0.0002 mg/m³, an inhalation rate of 20 m³/day and a body weight of 70 kg. The OMOE TRV is based on a benchmark concentration of 0.074 mg/m³ for pulmonary toxicity in rats for antimony trioxide converted to human equivalent concentration using benchmark dose modeling as presented by USEPA (1995).

A UF of 300 was applied to the value, 10 for human variability, 10 for extrapolation from sub-chronic to chronic, and 3 for database inadequacies.

Cancer Inhalation Toxicity Reference Values

The lack of suitable positive carcinogenic data precludes the derivation of an inhalation slope factor for cobalt.

Bioavailability

For this HHRA, the relative oral and inhalation bioavailability factor for soil was conservatively assumed to be 1 (Health Canada, 2010); while the relative dermal absorption fraction (RAF) was set as 0.1 (OMOE, 2011).

Conclusion

The following table presents antimony TRVs selected for use in this risk assessment.

Table 1 Oral and Inhalation TRVs used in the HHRA

COPC	Toxicity Reference Value	Value ^a	Critical Effect	Reference Type	Source
	Non-carcinogenic TRV	0.0004	Longevity, blood glucose, and cholesterol	RfD	IRIS, 1991
Antimony	Non-carcinogenic TRV - inhalation	0.000057	Pulmonary toxicity, chronic interstitial inflammation	RfC	OMOE, 2011
	Carcinogenic Slope Factor		NE		

^a Units: Non-carcinogenic COPC (mg/kg/day) , NE – Not Evaluated

References

- ATSDR (Agency for Toxic Substances and Disease Registry), 1992. Toxicological profile for antimony. U.S. Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department Of Health And Human Services, Washington, DC.
- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0.
- IRIS, 1991. Integrated Risk Information System (IRIS), Antimony (CASRN 7440-36-0), February 1991.
- OMOE, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15.
- Schroeder, H.A., M. Mitchner and A.P. Nasor. 1970. Zirconium, niobium, antimony, vanadium and lead in rats: Life term studies. J. Nutrition. 100: 59-66.
- US EPA (United States Environmental Protection Agency), 2013. Integrated Risk Information System (IRIS) Database. Available on-line at: http://www.epa.gov/iris.

TOXICITY PROFILE

Cobalt

Effects in humans following acute inhalation, oral and dermal exposures to cobalt have been reported. Occupational exposure of humans to cobalt has reported primarily respiratory effects, including decreased pulmonary function, asthma, interstitial lung disease, wheezing, and dyspnea. Animal studies have further identified respiratory tract hyperplasia, pulmonary fibrosis, and emphysema as sensitive effects of inhaled cobalt. Humans in the workplace have been shown to develop sensitivity to cobalt following inhalation exposures. Exposure to inhaled cobalt aerosols resulted in asthmatic attacks in sensitized individuals. This has been reported to be an allergic reaction within the lungs (ATSDR, 2004).

The most sensitive endpoint following oral exposure appears to be an increase in erythrocyte (polycythemia), hematocrit, and hemoglobin levels in both humans and animals. Following dermal exposure, the most commonly observed effect is dermatitis. Using patch test studies, it has been demonstrated that the dermatitis is most likely caused by an allergic reaction to cobalt with cobalt functioning as a hapten (ATSDR, 2004)

Lethal cardiomyopathy in humans was reported following repeated inhalation of airborne cobalt or ingestion of beer that contained cobalt. Occupational exposure to airborne cobalt is characterized by functional effects on the ventricles and enlargement of the heart, resulting in cardiomyopathy. Exposure of humans to beer containing cobalt as a foam stabilizer resulted in severe effects of the cardiovascular system, including cardiomyopathy and death. As well, gastrointestinal effects including nausea and vomiting and hepatic necrosis were reported (ATSDR, 2004).

Assessment of Carcinogenicity

Available studies of the carcinogenic effects of cobalt in workers have reported both positive and negative results. Lifetime occupational inhalation studies of cobalt reported increases in lung cancer mortality. As well, animal studies have reported increase in alveolar/bronchiolar neoplasms, with lung tumors occurring with significantly positive trends. USEPA does not report a cancer classification for cobalt (ATSDR, 2004).

Susceptible Populations

Pregnant women treated with cobalt for hematocrit and hemoglobin levels reported no observable effects to the fetuses. However, animal studies reported stunted fetuses, decrease in the number of litters and average litter weights, and increased mortality (ATSDR, 2004). Following inhalation and oral exposure of male rats to cobalt, adverse effects on the testes were observed (degeneration, atrophy, and decreased weight). An increase in the length of the estrous cycle was also reported in female mice following inhalation exposure (ATSDR, 2004).

Selection of Toxicity Reference Values

A summary of the reviewed studies, and the rationale for the selection of the TRVs used in the HHRA, is outlined below.

Oral Exposure

Non-Carcinogenic Toxicity Reference Values

The OMOE (2011) derived an oral tolerable daily intake (TDI) of 0.001 mg/kg-day based on the Davis and Fields (1958) study as presented in the ATSDR (2004) profile for cobalt. Six apparently normal men, ages 20–47, were administered a daily dose of cobalt chloride, administered as a 2% solution diluted in either water or milk, for up to 22 days. Five of the six received 150 mg cobalt chloride per day for the entire exposure period, while the sixth was started on 120 mg/day and later increased to 150 mg/day. Blood samples were obtained daily from free-flowing punctures of fingertips at least 2 hours after eating, and at least 15 hours after the last dosage of cobalt. Blood was analyzed for red blood cell counts, hemoglobin percentage, leukocyte counts, reticulocyte percentages, and thrombocyte counts. Exposure to cobalt resulted in the development of polycythemia in all six subjects. Davis and Fields (1958) identified a LOAEL of 150 mg cobalt chloride per day for increased levels of erythrocytes in volunteers. The dose of 150 mg cobalt chloride/day corresponds to ~1 mg Co/kg/day, assuming a reference body weight of 70 kg.

A UF of 1,000 was applied to the value, 10 for human variability, 10 because the effect level was a LOAEL of 1 mg/kg-day, and 10 for OMOE modification.

The OMOE value of 0.001 mg/kg-day was used as the exposure limit in this assessment.

Cancer Oral Toxicity Reference Values

The lack of suitable positive carcinogenic data precludes the derivation of an oral slope factor for cobalt.

Inhalation Exposure

Non-Carcinogenic Toxicity Reference Values

The derived inhalation tolerable daily intake (TDI) for cobalt of 0.00014 mg/kg-day is based on the OMOE TRV of 0.0005 mg/m³, an inhalation rate of 20 m³/day and a body weight of 70 kg. The OMOE TRV is based on a LOAEL of 0.05 mg/m³ for interstitial lung disease in humans as presented by RIVM (2001).

A UF of 100 was applied to the value, 10 for human variability and 10 for the extrapolation from a LOAEL to a NOAEL.

The OMOE value of 0.0001 mg/kg-day was used as the exposure limit in this assessment.

Cancer Inhalation Toxicity Reference Values

The lack of suitable positive carcinogenic data precludes the derivation of an inhalation slope factor for cobalt.

Bioavailability

For this HHRA, the relative oral and inhalation bioavailability factor for soil was conservatively assumed to be 1; while the relative dermal absorption fraction (RAF) was set as 0.01 (OMOE, 2011). For this HHRA, the relative oral bioavailability factor for fish was conservatively assumed to be 1 (Health Canada, 2010).

Conclusion

The following table presents cobalt TRVs selected for use in this risk assessment.

Table 1 Oral and Inhalation TRVs used in the HHRA

COPC	Toxicity Reference Value	Value ^a	Critical Effect	Reference Type	Source
	Non-carcinogenic TRV – oral	0.001	polycythemia	RfD	OMOE, 2011
Cobalt	Non-carcinogenic TRV - inhalation	0.00014	interstitial lung disease	RfC	OMOE, 2011
	Carcinogenic Slope Factor		NE		

^a Units: Non-carcinogenic COPC (mg/kg/day), NE – Not Evaluated

References

- ATSDR (Agency for Toxic Substances and Disease Registry), 2004. Toxicological profile for cobalt. U.S. Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department Of Health And Human Services, Washington, DC.
- OMOE, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario, April 15.
- RIVM, 2001. Re-evaluation of Human-Toxicological Maximum Permissible Risk Levels, RIVM Report 711701 025, March.

TOXICITY PROFILE

Lead

Lead is a naturally occurring element found in the earth's crust. While most of the lead found in the environment is the result of anthropogenic activities, there are significant natural sources as well, including volcanoes, forest fires, sea spray, and weathering of lead-containing minerals (Environment Canada, 1996). The different forms of lead found in the environment are governed by factors such as temperature, pH, and the presence of humic materials. Elemental lead occurs rarely in the ambient environment. The most common form of lead in the environment is Pb2+. Particulate-bound lead emitted from mining operations, smelters, and combustion sources occurs primarily in the form of lead-sulphur compounds such as PbSO₄, PbO·PbSO₄, and PbS (US EPA, 1986). In the ambient atmosphere, lead exists primarily in the form of particulate-bound PbSO₄ and PbCO₃, and is deposited onto soil and water surfaces in this form (ATSDR, 2007a).

The toxic effects of lead in humans are widely believed to be the same regardless of the route of entry, and are correlated to blood lead (PbB) in the vast majority of studies (ATSDR, 2007b). The effects from chronic exposure to lead in humans and experimental animals are primarily neurological, renal, hematological, reproductive, and developmental (ATSDR, 2007b). Well characterized human health effects include neurotoxicity and renal toxicity, which can be severe at blood lead levels greater than 120 µg/dL (US EPA, 1986). Severe lead exposure in children (PbB above 380 µg/dL) can cause coma, convulsions, and even death.

The most commonly reported and well-studied effects of environmental lead exposure are (1) adverse effects on neurological function and neurobehavioural development in children, and (2) reduced growth rate. However, it remains unclear if lead causes such effects in adults (US EPA, 2004). The effects in children often manifest as decreased IQ and memory, decreased gestation period, and retarded growth rate.

Assessment of Carcinogenicity

Epidemiological studies of occupationally exposed adults were not able to demonstrate an increase in cancers among an exposed population compared to a control group. The US EPA (2004) lists lead as a Group 2B, probable human carcinogen, based on sufficient animal evidence but did not recommend derivation of a quantitative estimate of oral carcinogenic risk due to a lack of understanding of the toxicological and pharmacokinetic characteristics of lead.

Health Canada (1992) classified lead as Group IIIB – possibly carcinogenic to humans (inadequate data in humans, limited evidence in animals) according to the classification scheme of the Environmental Health Directorate of Health and Welfare Canada (CCME, 1999). Chemicals classified in Group IIIB are treated as non-carcinogens and are evaluated against a tolerable daily intake (TDI), based on a no observed adverse effects level (NOAEL).

The International Agency for Research on Cancer (IARC) (2006) lists lead and inorganic lead compounds as Group 2A, probably carcinogenic to humans. IARC states that there is limited evidence for the carcinogenicity of inorganic lead compounds in humans.

For this assessment, lead was not assessed as a carcinogen.

Susceptible Populations

There is a very large database that documents the effects of acute and chronic lead exposure in adults and children. Extensive summaries of the human health effects of lead are available from a number of sources including ATSDR, 2007b. These reviews show that infants, young children up to the age of six, and developing fetuses in pregnant women are the most susceptible.

Selection of Toxicity Reference Values

A summary of the reviewed studies, and the rationale for the selection of the TRVs used in the HHRA, is outlined below.

Oral Exposure

Non-Carcinogenic Toxicity Reference Values

The 2007 DFO SSC for lead was developed based on a Provisional Tolerable Weekly Intake (PTWI) of 25 μ g/kg bw published by the World Health Organization (WHO, 1987). Based on the WHO report, Health Canada published a Tolerable Daily Intake (TDI) for lead of 3.6 μ g/kg bw – day and this value was adopted in the derivation of the 2007 DFO SSC. The WHO rescinded their PTWI (WHO, 2011) because they concluded that the PTWI could no longer be considered health protective. In turn, Health Canada withdrew their TDI (3.6 μ g/kg bw - day). In December 2009, the Contaminated Sites Division (CSD) of Health Canada published interim guidance on a TRV for lead (Health Canada, 2009) which indicated that until their toxicological review of lead was completed, the Ontario Ministry of the Environment (OMOE, 1994) Intake of Concern (IOC; 1.85 μ g/kg bw - day) should be adopted as the TRV for lead, for application in risk assessments at federal contaminated sites. This remains the last guidance published by Health Canada that provides a TRV for lead however it is understood that the Health Canada review is on-going at the time of writing this report.

In the absence of published Health Canada guidance, Amec Foster Wheeler, in collaboration with Dillon Consulting Limited and Stantec Consulting Ltd., has reviewed the recent scientific literature and regulatory guidance and proposed an interim TRV for lead for use in deriving the lead SSC for use at DFO sites in Maritimes and Gulf Region.

Based on the current state of the regulatory guidance published at the time of writing this report, we recommend adopting an interim risk specific dose (RSD) for lead of 1.1 μ g/kg-day for all age groups, based on the analysis and discussion presented in Attachment A (i.e., a RSD of 1.1 μ g/kg-day was derived for both a toddler and an adult receptor and is considered protective of all other human age classes as well). This approach provides a protective and scientifically sound basis for HHRA of lead at

DFO sites in Maritimes and Gulf Region until the draft Health Canada/CCME scientific criteria document has completed public review and is published, or Health Canada releases other guidance or decisions on a lead TRV for use in HHRAs.

While the final form of Health Canada lead guidance is unknown at this time, a preliminary review of the draft CCME scientific criteria document suggests that changes regarding the human health risk assessment of lead may be significant as compared to current CCME guidance. However, the interim lead TRV presented herein is based on a review of current science and the re-assessment being conducted by Health Canada will be based on the same science. Therefore, to the extent possible, we believe that the revised lead SSCs will not be significantly altered by future Health Canada lead guidance. Nevertheless, it is recommended that the DFO SSC for lead be reviewed again after the final Health Canada documentation is published.

Cancer Oral Toxicity Reference Values

The lack of suitable positive carcinogenic data precludes the derivation of an oral slope factor for lead.

Bioavailability

For this HHRA, the relative oral bioavailability factor for soil was conservatively assumed to be 0.6 (USEPA, 2007); while the relative dermal absorption fraction (RAF) was set as 0.006 (Health Canada, 2008). For this HHRA, the relative oral bioavailability factor for fish was conservatively assumed to be 1 (Health Canada, 2010).

Conclusion

The following table presents lead TRVs selected for use in this risk assessment. Note that the oral TRV of 0.001 mg/kg/day was also applied as the inhalation TRV.

Table 1 Oral TRVs used in the HHRA

СОРС	Toxicity Reference Value	Value ^a	Critical Effect	Reference Type	Source
Lead	Non-carcinogenic TRV	0.0011	Behavioural effects and learning disabilities in children	RSD	AFWEI, 2015
	Carcinogenic Slope Factor	NE			

^a Units: Non-carcinogenic COPC (mg/kg/day), NE – Not Evaluated

References

- Amec Foster Wheeler Environment & Infrastructure (AFWEI). 2015. Fisheries and Oceans Canada, Maritimes and Gulf Region, Surface Soil Criteria, Version 2, March 23, 2015.
- ATSDR (Agency for Toxic Substances and Disease Registry). 2007a. ToxFAQs for Lead. August 2007.
- ATSDR (Agency for Toxic Substances and Disease Registry), 2007b. Toxicological profile for lead. U.S. Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department Of Health And Human Services, Washington, DC.
- CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Lead (1999). In: Canadian Environmental Quality Guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.
- Health Canada, 1992. Guidelines for Canadian Drinking Water Quality Technical Documents: Lead.
- Health Canada. 2008. Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health Preliminary Quantitative Risk Assessment (PQRA), version October 31, 2008.
- Health Canada. 2009. Interim CSD Guidance on a TRV for Lead (Pb) and Interpretation of Pb Bioaccessibility Data for Federal Contaminated Site Human Health Risk Assessment in Canada.
- IARC (International Agency for Research on Cancer), 2006. Inorganic and organic lead compounds. International Agency for Research on Cancer IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Vol. 87.
- Ontario Ministry of the Environment (OMOE). 1994. Ontario Ministry of the Environment Rationale for the Development of Soil, Drinking Water and Air Quality Criteria for Lead. Queen's Printer for Ontario, December, 1994.
- US EPA (United States Environmental Protection Agency), 2004. Integrated Risk Information System (IRIS) Database. Lead and compounds (inorganic). Available on-line at: http://www.epa.gov/iris.
- USEPA. 2007. Estimation of Relative Bioavailability of Lead in Soil and Soil-Like Materials Using In Vivo and In Vitro Methods. Office of Solid Waste and Emergency Response 9285.7-77.
- WHO. 1987. Lead (Evaluation of Health Risks to Infants and Children). WHO Food Additive Series 21. Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) Joint Expert Committee on Food Additives (JECFA). Geneva, Switzerland.
- WHO. 2011. Safety Evaluation of Certain Food Additives and Contaminants. WHO Food Additive Series 64. Prepared by the 73rd Meeting of the Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) Joint Expert Committee on Food Additivies (JECFA). Geneva, Switzerland.

Appendix F ERA Supporting Information

Concentration Concentratio		
Fraction Organic Carbon 0.019 0.062 0.057 0.057 0.057 0.049 -Methylnaphthalene mg/kg 0.025 1.32 3.0E-03 0.06 0.97 2.2E-03 0.2 3.51 7.9E-03 0.05 0.88 2.0E-03 0.27 5.5		
1-Methylnaphthalene mg/kg 0.025 1.32 3.0E-03 0.06 0.97 2.2E-03 0.2 3.51 7.9E-03 0.05 0.88 2.0E-03 0.27 5.5 2-Methylnaphthalene mg/kg 0.05 2.63 5.9E-03 0.07 1.13 2.5E-03 0.24 4.21 9.4E-03 0.06 1.05 2.4E-03 0.38 7.7 Acenaphthene mg/kg 0.122 6.42 1.3E-02 0.146 2.35 4.8E-03 0.279 4.89 1.0E-02 0.168 2.95 6.0E-03 0.728 14.4 Acenaphthylnene mg/kg 0.039 2.05 4.5E-03 0.002 0.03 7.1E-05 0.045 0.79 1.7E-03 0.043 0.75 1.7E-03 0.076 1.5. Anthracene mg/kg 0.19 10.00 1.7E-02 0.22 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 2.0 Benzo(a)anthracene mg/kg 0.36 18.95 2.3E-02 0.42 6.77 8.1E-03 0.58 10.18 1.2E-02 0.43 7.54 9.0E-03 1.55 31.1 Benzo(a)pyrene mg/kg 0.36 18.95 1.9E-02 0.42 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 7.9E-03 0.41 7.19 7.3E-03 1.23 25. Benzo(b)fluoranthene mg/kg 0.03 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.29 5.09 4.6E-03 0.93 1.8 Benzo(b)fluoranthene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17.3 Benzo(b)fluoranthene mg/kg 0.01 1.0D 0.0 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14.4 Benzo(b)fluoranthene mg/kg 0.01 1.0D 0.0 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14.4 Benzo(b)fluoranthene mg/kg 0.01 1.0D 0.0 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14.4 Benzo(b)fluoranthene mg/kg 0.00 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 4.7E-05 0.003 0.05 1.70 3.4 Dibenz(a,h)anthracene mg/kg 0.00 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 0.06 0.06 0.06 1.20 0.005 0.06 0.06 0.005 0.06 0.005 0.06 0.005 0.005 0.005 0.005 0.005 0.005 0.005 0.005		
2-Methylmaphthalene mg/kg 0.05 2.63 5.9E-03 0.07 1.13 2.5E-03 0.24 4.21 9.4E-03 0.06 1.05 2.4E-03 0.38 7.7 Acenaphthylene mg/kg 0.122 6.42 1.3E-02 0.146 2.35 4.8E-03 0.279 4.89 1.0E-02 0.168 2.95 6.0E-03 0.728 14.4 Acenaphthylene mg/kg 0.039 2.05 4.5E-03 0.002 0.03 7.1E-05 0.045 0.79 1.7E-03 0.043 0.75 1.7E-03 0.076 1.5E Anthracene mg/kg 0.19 10.00 1.7E-02 0.22 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20.0 Benzo(a)anthracene mg/kg 0.36 18.95 2.3E-02 0.42 6.77 8.1E-03 0.58 10.18 1.2E-02 0.43 7.54 9.0E-03 1.55 31.1 Benzo(a)pyrene mg/kg 0.37 19.47 2.0E-02 0.42 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.3 1.5F9 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.22 5.09 4.6E-03 0.28 1.8E-03 0.38 18.8E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20.0 Benzo(b)fluoranthene mg/kg 0.3 1.5F9 1.6E-02 0.32 5.16 5.3E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17.3 Benzo(b)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14.4 Benzo(b)fluoranthene mg/kg 0.47 2.474 2.9E-02 0.51 8.23 9.7E-03 0.35 6.14 5.5E-03 0.23 4.04 4.1E-03 0.73 14.4 Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.05 0.26 6.8E-04 0.09 0.07 0.46 4.2E-03 0.55 0.00 0.00 0.00 0.00 0.00 0.00 0.		
Acenaphthene mg/kg 0.122 6.42 1.3E-02 0.146 2.35 4.8E-03 0.279 4.89 1.0E-02 0.168 2.95 6.0E-03 0.728 14. Acenaphthylene mg/kg 0.039 2.05 4.5E-03 0.002 0.03 7.1E-05 0.045 0.79 1.7E-03 0.043 0.75 1.7E-03 0.076 1.5E Anthracene mg/kg 0.19 10.00 1.7E-02 0.22 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20. Benzo(a)anthracene mg/kg 0.36 18.95 2.3E-02 0.42 6.77 8.1E-03 0.58 10.18 1.2E-02 0.43 7.54 9.0E-03 1.55 31. Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.23 25. Benzo(e)pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.93 18. Benzo(g),h)perylene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.72 14. Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.5E-03 0.72 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 0.72 1.10 1.00 1.0E-02 0.21 3.39 3.5E-03 0.35 6.14 6.8E-03 0.22 4.4E-03 0.72 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.99 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluoranthene mg/kg 0.05 0.26 6.8E-04 0.09 0.17 2.74 5.1E-03 0.31 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	1.2E-0	
Acenaphthylene mg/kg 0.039 2.05 4.5E-03 0.002 0.03 7.1E-05 0.045 0.79 1.7E-03 0.043 0.75 1.7E-03 0.076 1.5E Anthracene mg/kg 0.19 10.00 1.7E-02 0.22 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20.0E-02 0.32 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20.0E-02 0.32 5.6E-03 0.32 1.1E-02 0.43 7.54 9.0E-03 1.55 31.0E-02 0.49 4.0E-03 0.37 19.47 2.0E-02 0.42 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27.0E-02 0.49 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27.0E-02 0.49 6.79 1.0E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.23 25.0E-02 0.9Pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.33 18.0E-03 0.32 5.61 5.8E-03 0.32 5.09 4.6E-03 0.29 5.09 4.6E-03 0.86 17.0E-02 0.2E 0.2E-04 0.2E 4.4E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.72 14.0E-02 0.2E 0.2E-02 0.2E 0.2E 0.2E 0.2E 0.2E 0.2E 0.2E 0.	1.7E-0	
Anthracene mg/kg 0.19 10.00 1.7E-02 0.22 3.55 6.0E-03 0.31 5.44 9.2E-03 0.24 4.21 7.1E-03 1.01 20.0 Benzo(a)anthracene mg/kg 0.36 18.95 2.3E-02 0.42 6.77 8.1E-03 0.58 10.18 1.2E-02 0.43 7.54 9.0E-03 1.55 31.1 Benzo(a)pyrene mg/kg 0.37 19.47 2.0E-02 0.42 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.23 25. Benzo(a)pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.93 18. Benzo(g)pyrene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17. Benzo(f)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14. Benzo(f)fluoranthene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 7.89 1.6E-03 0.92 Benzo(b)fluoranthene mg/kg 0.003 0.00 0.0E+00 0.003 0.05 4.3E-03 0.03 0.05 4.7E-05 0.003 0	3.0E-0	
Benzo(a)anthracene mg/kg 0.36 18.95 2.3E-02 0.42 6.77 8.1E-03 0.58 10.18 1.2E-02 0.43 7.54 9.0E-03 1.55 31.18	3.4E-0	
Benzo(a)pyrene mg/kg 0.37 19.47 2.0E-02 0.42 6.77 7.0E-03 0.6 10.53 1.1E-02 0.44 7.72 8.0E-03 1.34 27. Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.23 25. Benzo(e)pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.93 18. Benzo(g,h,i)perylene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17. Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14. Benzo(jilluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.005 0.26 6.8E-04 0.09 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 2.2E-04 0.62 12. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	3.5E-0	
Benzo(b)fluoranthene mg/kg 0.36 18.95 1.9E-02 0.39 6.29 6.4E-03 0.55 9.65 9.9E-03 0.41 7.19 7.3E-03 1.23 25. Benzo(e)pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.93 18. Benzo(g,h,i)perylene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17. Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14. Benzo(j)fluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-03 0.05 4.7E-05 0.003 0.05 4.7E-06 0.09 1.0E-02 0.29 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.67 6.0E-03 1.09 2.2E-04 0.62 12. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	3.8E-02	
Benzo(e)pyrene mg/kg 0.3 15.79 1.6E-02 0.32 5.16 5.3E-03 0.42 7.37 7.6E-03 0.32 5.61 5.8E-03 0.93 18. Benzo(g,h,i)perylene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17. Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14. Benzo(j)fluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.05 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	2.8E-02	
Benzo(k)fluoranthene mg/kg 0.005 0.26 2.4E-04 0.28 4.52 4.1E-03 0.41 7.19 6.6E-03 0.29 5.09 4.6E-03 0.86 17: Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14: Benzo(j)fluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14: Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34: Dibenz(a,h)anthracene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73: Fluorene mg/kg 0.15 7.89 1.5E-02 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.2E-03 0.94 19: Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12: Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12:	2.6E-0	
Benzo(k)fluoranthene mg/kg 0.19 10.00 1.0E-02 0.23 3.71 3.8E-03 0.31 5.44 5.5E-03 0.26 4.56 4.6E-03 0.72 14. Benzo(j)fluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14. Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.003 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 4.7E-05 0.003 0.05 Fluoranthene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.15 7.89 1.5E-02 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.2E-03 0.94 19. Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	2.0E-02	
Benzo(j/fluoranthene mg/kg 0.21 11.05 1.1E-02 0.21 3.39 3.5E-03 0.35 6.14 6.3E-03 0.23 4.04 4.1E-03 0.73 14.05 (Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34.05 (Chrysene mg/kg 0.003 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 0.05 0.05 0.05 0.05 0.003 0.003 0.05 0.003 0.05 0.003 0.05 0.003 0.003 0.0	1.6E-02	
Chrysene mg/kg 0.47 24.74 2.9E-02 0.51 8.23 9.7E-03 0.67 11.75 1.4E-02 0.53 9.30 1.1E-02 1.7 34. Dibenz(a,h)anthracene mg/kg 0.003 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 4.7E-05 0.003 0.05 4.7E-05 0.003 0.05 Fluoranthene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.15 7.89 1.5E-02 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.2E-03 0.94 19. Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	1.5E-02	
Dibenz(a,h)anthracene mg/kg 0.003 0.00 0.0E+00 0.003 0.05 4.3E-05 0.003 0.05 4.7E-05 0.003 0.05 0.05 0.05 0.05 0.05 0.09 0.17 0.17 0.17 0.17 0.17 0.17 0.17 0.17	1.5E-02	
Fluoranthene mg/kg 0.92 48.42 6.8E-02 0.99 0.17 2.4E-04 1.59 27.89 3.9E-02 1.16 20.35 2.9E-02 3.62 73. Fluorene mg/kg 0.15 7.89 1.5E-02 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.2E-03 0.94 19. Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	4.1E-02	
Fluorene mg/kg 0.15 7.89 1.5E-02 0.17 2.74 5.1E-03 0.32 5.61 1.0E-02 0.19 3.33 6.2E-03 0.94 19. Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22. Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.	5.5E-0	
Indeno(1,2,3-cd)pyrene mg/kg 0.005 0.26 2.4E-04 0.29 4.68 4.2E-03 0.51 8.95 8.0E-03 0.38 6.67 6.0E-03 1.09 22 Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12	1.0E-0	
Naphthalene mg/kg 0.005 0.26 6.8E-04 0.005 0.08 2.1E-04 0.32 5.61 1.5E-02 0.005 0.09 2.3E-04 0.62 12.005	3.6E-0	
	2.0E-0	
Persions mailing 0.005 1.20 1.4E-02 0.44 1.77 1.9E-02 0.45 2.62 2.7E-02 0.40 2.44 2.2E-02 0.20 0.20	3.3E-0	
Perylene mg/kg 0.025 1.32 1.4E-03 0.11 1.77 1.8E-03 0.15 2.63 2.7E-03 0.12 2.11 2.2E-03 0.33 6.7	7.0E-0	
Phenanthrene mg/kg 0.91 47.89 8.0E-02 0.94 15.16 2.5E-02 1.67 29.30 4.9E-02 1.12 19.65 3.3E-02 4.05 82.10 (2.5E-02)	1.4E-0	
Pyrene mg/kg 0.87 45.79 6.6E-02 0.8 12.90 1.9E-02 1.19 20.88 3.0E-02 0.9 15.79 2.3E-02 2.61 53.	7.6E-02	
Total PAH Concentration (not normalized) 5.579 6.586 10.717 7.349 24.787		
Sum ESBTU* 4.0E-01 1.2E-01 2.7E-01 1.7E-01 7.1E-01		
Uncertainty Factor (95 percentile) 4.14 4.14 4.14 4.14 4.14 4.14	4.14	
Sum ESBTU with Uncertainty Factor* 1.7 0.49 1.1 0.71 2.9		

Notes:

ESBTU - Equilibrium Partitioning Sediment Benchmark Toxic Unit for PAH based on the Final Chronic Value. COC, PAH FCV - Effect Concentration of a PAH in sediment on an organic carbon basis.

^{* -} Summed ESBTU below 1 represents a low risk to sensitive benthic invertebrates.

^{* -} Summed ESBTU below 3 represents a low risk to common benthic invertebrates.

Constituent Units		1	18-MNMA-S6		Fie	18-MNMA-DUP1 Field Duplicate 18-MNMA-S6		1	8-MNMA-S7		1	8-MNMA-S8		1	8-MNMA-S9	
Constituent	Units	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU
Total organic Carbon	g/kg		80			83			113			106			88	
Fraction Organic Carbon			0.08			0.083			0.113			0.106			0.088	
1-Methylnaphthalene	mg/kg	0.06	0.75	1.7E-03	0.025	0.30	6.8E-04	0.025	0.22	5.0E-04	0.025	0.24	5.3E-04	0.2	2.27	5.10E-03
2-Methylnaphthalene	mg/kg	0.07	0.88	2.0E-03	0.03	0.36	8.1E-04	0.005	0.04	9.9E-05	0.04	0.38	8.4E-04	0.2	2.27	5.08E-03
Acenaphthene	mg/kg	0.179	2.24	4.6E-03	0.101	1.22	2.5E-03	0.003355	0.03	6.0E-05	0.0831	0.78	1.6E-03	0.226	2.57	5.23E-03
Acenaphthylene	mg/kg	0.063	0.79	1.7E-03	0.034	0.41	9.1E-04	0.02	0.18	3.9E-04	0.058	0.55	1.2E-03	0.06	0.68	1.51E-03
Anthracene	mg/kg	0.27	3.38	5.7E-03	0.17	2.05	3.4E-03	0.05	0.44	7.4E-04	0.17	1.60	2.7E-03	0.33	3.75	6.31E-03
Benzo(a)anthracene	mg/kg	0.59	7.38	8.8E-03	0.29	3.49	4.2E-03	0.11	0.97	1.2E-03	0.35	3.30	3.9E-03	0.59	6.70	7.97E-03
Benzo(a)pyrene	mg/kg	0.57	7.13	7.4E-03	0.29	3.49	3.6E-03	0.1	0.88	9.2E-04	0.35	3.30	3.4E-03	0.52	5.91	6.12E-03
Benzo(b)fluoranthene	mg/kg	0.56	7.00	7.2E-03	0.27	3.25	3.3E-03	0.11	0.97	9.9E-04	0.35	3.30	3.4E-03	0.49	5.57	5.69E-03
Benzo(e)pyrene	mg/kg	0.43	5.38	5.6E-03	0.21	2.53	2.6E-03	0.08	0.71	7.3E-04	0.35	3.30	3.4E-03	0.37	4.20	4.35E-03
Benzo(g,h,i)perylene	mg/kg	0.38	4.75	4.3E-03	0.005	0.06	5.5E-05	0.005	0.04	4.0E-05	0.005	0.05	4.3E-05	0.32	3.64	3.32E-03
Benzo(k)fluoranthene	mg/kg	0.29	3.63	3.7E-03	0.19	2.29	2.3E-03	0.05	0.44	4.5E-04	0.43	4.06	4.1E-03	0.25	2.84	2.90E-03
Benzo(j)fluoranthene	mg/kg	0.24	3.00	3.1E-03	0.12	1.45	1.5E-03	0.06	0.53	5.4E-04	0	0.00	0.0E+00	0.32	3.64	3.71E-03
Chrysene	mg/kg	0.7	8.75	1.0E-02	0.33	3.98	4.7E-03	0.14	1.24	1.5E-03	0.41	3.87	4.6E-03	0.66	7.50	8.89E-03
Dibenz(a,h)anthracene	mg/kg	0.003	0.04	3.3E-05	0.003	0.04	3.2E-05	0.003	0.03	2.4E-05	0.003	0.03	2.5E-05	0.003	0.03	3.04E-05
Fluoranthene	mg/kg	1.37	17.13	2.4E-02	0.8	9.64	1.4E-02	0.3	2.65	3.8E-03	0.92	8.68	1.2E-02	1.67	18.98	2.68E-02
Fluorene	mg/kg	0.2	2.50	4.6E-03	0.12	1.45	2.7E-03	0.03	0.27	4.9E-04	0.11	1.04	1.9E-03	0.26	2.95	5.49E-03
Indeno(1,2,3-cd)pyrene	mg/kg	0.005	0.06	5.6E-05	0.005	0.06	5.4E-05	0.005	0.04	4.0E-05	0.005	0.05	4.2E-05	0.42	4.77	4.28E-03
Naphthalene	mg/kg	0.005	0.06	1.6E-04	0.005	0.06	1.6E-04	0.005	0.04	1.1E-04	0.005	0.05	1.2E-04	0.005	0.06	1.48E-04
Perylene	mg/kg	0.15	1.88	1.9E-03	0.025	0.30	3.1E-04	0.025	0.22	2.3E-04	0.025	0.24	2.4E-04	0.13	1.48	1.53E-03
Phenanthrene	mg/kg	1.26	15.75	2.6E-02	0.74	8.92	1.5E-02	0.22	1.95	3.3E-03	0.78	7.36	1.2E-02	1.5	17.05	2.86E-02
Pyrene	mg/kg	1.13	14.13	2.0E-02	0.57	6.87	9.9E-03	0.24	2.12	3.0E-03	0.76	7.17	1.0E-02	1.27	14.43	2.07E-02
Total PAH Concentration (not norm	alized)		8.525			4.333			1.586355			5.2291			9.794	
Sum ESBTU*			1.4E-01			7.2E-02			1.9E-02			6.7E-02			1.5E-01	
Uncertainty Factor (95 percentile)		-	4.14			4.14			4.14			4.14			4.14	
Sum ESBTU with Uncertainty Facto	or*		0.59			0.30			0.079			0.28			0.64	
								•						•		

Notes:

ESBTU - Equilibrium Partitioning Sediment Benchmark Toxic Unit for PAH based on the Final Chronic Value. COC, PAH FCV - Effect Concentration of a PAH in sediment on an organic carbon basis.

* - Summed ESBTU below 1 represents a low risk to

sensitive benthic invertebrates.
* - Summed ESBTU below 3 represents a low risk to common benthic invertebrates.

Constituent Units		18-MNMA-S10		18-MNMA-S11		Fi	-MNMA-DUP2 eld Duplicate 8-MNMA-S11		11	B-MNMA-S12		18-MNMA-S13				
Constituent	Units	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU
Total organic Carbon	g/kg		99			109			159			198			370	
Fraction Organic Carbon			0.099			0.109			0.159			0.198			0.37	
1-Methylnaphthalene	mg/kg	0.07	0.71	1.6E-03	0.025	0.23	5.1E-04	0.025	0.16	3.5E-04	0.025	0.13	2.8E-04	0.025	0.07	1.51E-04
2-Methylnaphthalene	mg/kg	0.09	0.91	2.0E-03	0.02	0.18	4.1E-04	0.02	0.13	2.8E-04	0.02	0.10	2.3E-04	0.01	0.03	6.05E-05
Acenaphthene	mg/kg	0.269	2.72	5.5E-03	0.003355	0.03	6.3E-05	0.003355	0.02	4.3E-05	0.003355	0.02	3.5E-05	0.0478	0.13	2.63E-04
Acenaphthylene	mg/kg	0.095	0.96	2.1E-03	0.049	0.45	9.9E-04	0.465	2.92	6.5E-03	0.03	0.15	3.4E-04	0.039	0.11	2.33E-04
Anthracene	mg/kg	0.49	4.95	8.3E-03	0.12	1.10	1.9E-03	0.56	3.52	5.9E-03	0.28	1.41	2.4E-03	0.16	0.43	7.28E-04
Benzo(a)anthracene	mg/kg	1.26	12.73	1.5E-02	0.28	2.57	3.1E-03	1.45	9.12	1.1E-02	0.34	1.72	2.0E-03	0.3	0.81	9.64E-04
Benzo(a)pyrene	mg/kg	1.06	10.71	1.1E-02	0.22	2.02	2.1E-03	1.42	8.93	9.3E-03	0.25	1.26	1.3E-03	0.24	0.65	6.72E-04
Benzo(b)fluoranthene	mg/kg	1	10.10	1.0E-02	0.23	2.11	2.2E-03	1.2	7.55	7.7E-03	0.26	1.31	1.3E-03	0.24	0.65	6.63E-04
Benzo(e)pyrene	mg/kg	0.74	7.47	7.7E-03	0.18	1.65	1.7E-03	0.89	5.60	5.8E-03	0.18	0.91	9.4E-04	0.19	0.51	5.31E-04
Benzo(g,h,i)perylene	mg/kg	0.64	6.46	5.9E-03	0.005	0.05	4.2E-05	0.76	4.78	4.4E-03	0.005	0.03	2.3E-05	0.005	0.01	1.23E-05
Benzo(k)fluoranthene	mg/kg	0.53	5.35	5.5E-03	0.11	1.01	1.0E-03	0.59	3.71	3.8E-03	0.19	0.96	9.8E-04	0.11	0.30	3.03E-04
Benzo(j)fluoranthene	mg/kg	0.41	4.14	4.2E-03	0.15	1.38	1.4E-03	0.6	3.77	3.8E-03	0.13	0.66	6.7E-04	0.14	0.38	3.86E-04
Chrysene	mg/kg	1.63	16.46	2.0E-02	0.33	3.03	3.6E-03	1.37	8.62	1.0E-02	0.39	1.97	2.3E-03	0.33	0.89	1.06E-03
Dibenz(a,h)anthracene	mg/kg	0.003	0.03	2.7E-05	0.003	0.03	2.5E-05	0.003	0.02	1.7E-05	0.003	0.02	1.3E-05	0.003	0.01	7.22E-06
Fluoranthene	mg/kg	2.76	27.88	3.9E-02	1.08	9.91	1.4E-02	3.93	24.72	3.5E-02	0.49	2.47	3.5E-03	0.56	1.51	2.14E-03
Fluorene	mg/kg	0.35	3.54	6.6E-03	0.04	0.37	6.8E-04	0.13	0.82	1.5E-03	0.06	0.30	5.6E-04	0.07	0.19	3.52E-04
Indeno(1,2,3-cd)pyrene	mg/kg	0.65	6.57	5.9E-03	0.005	0.05	4.1E-05	1.13	7.11	6.4E-03	0.005	0.03	2.3E-05	0.005	0.01	1.21E-05
Naphthalene	mg/kg	0.005	0.05	1.3E-04	0.005	0.05	1.2E-04	0.005	0.03	8.2E-05	0.02	0.10	2.6E-04	0.005	0.01	3.51E-05
Perylene	mg/kg	0.25	2.53	2.6E-03	0.025	0.23	2.4E-04	0.41	2.58	2.7E-03	0.025	0.13	1.3E-04	0.025	0.07	6.99E-05
Phenanthrene	mg/kg	2.41	24.34	4.1E-02	0.32	2.94	4.9E-03	1.42	8.93	1.5E-02	0.33	1.67	2.8E-03	0.42	1.14	1.90E-03
Pyrene	mg/kg	2.13	21.52	3.1E-02	0.83	7.61	1.1E-02	2.98	18.74	2.7E-02	0.41	2.07	3.0E-03	0.5	1.35	1.94E-03
Total PAH Concentration (not norm	nalized)		16.842			4.030355			19.361355			3.446355			3.4248	
Sum ESBTU*			2.3E-01			5.0E-02			1.6E-01			2.3E-02			1.2E-02	
Uncertainty Factor (95 percentile)			4.14			4.14			4.14		4.14		4.14			
Sum ESBTU with Uncertainty Factor	or*		0.93			0.21			0.65			0.096			0.052	

Notes:

ESBTU - Equilibrium Partitioning Sediment Benchmark Toxic Unit for PAH based on the Final Chronic Value. COC, PAH FCV - Effect Concentration of a PAH in sediment on an organic carbon basis.

^{* -} Summed ESBTU below 1 represents a low risk to

sensitive benthic invertebrates.

* - Summed ESBTU below 3 represents a low risk to common benthic invertebrates.

		1	8-MNMA-S14		1	8-MNMA-S15		18-	MNMA-REF1		18-	-MNMA-REF2		18	-MNMA-REF3		coc,
Constituent	Units	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	Concentration	Concentration Normalized for TOC	ESBTU	PAH FCV
Total organic Carbon	g/kg		75			101			34			51			29		
Fraction Organic Carbon			0.075			0.101			0.034			0.051			0.029		
1-Methylnaphthalene	mg/kg	0.11	1.47	3.3E-03	80.0	0.79	1.8E-03	0.025	0.74	0.002	0.025	0.49	0.001	0.025	0.86	0.002	446
2-Methylnaphthalene	mg/kg	0.13	1.73	3.9E-03	0.09	0.89	2.0E-03	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	447
Acenaphthene	mg/kg	0.48	6.40	1.3E-02	0.209	2.07	4.2E-03	0.003355	0.10	0.000	0.003355	0.07	0.000	0.003355	0.12	0.000	491
Acenaphthylene	mg/kg	0.084	1.12	2.5E-03	0.081	0.80	1.8E-03	0.002	0.06	0.000	0.002	0.04	0.000	0.002	0.07	0.000	452
Anthracene	mg/kg	0.72	9.60	1.6E-02	0.44	4.36	7.3E-03	0.015	0.44	0.001	0.015	0.29	0.000	0.015	0.52	0.001	594
Benzo(a)anthracene	mg/kg	1.08	14.40	1.7E-02	0.72	7.13	8.5E-03	0.03	0.88	0.001	0.02	0.39	0.000	0.005	0.17	0.000	841
Benzo(a)pyrene	mg/kg	1.04	13.87	1.4E-02	0.66	6.53	6.8E-03	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	965
Benzo(b)fluoranthene	mg/kg	1	13.33	1.4E-02	0.66	6.53	6.7E-03	0.025	0.74	0.001	0.025	0.49	0.001	0.025	0.86	0.001	979
Benzo(e)pyrene	mg/kg	0.74	9.87	1.0E-02	0.49	4.85	5.0E-03	0.025	0.74	0.001	0.025	0.49	0.001	0.025	0.86	0.001	967
Benzo(g,h,i)perylene	mg/kg	0.68	9.07	8.3E-03	0.4	3.96	3.6E-03	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	1095
Benzo(k)fluoranthene	mg/kg	0.38	5.07	5.2E-03	0.35	3.47	3.5E-03	0.02	0.59	0.001	0.005	0.10	0.000	0.005	0.17	0.000	981
Benzo(j)fluoranthene	mg/kg	0.39	5.20	5.3E-03	0.28	2.77	2.8E-03	0.05	1.47	0.001	0.05	0.98	0.001	0.05	1.72	0.002	981
Chrysene	mg/kg	1.19	15.87	1.9E-02	0.83	8.22	9.7E-03	0.03	0.88	0.001	0.03	0.59	0.001	0.005	0.17	0.000	844
Dibenz(a,h)anthracene	mg/kg	0.003	0.04	3.6E-05	0.003	0.03	2.6E-05	0.003	0.09	0.000	0.003	0.06	0.000	0.003	0.10	0.000	1123
Fluoranthene	mg/kg	2.91	38.80	5.5E-02	1.84	18.22	2.6E-02	0.07	2.06	0.003	0.07	1.37	0.002	0.025	0.86	0.001	707
Fluorene	mg/kg	0.52	6.93	1.3E-02	0.26	2.57	4.8E-03	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	538
Indeno(1,2,3-cd)pyrene	mg/kg	0.87	11.60	1.0E-02	0.53	5.25	4.7E-03	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	1115
Naphthalene	mg/kg	0.32	4.27	1.1E-02	0.005	0.05	1.3E-04	0.005	0.15	0.000	0.005	0.10	0.000	0.005	0.17	0.000	385
Perylene	mg/kg	0.29	3.87	4.0E-03	0.18	1.78	1.8E-03	0.025	0.74	0.001	0.025	0.49	0.001	0.025	0.86	0.001	967
Phenanthrene	mg/kg	2.82	37.60	6.3E-02	1.51	14.95	2.5E-02	0.06	1.76	0.003	0.04	0.78	0.001	0.015	0.52	0.001	596
Pyrene	mg/kg	2.27	30.27	4.3E-02	1.54	15.25	2.2E-02	0.05	1.47	0.002	0.06	1.18	0.002	0.025	0.86	0.001	697
Total PAH Concentration (not norn	nalized)		18.027			11.158			0.463355			0.428355			0.283355]
Sum ESBTU*	3.3E-01 1.5E-01		0.019		0.012			0.013									
Uncertainty Factor (95 percentile)	Incertainty Factor (95 percentile) 4.14		4.14 4.14			4.14			4.14]					
Sum ESBTU with Uncertainty Fact	Sum ESBTU with Uncertainty Factor* 1.4 0.61				0.077			0.048			0.055						
Notes:	•	•	•						•					•	•		_

ESBTU - Equilibrium Partitioning Sediment Benchmark Toxic Unit for PAH based on the Final Chronic Value. COC, PAH FCV - Effect Concentration of a PAH in

sediment on an organic carbon basis.

- * Summed ESBTU below 1 represents a low risk to sensitive benthic invertebrates.
- * Summed ESBTU below 3 represents a low risk to common benthic invertebrates.

Table F-2 Benthic Invertebrate Results Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

		Benthic Invertebrate Grab Samples											
Sample/Site ID	18-MNMA-BMI-REF2	18-MNMA-BMI-REF2											
Year Sampled	2018	2018	2018	2018	2018	2018	2018	2018					
Location													
Abundance (#/sample) NEMATODA	243	243	7	91	97	28	124	2					
Oncholaimellus brevicauda	223	15	0	0	0	0	0	0					
POLYCHAETA													
Arabella iricolor	0	3	0	4	6	3	32	0					
Arcteobia anticostiensis	0	0	0	0	0	1	0	0					
Asabellides oculata	0	4	1	8	28	3	0	0					
Brada villosa	0	0	0	2	0	0	0	0					
Capitella capitata	0	0	0	1	0	0	0	0					
Chaetozone setosa	0	3	0	0	0	0	1	0					
Chone infundibuliformis	0	0	0	0	1	0	0	0					
Cistena granulata	0	0	0	0	7	0	0	0					
Eteone flava	0	2	0	5	4	3	1	0					
Eteone longa	0	2	0	3	3	0	1	0					
Eteone trilineata	0	0	0	0	2	0	0	0					
Euchone rubrocincta	0	6	0	0	0	0	0	0					
Glycera capitata	3	31	0	1	0	0	0	0					
Goniada norvegica	0	0	0	0	0	0	0	2					
Harmothoe extenuata	0	4	0	1	0	0	1	0					
Harmothoe imbricata	0	0	0	0	0	0	6	0					
Harmothoe nodosa	0	0	0	0	0	1	0	0					
Harmothoe oerstedi	0	0	0	0	1	0	0	0					
Laonice cirrata	0	20	0	0	0	0	0	0					
Lepidonotus squamatus	0	5	0	0	2	0	2	0					
Nephtys incisa	0	0	0	1	0	0	0	0					
Nephtys picta	0	8	2	2	1	1	0	0					
Nereis diversicolor	0	3	0	0	0	0	0	0					
Ophelia acuminata	0	0	0	0	0	0	1	0					
Ophelina acuminata	0	1	0	0	2	0	0	0					
Ophioglycera gigantia	0	3	0	0	0	0	0	0					
Pherusa plumosa	0	4	0	3	4	1	0	0					
Phyllodoce groenlandica	0	3	0	4	4	2	0	0					
Praxillella gracilis	0	6	1	9	2	0	2	0					
Samytha sexcirrata	0	2	0	8	5	0	5	0					
Scolecolepides viridis	1	65	0	35	6	8	53	0					
AMPHIPODA													
Aeginina longicornis	0	0	0	0	1	0	0	0					
Calliopius laeviusculus	0	1	0	0	0	0	2	0					
Orchomenella groenlandica	4	0	0	0	3	0	0	0					
Photis reinhardi	0	6	0	0	0	0	0	0					
Phoxocephalus holbolli	0	4	0	1	1	0	10	0					

Table F-2 Benthic Invertebrate Results Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Benthic Invertebrate Grab Samples									
Sample/Site ID	18-MNMA-BMI-REF2	18MNMA-BMI 1	18-MNMA-BMI3	18-MNMA-BMI5	18-MNMA-BMI 6	18-MNMA-BMI 11	18-MNMA-BMI 12	18-MNMA-BMI 14		
Year Sampled	2018	2018	2018	2018	2018	2018	2018	2018		
Location	0.40	0.40		24	27	20	404			
Abundance (#/sample) GASTROPODA	243	243	7	91	97	28	124	2		
Buccinum undatum	1	1	0							
BIVALVIA		·	,							
Cerastoderma pinnulatum	0	4	0	0	0	0	0	0		
Crenella faba	0	0	0	0	0	0	4	0		
Ensis directus	0	1	0	0	0	0	0	0		
Nucula expansa	0	1	0	0	0	0	0	0		
Yoldia myalis	10	21	1	3	3	1	1	0		
Yoldia sapotilla	0	6	0	0	0	0	0	0		
OPHIUROIDEA										
Amphiopholis squamata	0	0	0	0	0	1	0	0		
Ophiopholis aculeata	0	0	0	0	5	1	0	0		
Ophiura sarsi	1	0	0	0	0	0	0	0		
ANTHOZOA										
Edwardsia elegans	0	5	0	0	0	0	0	0		
Tealia felina	0	0	0	0	1	1	0	0		
HARPACTICOIDEA	0	2	0	0	0	0	0	0		
AMPHINEURA										
Ischochiton ruber	0	0	0	0	0	0	1	0		
Tonicella marmorea	0	1	0	0	0	0	0	0		
HOLOTHUROIDEA										
Molpadia oolitica	0	0	2	0	0	0	0	0		
NEMERTEA										
Amphiporus groenlandicus	0	0	0	0	3	1	1	0		
ASTEROIDEA										
Astarias forbesii	0	0	0	0	2	0	0	0		
SUMMARY										
Abundance (#/sample)	243	243	7	91	97	28	124	2		
Taxon Richness (#/sample)	7	32	5	17	24	14	17	1		
Shannon Wiener Diversity (In)	0.40	2.75	1.55	2.21	1.60	2.34	1.54	NA		
Dominant Species	Oncholaimellus brevicauda	Scolecolepides viridis	Nephtys picta & Molpadia oolitica	Scolecolepides viridis	Asabellides oculata	Scolecolepides viridis	Scolecolepides viridis	Goniada norvegica		
% Dominant Taxa	91.8	26.7	28.6	38.5	28.9	28.6	42.7	100.0		
Total Number of Dominant Taxa	223	65	2	35	28	8	53	2		

Table F-3 Exposure Point Concentrations Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

Parameter	Percent Composition	Measured Sediment Conc. (1)	Surface Water Conc. (2)	Predicted Marine Plant Tissue Conc.	Measured Marine Invertebrate Tissue Conc.	Predicted Marine Fish Tissue Conc.
		(mg/kg dw)	(mg/L)	(mg/kg ww)	(mg/kg ww)	(mg/kg ww)
Polycyclic Aromatic Hydrod	carbons					
LMW PAHs	-	5.9	0.0	0.090	0.10	0
HMW PAHs	-	7.5	0.0	0.18	0.03	0
Polychlorinated Biphenyls						
Total PCBs		0.32	0.00	0.00043	0.50	0.50
Inorganics						
Arsenic		40	0.00	0.16	3.3	3.3
Cadmium		0.56	0.00	0.068	8.60	8.60
Copper	-	168	0.011	2.3	10.3	10.3
Lead	-	362	0.00	1.1	0.7	0.7
Mercury (total)	-	0.16	0.00	0.020	0.050	0.050
Mercury (inorganic)	-	0.16 (a)	0.00	0.020	0.025	0.009
Mercury (methyl)	-	0 (a)	0.00	0	0.025	0.04
Selenium		1.6	0.002	0.13	0.50	0.50
Zinc	-	1,681	0.00	44.7	57.6	57.6

⁽a) The proportion of methylmercury of total mercury in sediment is negligible (0.77%) (Kannan et al. 1998). Therefore, total mercury in sediment is assumed to be entirely made up of inorganic mercury.

⁽¹⁾ Sediment concentrations are based on the 95 percent upper confidence limit (UCL) of the mean, as calculated in USEPA's ProUCL Version 5.1 software. See ProUCL output sheets.

⁽²⁾ COPCs not detected in surface water were applied a concentration of "0".

For all other parameters, the maximum detected concentrations were applied as there were insufficient sample numbers to calculate a 95 percent UCL

⁽³⁾ Invertebrate concentrations based on 95%UCL values measured in Site tissue. Maximums were applied if a 95%UCL could not be calculated. 1/2 method detection limits used for parameters with no detectable concentrations (PCBs, mercury)

Table F-3 Exposure Point Concentrations Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

Predicted Marine Plant Concentrations

Inorganics

In(plant tissue)= intercept + slope(In[C_{sed}]) (Efroymson et al., 2001) x dry weight to wet weight conversion (0.15)

Where

C_{sed} = measured sediment concentration (mg/kg dw)

	<u>Intercept</u>	<u>Slope</u>	
Arsenic	-1.992	0.564	Efroymson et al., 2001
Cadmium	-0.476	0.546	Efroymson et al., 2001
Copper	0.699	0.394	Efroymson et al., 2001
Lead	-1.328	0.561	Efroymson et al., 2001
Mercury (total)	-0.996	0.544	Efroymson et al., 2001
Selenium	-0.678	1.104	Efroymson et al., 2001
Zinc	1.575	0.555	Efroymson et al., 2001

Mercury (inorganic) calculated Difference between total mercury and methylmercury Mercury (methyl) 0 Assumed

 $C_{plant tissue} = C_{sed} \times UF_{SP} \times dry$ weight to wet weight conversion (0.15)

Where:

UF_{SP} = uptake factor

Barium	0.156	USEPA, 2007
Cobalt	0.0075	USEPA, 2007
Tin	0.03	Baes et al., 1984

Organics (Polycyclic Aromatic Hydrocarbons)

LMW PAHs In(plant tissue) = 0.4544 x In[Csed] - 1.3205 (USEPA, 2007) x dry weight to wet weight conversion (0.15)

HMW PAHs In(plant tissue) = 0.9469 x In[Csed] - 1.7026 (USEPA, 2007) x dry weight to wet weight conversion (0.15)

Organics (PCBs)

 $C_{plant tissue} = C_{soil} x UF_{SP} x dry weight to wet weight conversion (0.15)$

Where

 $UF_{SP} = 10^{1.588 - 0.578 \times logKow}$ (USEPA, 2007; Travis and Arms, 1988)

Where:

	logKoc (CCME, 2008)	Koc	Kow = Koc / 0.41	logKow (CCME, 2008; OMOE, 2011)	UF_{SP}
Total PCBs	-	-	_	6.29	0.009

Table F-3 Exposure Point Concentrations Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

Predicted Marine Fish Concentration

Inorganics

 $\overline{C_{fish}}$ = Measured invertebrate concentration

Methylmercury is assumed to be 83% of the total mercury within fish tissue (Kannan et al., 1998); therefore, the fish tissue methylmercury concentration was calculated by multiplying the total mercury concentration by 0.83.

Table F-4
Input Parameters and Exposure Factors for Modeled Species
Supplemental Phase II ESA and HHERA
Marystown Shipyard
Marystown, NL

		Avian Receptors	Avian Receptors
Parameters	Units	Lesser Scaup	Common Loon
		Insectivore	Piscivore
Body Mass	kg	0.707	5.3
Ingestion - Food	kg/day (Wet)	0.19	1
Ingestion - Water	L/day	0.049	0.159
Ingestion - Soil/Sediment	kg/day (Dry)	0.00099	0.0055
Diet			
Marine Plants	%/100	0.1	0
Marine Invertebrates	%/100	0.9	0.1
Marine Fish	%/100	0	0.9
Foraging Range	ha	10	4.4

		Mammalian Receptors
Parameters	Units	River Otter
		Piscivore/Insectivore
Body Mass	kg	7.5
Ingestion - Food	kg/day (Wet)	0.86
Ingestion - Water	L/day	0.6
Ingestion - Soil/Sediment	kg/day (Dry)	0.0045
Diet		
Marine Plants	%/100	0
Marine Invertebrates	%/100	0.2
Marine Fish	%/100	0.8
Foraging Range	ha	900

Notes:

All receptor exposure factors and input parameters were obtained from FCSAP (2012; Module 3). Ingestion rates assumes marine invertebrates are 77% water (average for marine invertebrates), and fish are 72% water (average for bony fishes and herring), as indicated in Sample et al., 1994.

Table F-5 Bird and Mammal TRVs Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	Avian ¹	Wildlife	Man	nmalian Wildlife
COPC	LOAEL (mg/kg-day)	Source	LOAEL (mg/kg-day)	Source
Polycyclic Aromatic Hydrocarbons (PAHs)				
LMW PAHs	NA	-	367	EcoSSL
HMW PAHs	20	EcoSSL ^a	32	EcoSSL
Polychlorinated Biphenyls (PCBs)				
Total PCBs	1.8	Sample et al., 1996	0.68	Sample et al., 1996
Metals				
Arsenic	4.5	EcoSSL	5.7	EcoSSL
Cadmium	7.8	EcoSSL	7.1	EcoSSL
Cobalt	18	EcoSSL	19	EcoSSL
Copper	37	EcoSSL	74	EcoSSL
Lead	52	EcoSSL	170	EcoSSL
Mercury	0.9	Sample et al., 1996	10	Sample et al., 1996 ^a
Methylmercury	0.064	Sample et al., 1996	0.16	Sample et al., 1996
Selenium	1.2	EcoSSL	0.8	EcoSSL
Zinc	190	EcoSSL	290	EcoSSL

Notes:

COPC - contaminant of potential concern

LOAEL - Lowest Observed Adverse Effect Level

NOAEL - No Observed Adverse Effect Level

LMW - Low Molecular Weight

HMW - High Molecular Weight

NA - Not Available

Sources:

CCME, 2008: Canadian Council of Ministers of the Environment (CCME). 2008. Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale. Supporting Technical Document. PN 1399.

EcoSSL: United States Environmental Protection Agency Guidance for Developing Ecological Soil Screening Levels Ecological Soil

Screening Levels (EcoSSLs), OSWER Directive 9285.7-55.

Geometric mean of NOAELs and LOAELs for survival, growth, and reproduction identified in the chemical-specific Eco-SSL source documents were applied

Sample et al., 1996: Sample, B. E., Opresko, D. M., & Suter II, G. W. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Risk Assessment Program, Health Sciences Research Division. Tennessee: Oak Ridge.

^a - NOAEL not available; the NOAEL is set to the LOAEL/10, consistent with the approach in Sample et al., 1996

^a - Trust et al. (1994) as cited in Eco-SSL source document for PAHs

^a - LOAEL not available; the LOAEL is set to the NOAEL x 10, consistent with the approach in Sample et al., 1996.

Table F-6

Detailed Ecological Hazard Quotients for the River Otter Exposed to Constituents of Concern Supplemental Phase II ESA and HHERA Marystown Shipyard Marystown, NL

	ADD - Sediment Ingestion (mg/kg-day)	ADD - Water Ingestion (mg/kg-day)	ADD - Marine Plant Ingestion (mg/kg-day)	ADD - Marine Benthic Invertebrate Ingestion (mg/kg-day)	ADD - Marine Fish Ingestion (mg/kg-day)	ADD _{Total} (mg/kg-day)	TRV (mg/kg-day)	EHQ (unitless)
Inorganics								
Arsenic	0.024	0	0	0.076	0.30	0.40	5.7	0.071
Cadmium	0.00034	0	0	0.1972	0.7889	0.99	7.1	0.13894
Copper	0.10	0.0009	0	0.24	0.94	1.28	74	0.017
Lead	0.22	0	0	0.016	0.06	0.30	170	0.0017
Mercury (Total) (1)		0				0.00		0.03
Mercury (Inorganic)	0.00010	0	0	0.00057	0.0008	0.00	10	0.00014
Mercury (Methyl)	0	0	0	0.00057	0.004	0.00	0.16	0.03
Selenium	0.00097	0.0002	0	0.0115	0.046	0.06	0.80	0.073
Zinc	1.0	0	0	1.3	5.3	7.61	290	0.026
Polycyclic Aromatic Hydrocarbons								
LMW PAHs	0.0036	0	0	0.0023	0	0.006	367	0.000016
HMW PAHs	0.0045	0	0	0.0007	0	0.005	32	0.00016
Polychlorinated Biphenyls								
Total PCBs	0.00019	0	0	0.0115	0.046	0.058	0.68	0.085

Bold Font identifies EHQ > 1

TRV, toxicity reference value

ADD, average daily dose

LMW PAHs, low molecular weight PAHs

HMW PAH, high molecular weight PAHs

(1) The HQ for total mercury is the sum of the HQs for inorganic mercury and methylmercury.

Table F-7 Detailed Ecological Hazard Quotients for the Lesser Scaup Exposed to Constituents of Concern Supplemental Phase II ESA and HHERA Marystown Shipyard

Marystown, NL

	ADD - Sediment Ingestion (mg/kg-day)	ADD - Water Ingestion (mg/kg-day)	ADD - Marine Plant Ingestion (mg/kg-day)	ADD - Marine Benthic Invertebrate Ingestion (mg/kg-day)	ADD - Marine Fish Ingestion (mg/kg-day)	ADD _{Total} (mg/kg-day)	TRV (mg/kg-day)	EHQ (unitless)
Inorganics								
Arsenic	0.057	0	0.0045	0.81	0	0.87	4.5	0.19
Cadmium	0.00078	0	0.0019	2.120	0	2.12	7.8	0.2721
Copper	0.24	0.001	0.062	2.5	0	2.84	37	0.077
Lead	0.51	0	0.030	0.2	0	0.71	52	0.014
Mercury (Total) (1)		0				0.00		0.104
Mercury (Inorganic)	0.00022	0	0.00056	0.0062	0	0.01	0.9	0.0077
Mercury (Methyl)	0	0	0	0.0062	0	0.01	0.064	0.096
Selenium	0.0023	0.0001	0.0035	0.123	0	0.13	1.2	0.108
Zinc	2.4	0	1.2	14	0	17.78	190	0.09
Polycyclic Aromatic Hydrocarbons								
LMW PAHs	0.0083	0	0.0025	0.025	0	0.04	-	=
HMW PAHs	0.010	0	0.0050	0.01	0	0.02	20	0.0011
Polychlorinated Biphenyls								
Total PCBs	0.00045	0	0.000012	0.123	0	0.12	1.8	0.0687

Bold Font identifies EHQ > 1

TRV, toxicity reference value

ADD, average daily dose

LMW PAHs, low molecular weight PAHs

HMW PAH, high molecular weight PAHs

(1) The HQ for total mercury is the sum of the HQs for inorganic mercury and methylmercury.

Table F-8 Detailed Ecological Hazard Quotients for the Common Loon Exposed to Constituents of Concern Supplemental Phase II ESA and HHERA

Marystown Shipyard Marystown, NL

	ADD - Sediment Ingestion (mg/kg-day)	ADD - Water Ingestion (mg/kg-day)	ADD - Marine Plant Ingestion (mg/kg-day)	ADD - Marine Benthic Invertebrate Ingestion (mg/kg-day)	ADD - Marine Fish Ingestion (mg/kg-day)	ADD _{Total} (mg/kg-day)	TRV (mg/kg-day)	EHQ (unitless)
Inorganics								
Arsenic	0.042	0	0	0.063	0.56	0.67	4.5	0.149
Cadmium	0.00058	0	0	0.1634	1.4706	1.63	7.8	0.2096
Copper	0.18	0.00033	0	0.20	1.76	2.13	37	0.058
Lead	0.38	0	0	0.01	0.1	0.51	52	0.010
Mercury (Total) (1)								0.12
Mercury (Inorganic)	0.00017	0	0	0.00048	0.0015	0.00	0.9	0.0023
Mercury (Methyl)	0	0	0	0.00048	0.007	0.01	0.064	0.12
Selenium	0.0017	0.00006	0	0.0095	0.086	0.10	1.2	0.081
Zinc	1.8	0	0	1.1	10	12.70	190	0.067
Polycyclic Aromatic Hydrocarbons								
LMW PAHs	0.0062	0	0	0.0019	0	0.01	-	-
HMW PAHs	0.0078	0	0	0.0006	0	0.01	20	0.00042
Polychlorinated Biphenyls								
Total PCBs	0.00033	0	0	0.0095	0.086	0.10	1.8	0.053
						•		

Bold Font identifies EHQ > 1

TRV, toxicity reference value

ADD, average daily dose

LMW PAHs, low molecular weight PAHs

HMW PAH, high molecular weight PAHs

(1) The HQ for total mercury is the sum of the HQs for inorganic mercury and methylmercury.

Appendix G
Potential Species at Risk Supporting
Information

 From:
 Durocher, Adam

 To:
 Leslie Williams

 Cc:
 DataNL

Subject: RE: ACCDC Search Request - Marystown Shipyard, Marystown, NL ~MSC-11178792-02~

Date: Tuesday, November 13, 2018 11:55:42 AM

Attachments: Map.ipg

RareFauna.xls RareFlora.xls RQ0702.pdf Caveats.doc

DATA DICTIONARY.doc

herbaria.xls RANKING.rtf

Hi Leslie.

Attached are the data request results for the Marystown Shipyard Property in Marystown, Newfoundland and Labrador.

Summary: Within your study area, there were 2 rare animal records and 1 rare plant record found. These 2 rare animal records were 2 Harlequin Duck observations, a species which is *Vulnerable* under our provincial Endangered Species Act (ESA) and *Special Concern* under COSEWIC. As for the rare plant record, this record is for Seaside Goldenrod (*Solidago sempervirens subsp. sempervirens*), a plant which is not provincially or nationally listed, but is considered rare on the Island of Newfoundland.

Secondly, a new addition to our standard data requests is the use of Expert Opinion Maps. These maps are the result of our work with species-specific experts to gather suggestions about locations where species at risk - either provincially or COSEWIC listed - may be found. While we don't have observations in our database for these species within your study area, our Expert Opinion Maps suggest that Banded Killifish, Short-eared Owls and Boreal Felt Lichen are *possible*. Your area is also said to be within the Barrow's Goldeneye's *range*.

For more information, including a map of the area showing the locations of the rare fauna, rare flora and the area of interest, please refer to the following attached documents:

Map.jpg - shows the locations of the rare fauna, rare flora and the 5 km buffer around the area of interest. RareFauna.xls - a list of rare animal records, including their SRANK, NRANK, GRANK and habitats. RareFlora.xls - a list of rare plant records, including their SRANK, NRANK, GRANK and habitats.

Data Dictionary.doc - explains the various columns in RareFauna.xls and RareFlora.xls.

Ranking.rtf - explains the S, N and GRANKS.

Herbaria.xls - A list of herbariums in case you would like to follow up on the specimens included in this request.

Caveats.doc - The fine print - please read. This is also included at the end of this email.

RQ0702.pdf – Invoice for the data request.

Please do not hesitate to contact me if you have any questions.

Adam Durocher

Data Manager Atlantic Canada Conservation Data Centre Corner Brook, NL 709-637-2494

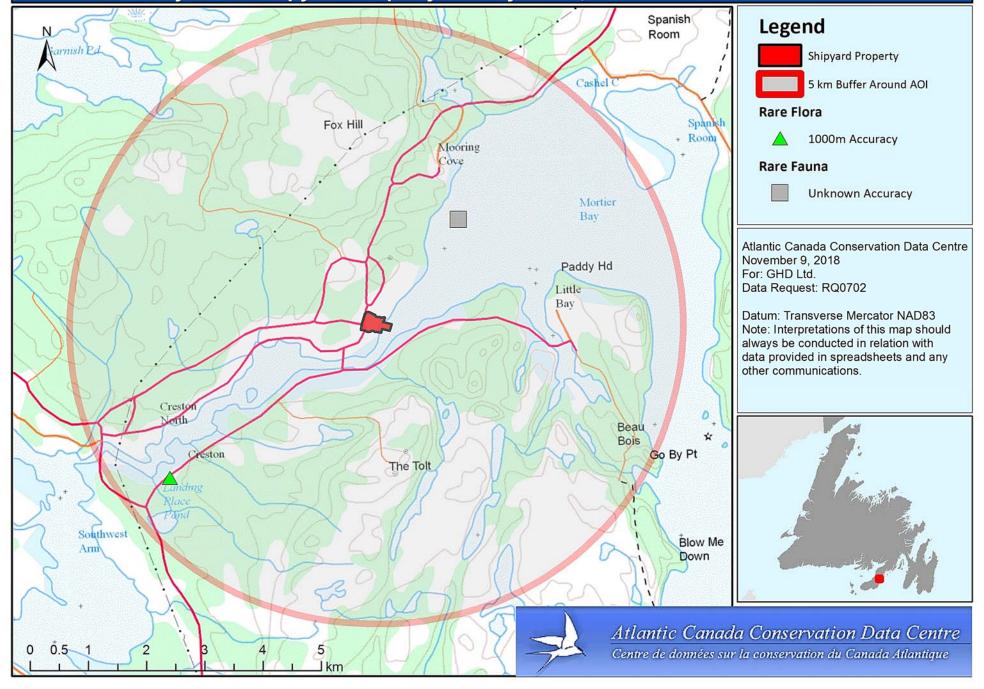
DATA SOURCES:

All data housed at Atlantic Canada Conservation Data Centre (ACCDC). Refer to the 'CITATION' field for data sources.

CAVEATS:

ACCDC rare taxa occurrence records are offered as a guide recognizing that the ability to find plants and animals will

GIS Scan of Rare and Provincially/Federally Listed Species for Marystown Shipyard Property in Marystown, Newfoundland and Labrador



Appendix H Divers Report

Marystown Sampling December 2018

DETAILS

SITE LOCATION - MARYSTOWN

Report Writer: Brandon Sparkes

Date: Dec 11-14 2018



CONTENTS

Scope of work	2
Preliminary Information	2
Water conditions	2
Dive Crew	2
Sample Locations Plans	3



SCOPE OF WORK

The scope of work included the completion of a dive survey and collection of marine sediment and biological tissue samples. The dive survey included the documentation of bottom substrate conditions and aquatic habitat, and obtaining photographic evidence and video footage of the benthic communities at each sampling location.

PRELIMINARY INFORMATION

WATER CONDITIONS

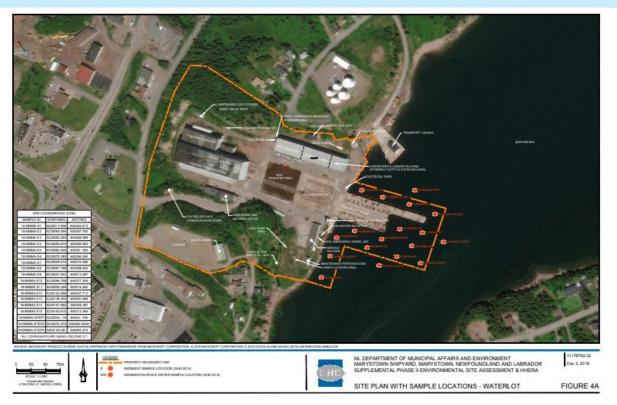
Wave Height(M) - 0 Depth – Max depth 35 Temperature – 2 Celsius Visibility – 5-10 Meters Tide – 0-3 Knots

DIVE CREW

Supervisor – Brandon Sparkes Crew – Nick Wadded Crew – Riley Allen Crew – Cole Saldat



SAMPLE LOCATIONS PLANS





Station ID	GPS Coordinates (Northing / Easting) ^{1,2}	Water Dept h (m)	Harbour Bottom/ Substrate ³	Macro faunal Life Observed	Macro floral Life Observed	Fish/Shellfish Specimens Collected (# and type)
18-MNMA-S1	LAT 47° 9' 49.22" LONG 55° 8' 58.71"	14	Black Mud	Periwinkles, Rock Crab, Scallops	Eel Grass, Tubed weed, Kelp	3 Scallop 2 Crab
18-MNMA-S2	LAT 47° 9' 50.39" LONG 55° 8' 57.95"	14	Black Mud	Periwinkles, Rock Crab, Scallops	Eel Grass, Tubed weed, Kelp	3 Scallop 2 Crab
18-MNMA-S3	LAT 47° 9' 51.42" LONG 55° 8' 57.38"	25	Black Mud	Periwinkles, Scallops	Eel Grass, Tubed weed, Kelp	5 Scallop 2 Periwinkles
18-MNMA-S4	LAT 47° 9' 51.77" LONG 55° 8' 55.9"	31	Black Mud	Periwinkles, Rock Crab, Scallops	Eel Grass, Tubed weed, Kelp	2 Crab 2 Scallop
18-MNMA-S5	LAT 47° 9' 50.82" LONG 55° 8' 54.92"	23	Black Mud	Periwinkles, Rock Crab, Scallops	Eel Grass, Tubed weed, Kelp	6 Scallop 1 Crab
18-MNMA-S6	LAT 47° 9' 51.27" LONG 55° 8' 53.71"	32	Black Mud	Periwinkles, Rock Crab, Scallops	Eel Grass, Tubed weed, Kelp	2 Scallop 1 Crab
18-MNMA-S7	LAT 47° 9' 50.29" LONG 55° 8' 52.52"	30	Black Mud	Periwinkles, Rock Crab, Scallops	Kelp	2 Scallop 2 Crab
18-MNMA-S8	LAT 47° 9' 50.86" LONG 55° 8' 51.26"	30	Sand/Gravel	Periwinkles, Rock Crab, Mussels	Knotted Wrack, Tubed weed	2 Crab 4 Mussel
18-MNMA-S9	LAT 47° 9' 49.88" LONG 55° 8' 50.59"	28	Sand/Gravel	Periwinkles, Mussels, Rock Crab	Kelp, Knotted Wrack	1 Mussel 1 Crab
18-MNMA-S10	47° 9' 51.81" LONG 55° 8' 52.22"	36	Black Mud	Scallops, Rock Crab	Kelp, Sea Colander	9 Scallop 1 Crab
18-MNMA-S11	LAT 47° 9' 51.57" LONG 55° 8' 50.38"	22	Black Mud	Mussels, Scallop	Kelp, Sea Colander	5 Scallop
18-MNMA-S12	LAT 47° 9' 52.6" LONG 55° 8' 49.32"	32	Black Mud	Mussels, Scallop, Rock	Kelp, Sea Colander	5 Scallop 1 Crab



				Crab		
18-MNMA-S13	LAT 47° 9' 53.17" LONG 55° 8' 51.4"	33	Black Mud	Scallop, Rock Crab	Kelp, Edible Kelp, Tubed Weed	1 Crab 2 Scallop
18-MNMA-S14	LAT 47° 9' 53.61" LONG 55° 8' 53.53"	32	Black Mud	Scallop, Rock Crab,	Rockweed, Kelp	5 Scallop 1 Crab
18-MNMA-S15	LAT 47° 9' 54.03" LONG 55° 8' 55.23"	32	Black Mud	Rock Crab, Periwinkle, Scallop	Eel Grass, Brown Seaweed, Tube Weed	4 Scallop 1 Crab
18-MNMA- REF1	LAT 47° 10' 06.8" LONG 55° 07' 40.1"	25	Grey Sand / Gravel	Periwinkle, Scallops, Common Sea Star, Rock Crab	Brown Seaweed, Eel Grass, Knotted Wrack, Tubed Weed	3 Scallop 1 Crab
18-MNMA- REF2	LAT 47° 10' 06.5" LONG 55° 07' 46.6"	10	Grey Sand/ Gravel	Periwinkles, Scallop	Eel Grass, Kelp, Tubed weed	2 Scallop
18-MNMA- REF3	LAT 47° 10' 21.9" LONG 55° 08' 10.4"	30	Grey Sand	Scallop, Mussels	Tubed Weed, Kelp	2 Scallop 4 Mussel
18-MNMA- STEP1	LAT47°49.81"N LONG 55° 8'54.01"W	25	Grey Sand/ Gravel	Scallop, mussels, periwinkles	Tubed Weed, Kelp, Rock Weed	None Collected
18-MNMA- STEP2	LAT 47° 9'51.02"N LONG 55° 8'48.70"W	25	Black Mud/ Sand	Mussels, Scallop, Periwinkles, Common Sea Star	Rock Weed, Kelp	None Collected
18-MNMA- STEP3	LAT 47° 9'53.94"N LONG 55° 8'50.93"W	35	Black Mud/ Sand	Scallops, Periwinkles, Mussels, Hermit crab	Rock Weed, Kelp	None Collected